WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Rosedale Flood Study – Assess & Treat Risk (R03)

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WELLINGTON SHIRE COUNCIL
The Heart of Gippsland

West Gippsland Catchment Management Authority

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1. INTRODUCTION

Water Technology was commissioned by the West Gippsland CMA to undertake the Rosedale Flood Study. This study included detailed hydrological and hydraulic modelling of Blind Joes Creek, taking into account the adjacent catchments (east of Blind Joes Creek) and stormwater runoff within the Rosedale Township itself. The project produced flood mapping of the Rosedale Township and provided recommendations for flood mitigation works, land use planning and flood warning, and generated flood intelligence for emergency response purposes

This report details the existing flood risk within the Rosedale area and a number of potential options to treat and reduce the flood risk. The Wellington Shire Municipal Flood Emergency Plan (MFEP) was also updated at the same time as this report was written. Much of the information in this report is also contained within the MFEP. This report is one of a series of reports documenting the outcomes of the Rosedale Flood Study.

- R01 - Data Review Report (Water Technology 2016a)
- R02 - Hydrology and Hydraulics Report (Water Technology 2016b)
- **R03 - Assess and Treat Risk Report (Water Technology 2016c) – this report**
- R04 - Summary Report (Water Technology 2016d)

2. STUDY AREA

Rosedale is a small regional town within the Wellington Shire Council district. It has 1077 permanent residents (ABS, 2006). The township lies between the regional cities of Sale and Traralgon and is 184 km east of Melbourne. With limited employment in the town itself, most residents commute to Sale or Traralgon for work. In recent times, Rosedale has seen an increase in demand for residential land and this has led to investigations into developing land currently zoned as flood prone at the western edge of the township.

The town is located at the downstream end of the Blind Joes Creek catchment, with the creek flowing along the western and northern boundary of the township, before discharging into the Latrobe River east of the main town. In times of significant flooding, the Latrobe River can engage all of the floodplain north of the town, including backing up into the end of the Blind Joes Creek system. The study area and significant watercourses are shown in Figure 2-1.

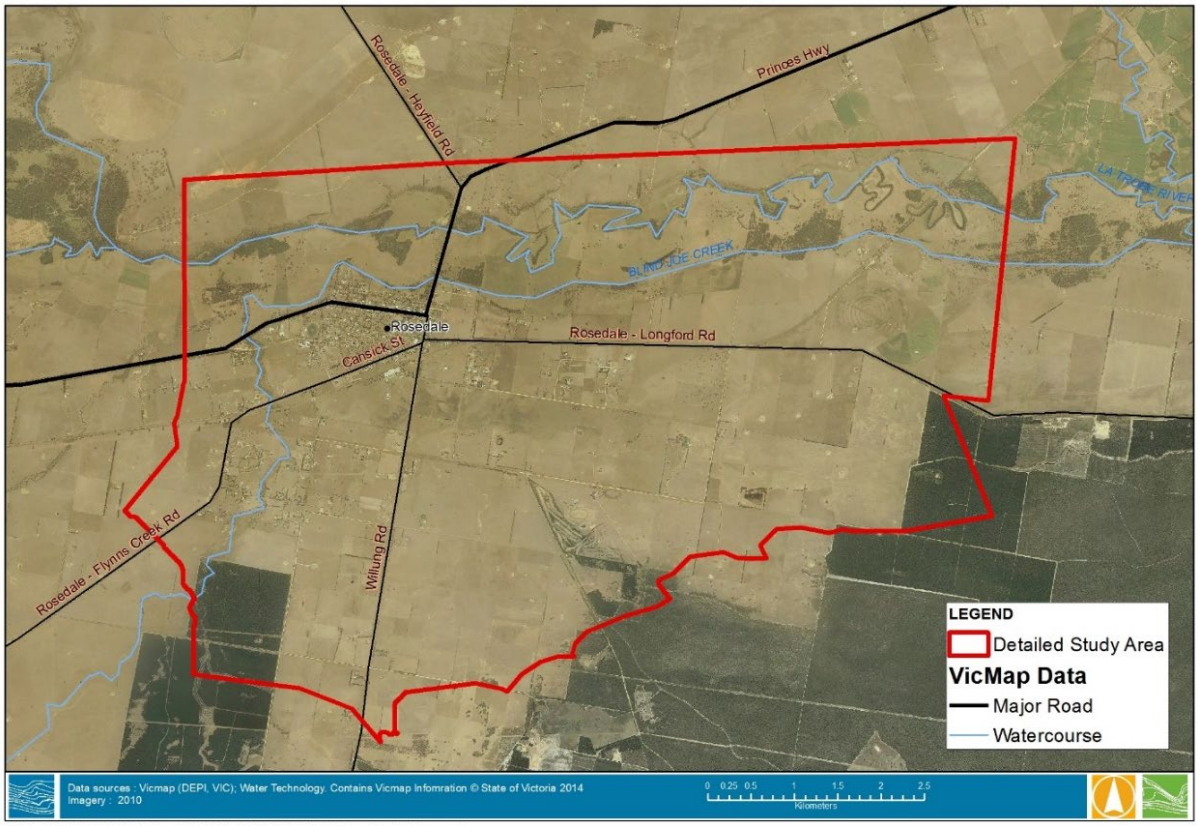

Figure 2-1 Rosedale Study Area

3. FLOOD INTELLIGENCE

Flooding in and around Rosedale can occur via three independent mechanisms:

- Flooding from the Latrobe River. Latrobe River has a large upstream catchment area approximately 4,150 km² so can generate larger flows and take longer to reach Rosedale after rainfall occurs.
- Flooding from the smaller catchments south of the township including Blind Joes Creek. Relatively small catchment area of approximately 150 km², generates less flow than the Latrobe River and will arrive quicker than Latrobe River flows after intense rainfall.
- Localised flooding within the town itself from high intensity short duration rainfall generating stormwater flooding.

Flooding from each of these mechanisms can occur independently or often at the same time. As the main portion of town sits above the Latrobe River floodplain, direct flooding from the Latrobe River is relatively limited with the Latrobe River Flood Study (Cardno 2013) showing only Mackay, King and Queen Streets seeing direct inundation from the Latrobe River and only in very rare events (1% and 2% AEP floods). Similarly, stormwater flooding can cause significant localised nuisance flooding but is unlikely to cause inundation above floor levels or isolation for extended periods (road closures). The major driver of significant flooding in Rosedale is the smaller catchments found to the south of the township including Blind Joes Creek. Whilst flooding from these catchments doesn't inundate a lot of dwellings above floor, inundation is widespread and can cause isolation.

3.1 Latrobe River Flooding

Currently declared flood class levels are set for the Latrobe River at Rosedale gauging station and are shown in Table 3-1

Table 3-1 Latrobe River Flood Class Levels (226228 Rosedale - Main Stream) SOURCE: Australian Bureau of Meteorology

Flood Class Level	Gauge Height (m)	Water Surface Level (m AHD)
Minor	4.0	13.7
Moderate	4.8	14.5
Major	5.5	15.2

A desktop analysis of the Latrobe River Flood Study (Cardno 2013) results (Table 3-2) versus the existing declared flood class levels suggests that even at major flood heights the township (if flooding only occurred in the Latrobe River) would largely be un-impacted. Major impacts (flood damages) could still be expected on the agricultural land which fringes the floodplain.

Table 3-2 Latrobe River Stream Flow Gauge and Design Flood Levels SOURCE: Latrobe River Flood Study (2013)

Flood Event	Gauge Height (m)*	Water Surface Level (m AHD)
10% AEP	4.288	13.988
5% AEP	4.614	14.314
2% AEP	5.121	14.821
1% AEP	5.714	15.414

* Estimated using Water Surface elevation data provide by the WGCMA and a gauge zero estimate of 9.7 m AHD

Analysis of the water surface elevation data from the Latrobe River Flood Study, removing any flooding direct from Blind Joes Creek, has shown that the main township of Rosedale is not significantly impacted by direct flooding from only the Latrobe River. Only Mackay, King and Queen Streets receive direct inundation from the Latrobe River and only in very rare events (1% and 2% AEP floods). Figure 3-1 shows a simplified analysis of what peak flood levels might look like if flooding only occurred in the Latrobe River.

A major conclusion of this study is that significant rainfall and flooding must also occur in the Blind Joes Creek catchment (and the smaller catchments to the south-east) for significant flooding to impact the greater Rosedale area.

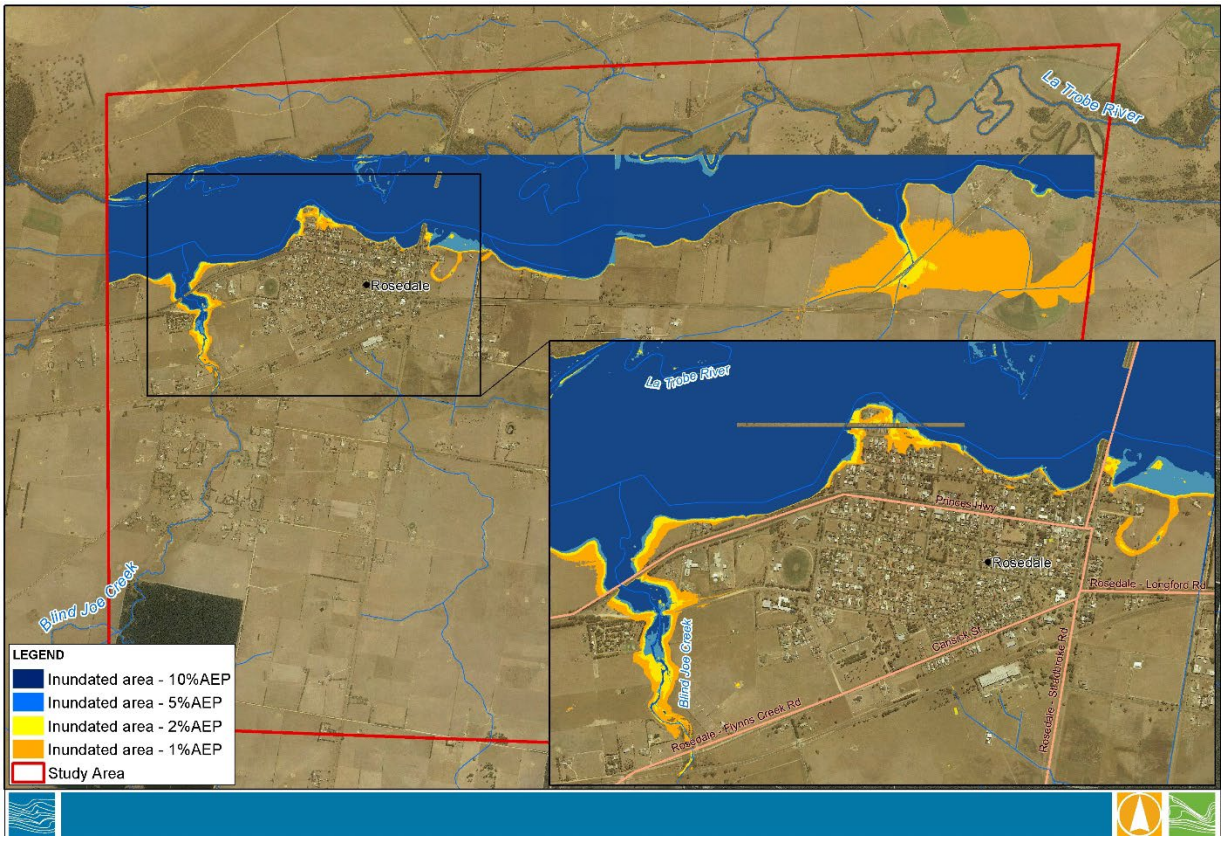

Figure 3-1 Latrobe Flood Study Results – Estimated area inundated by the Latrobe River (excludes Blind Joes Creek flooding)

3.2 Blind Joes Creek and localised Flooding

This study has shown that rainfall in the ranges south of Rosedale is a major driver of flooding in the town. For example, for the Blind Joes Creek floodway south of the township to be engaged, flood water from the Blind Joes Creek catchment must break its banks south of the railway line and flow east. This phenomenon cannot occur with only Latrobe River flooding. Once flood water breaks out of Blind Joes Creek south of the railway line, it tends to combine with the other adjacent catchment flows from the ranges south of town and inundates the low land south of the railway line and Huffers Lane. Some of this flood water can make its way into the township via flow paths over the railway line at Friends Road, two culvert crossings between Friends Road and the Tannery and at Willung Road. Some flood water also leaves the Blind Joes Creek and moves up an open drain on the north side of the railway eventually flowing over Cansick Street and inundating some of the residential land on the western boundary of the township.

Figure 3-2 below provides flood mapping for a number of selected design flood events. This shows the general increase in flood impacts with larger magnitude flood events. Table 3-3 below provides a description of the general flood behaviour of various flood events and the consequences for Rosedale. For a given flood height, the consequences likely to be experienced include all the consequences described for the smaller events in the above rows of the table. The table should therefore be read from top down.

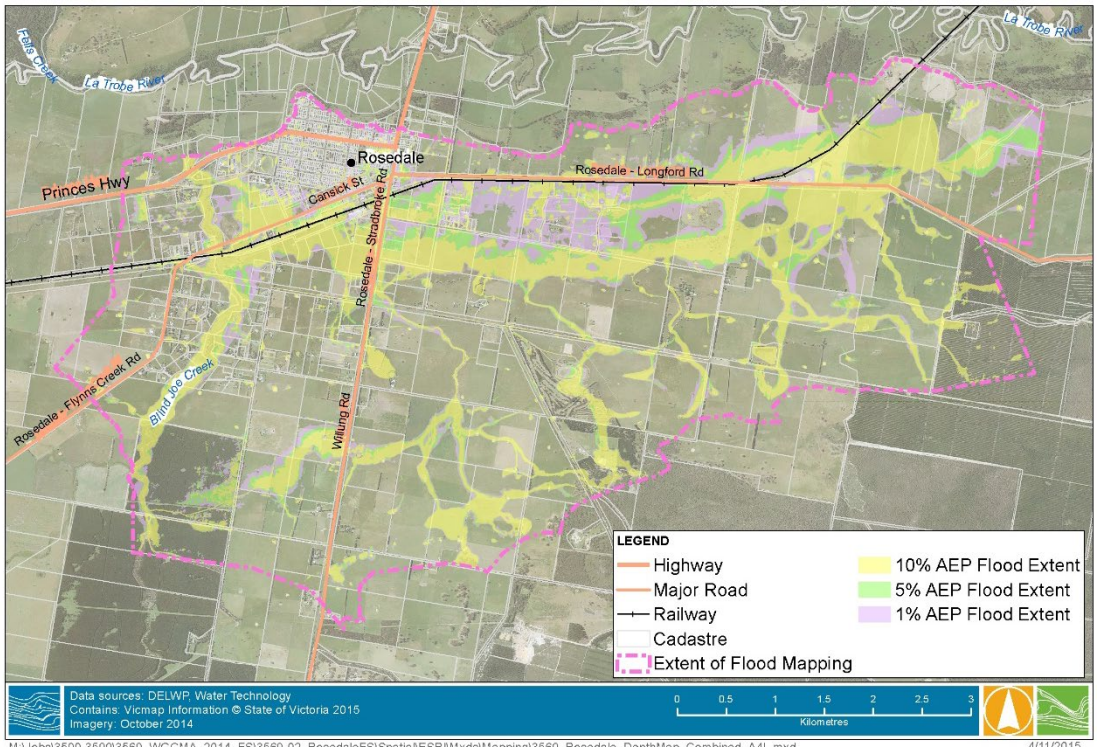

Figure 3-2 Rosedale Flood Extents for Selected Design Flood Events

3.2.1 Impact of stormwater (localised) flooding in Rosedale

Flood modelling of Rosedale in this study has considered impacts of the Latrobe River, catchments to the south of the township and also localised flooding within the township (stormwater flooding). Figure 3-3 shows the effect of including the catchment flows from lower land immediately north of the ranges. It shows that the major impacts inside the township tend to be driven by the catchment flows from the ranges but that there are many places within the township itself which are only impacted by stormwater.

Fortunately, most of the observed stormwater impacts in the township are confind to the local road network and natural low points but do not tend to impact homes or major infrastructure.

For the remainder of this report, flood impacts of localised stormwater flooding and flooding from the ranges south of the township will be considered together.

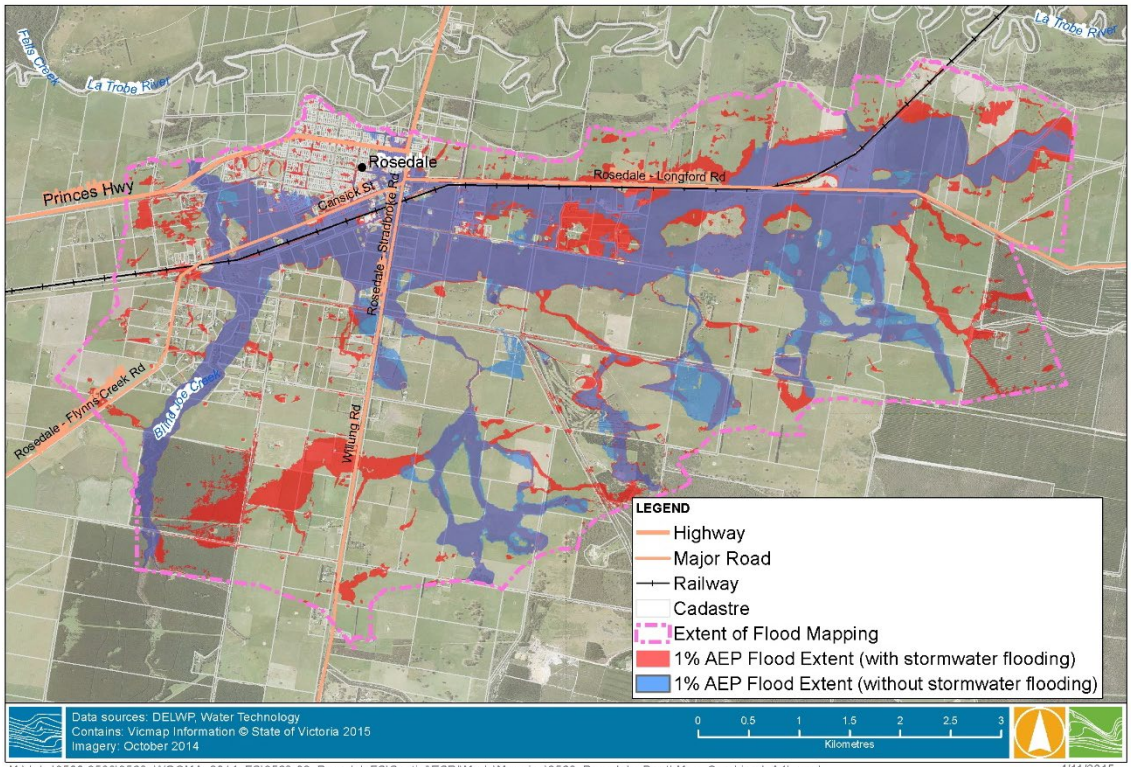

Figure 3-3 Impact of localised rainfall (valley floor) on overall flood extents (1% AEP event)

When using Table 3-3 to identify particular consequences for a given flood event, the reader should read all rows of consequences above the selected magnitude design event.

Table 3-3 Design flood events and associated flooding areas

AEP Design Event	Flood Consequences
10% AEP	Blind Joes Creek floodway engaged, ponding behind Friends, Rosedale-Longford and Willung Roads. Moore Street, McLeod Street, Cricket Street and Cansick Streets cut by flood water. Localised ponding (stormwater impacts) in the low lying land between Princes highway and Albert Street. **Residential Buildings Flooded Above Floor 0** **Commercial Buildings Flooded Above Floor 0** **Properties Flooded Below Floor 177**
5% AEP	Blind Joes Creek floodway flows enter the township via Friends and Willung Road. Ponding behind Wilung road, Friends and Rosedale-Longford roads over a 1 m deep in sections. Newer sections of the western edge of the town between Cansick and Cricket Street are inundated from breakout flows from Blind Joes Creek. Larger portions of land on the township fringes inundated such as land between Cansick street and the railway line (east of Blind Joes creek), and Huffers and Mill Lane area. Ponding in the low lying land between Princes highway and Albert Street is now more significant with one residential lot flooded above floor level. **Residential Buildings Flooded Above Floor 1** **Commercial Buildings Flooded Above Floor 1 (depth less than 10 mm)** **Properties Flooded Below Floor 212**
2% AEP	Most of the Blind Joes Creek Floodway is deeper than 0.5 m. Residents in some of the newer streets (e.g. Macleod Street) west of the main township may be isolated by floodwater. Flooding east of Willung Road is more significant with deeper flooding observed in the industrial estate east of Mill Lane. Mill Lane itself would likely be cut with flood water. Deep flooding (>0.5 m) is observed on the low density residential land north of Huffers Lane. Flooding in the CBD is much more significant with some streets inundated up to 0.5 m deep. The riverine and stormwater flooding combine likely cutting the Princes highway between Willung Road and Latrobe Street. The car park north of the Princes Highway is inundated with flood water making it to Queen Street. Ponding in the low lying land between Princes Highway and Albert Street is significant with one residential lot and 5 commercial lots flooded above floor level. **Residential Buildings Flooded Above Floor 1** **Commercial Buildings Flooded Above Floor 5** **Properties Flooded Below Floor 219**
1% AEP	Generally flood extents between the 1% AEP and 2% AEP are not significantly different but flood depths tend to be significantly deeper. A large portion of the Blind Joes Creek floodway is now deeper than 1 m. Ponding at the intersection of Willung and Rosedale-Longford Roads is deep (up to a 1 m). Most homes east of Willung Road and south of the Rosedale-Longford Road would lose access to the main township (for several hours) during this flood. Much of the low density residential land north of Huffers Lane is between 250 mm and 500 mm deep.

	Residential Buildings Flooded Above Floor 2 **Commercial Buildings Flooded Above Floor 7** **Properties Flooded Below Floor 234**
0.5% AEP	The flood extent is similar to the 2% and 1% AEP events, but flood depths throughout the township are now hazardous at many locations. The majority of the land on the western fringe of the main township (east of Blind Joes Creek) is inundated. Residential land north of Cansick Street and west of Willung Road and east of Hood Street is significantly impacted by riverine flooding. Additional flooding is observed north of the Princes Highway in Queen Street. People living east of Willung Road would expect to be isolated from the Rosedale township for extended periods during this event. **Residential Buildings Flooded Above Floor 7** **Commercial Buildings Flooded Above Floor 8** **Properties Flooded Below Floor 239**

3.3 Flood Risk

Flood Risk is the product of the likelihood of a certain event and the consequence of that event occurring. To assess the flood risk within Rosedale, the hydraulic modelling outputs (depth, velocity and flood hazard mapping) can be used to identify both the likelihood of the event happening (in terms of annual exceedance probability) and the consequence of such an event happening. Depth maps are useful in showing the areas impacted by the flooding, while the velocity and flood hazard mapping provides more detail for the areas which pose a higher consequence. Flood hazard is based on criteria including depth, velocity and depth x velocity and is explained further below. The high and low flood hazard areas for the 1% AEP flood event is shown in Figure 3-4.

When considering the emergency response for Rosedale during a flood event, it is important to consider the areas that are flooded first within the township, not just areas of high consequence (high hazard). Areas first flooded are often areas that have a higher likelihood of occurring and will occur at lower flow rates. A plot of the flood hazard categories for a 10% AEP flood event is shown in Figure 3-5. This plot highlights that for a 10% AEP flood event, the majority of the high hazard areas are located within the Blind Joes Creek channel. Some areas of high depth built up behind roads are observed south of the township, with some high depths along Moore Street, Widdowson, McLeod and Chown Courts.

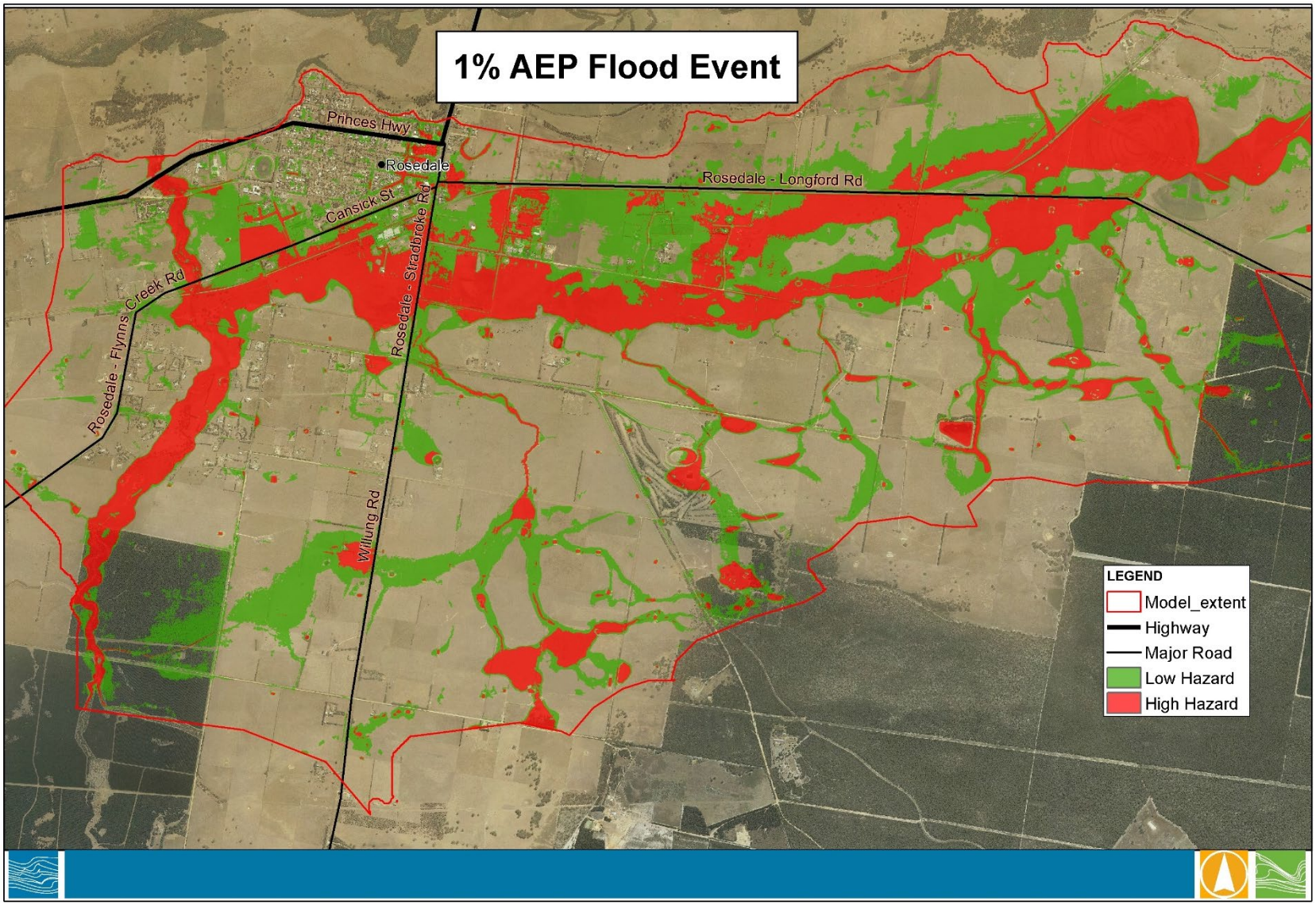

Figure 3-4 Flood Hazard for 1% AEP Flood Event

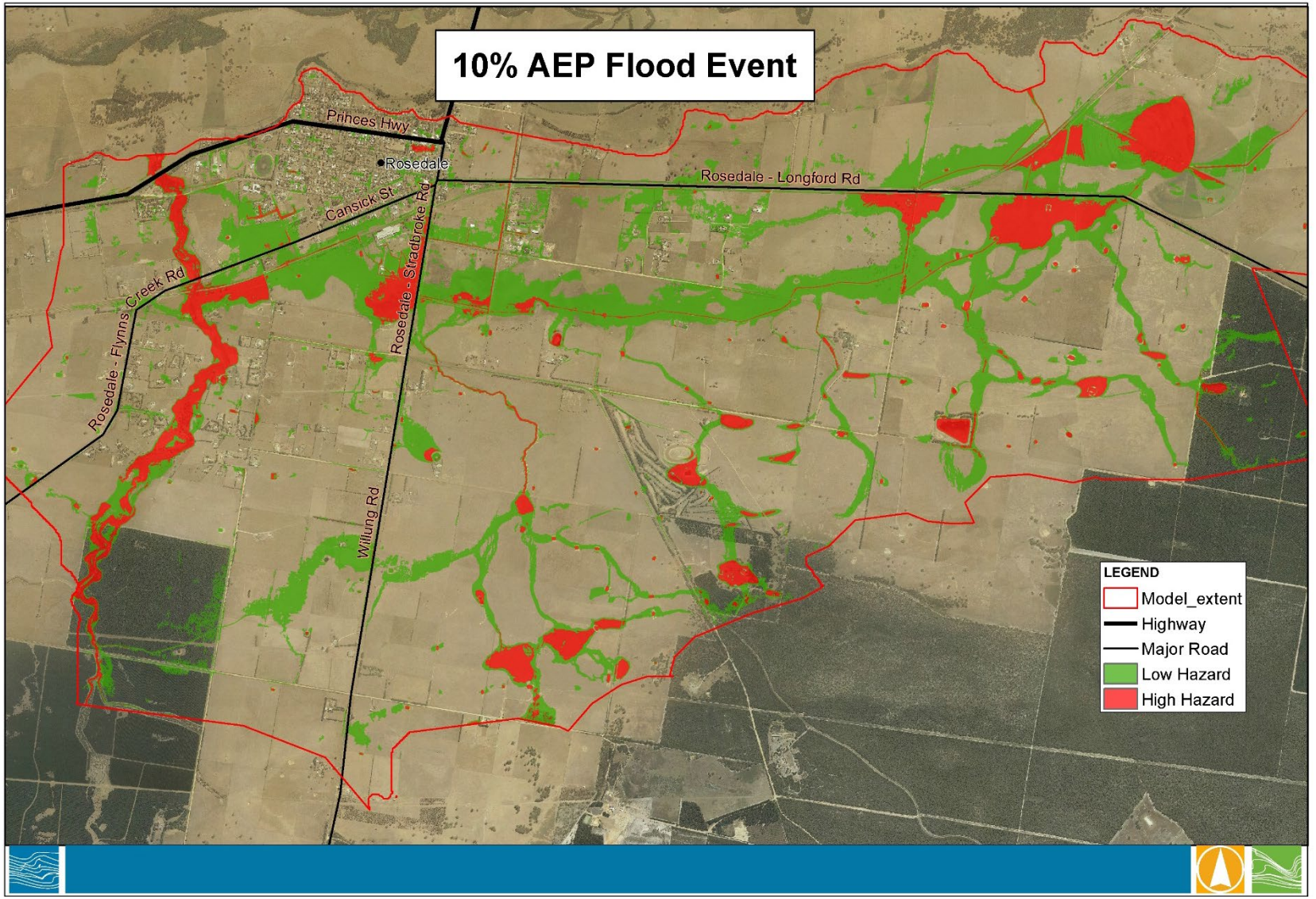

Figure 3-5 Flood Hazard for 10% AEP Flood Event

3.4 Flood Warning

As previously discussed, it has been identified that one of the main drivers for significant flooding in Rosedale is from intense rainfall in the ranges south of the township. Due to Rosedale's proximity to these ranges, the onset of flooding can potentially occur quite soon after heavy rainfall. The hydrological modelling showed that for the catchments south of the township a 12 hour storm duration is generally the critical duration for a range of design storms. The onset of flooding can occur before the peak of the flood, so this means that the available flood warning time is potentially less than 12 hours after the start of the storm event.

Hydraulic modelling of historical floods and potential future flood (design events) has added some useful information on flood travel times. This information is based on the design event assumptions and it must be noted that every storm and flood is different, so actual timing may differ depending on the characteristics of the storm and the catchment conditions at the time of the event.

Table 3-4 Travel Time between beginning of Rainfall and Flood Peaks

Event	Time from beginning of the intense* rainfall to peak level observed at Railway Bridge south of Rosedale
2012	13 hrs
1993	12 hrs
Design Modelling (Future Floods)	6 -8 hrs

* Assumed to be approximately >5mm/h for consecutive hours

Table 3-4 above shows the difference in two of the historic events compared to the design floods. The historic events had a less intense longer duration storm than the critical duration design storms for design flood mapping. This highlights the large differences that can be experienced across a range of storm events, which may lead to different observed flood behaviour during an event.

The major challenge in managing flood warning in Rosedale is the complete lack of localised information to base a warning off. Currently there is no stream flow gauging or government operated rain gauges with the catchment south of the township.

Table 3-5 Rainfall Totals and Design Flood Magnitude

Event	Rainfall (mm)		
	Strzelecki Ranges	Valley Floor (Rosedale)	Duration
June 2012	~105-95	~80	48 hours with majority of rain over a 20 hour period
September 1993	~115-105	~80-90	48 hours with majority of rain over a 16 hour period
10% AEP		55	12 hours
5% AEP		65	12 hours
2% AEP		80	12 hours

1% AEP	91	12 hours
0.5% AEP	104	12 hours

Table 3-5 above presents the historic rainfall totals that were recorded for 1993 and 2012 flood events in the ranges and more locally across the valley floor. For the design events, only a single rainfall total is provided, which was uniform across the catchment, a reasonable assumption given the catchment is quite small.

A review of official rain gauges closest to Rosedale located high on the Strezlecki Ranges (e.g. Callignee South, Balook, Stradbroke West and others) has shown that rainfall totals can be very different to rainfall recorded lower on the valley floor, particularly as an east coast low moves into the region. A review of rainfall data provided from the community has shown that event totals in the local catchment in 1993 and 2012 were up to 150 mm less than recorded in some of the gauges higher up on the ranges.

There is currently no flood warning service provided by the Bureau of Meteorology for the Blind Joes Creek catchment, and given the short available warning time the Bureau would most likely classify this as flash flooding so would not be covered under the traditional flood warning service. The Flood Warning Arrangements for Victoria (VFWCC, 2001) report outlines the following principles for flash flood warning services: The Bureau of Meteorology has a responsibility to provide predictions of weather conditions likely to lead to flash flooding (e.g. thunderstorms). Local Government has prime responsibility for flash flood warning extending from system establishment and operation through to the provision of predictions of stream levels if required. The Bureau of Meteorology will provide specialist technical assistance and advice to Local Government to assist in system establishment and in relation to flood prediction techniques. This means that any flood warning system considered for Rosedale would be the responsibility of Wellington Shire Council, with the Bureau of Meteorology providing assistance in the development of the system and the supply of software, as well as the supply of severe weather warnings and flood watches. It is understood that the State Government through DELWP can assist in funding the setup of flood warning systems but the cost to maintain and operate the systems is the Council's responsibility.

Considering these points, it is recommended that Wellington Shire Council investigate and document the feasibility of a flash flood warning service. Wellington Shire Council can seek assistance in this investigation from the Bureau of Meteorology and the West Gippsland CMA.

While it is not within the scope of this project to develop a comprehensive flash flood warning system for the township, it has been considered at a high level. To better manage and understand flood warning in Rosedale, it is recommended that two rain gauges with telemetry are established, one within the township of Rosedale and the other towards the top of the Blind Joes Creek catchment. These gauges would provide the information required for a flash flood warning system, coupled with a gauge at a location upstream of the railway line. Whilst it would be excellent if a telemetered water level gauge could be installed, a manually read gauge board is considered sufficient if a community observer relationship is developed to monitor this gauge during an event.

With access to this information via the internet and radio during times of predicted flooding, emergency management authorities and the general public would be better placed to understand the likely impact of future floods and have some lead time to prepare for and respond to a flood when it arrives. While no two floods are the same, predictions such as "this flood is expected to be bigger than 1993" can be very useful to people who are directly impacted and those that are tasked with managing such emergencies.

Figure 3-6 is a flash flooding early warning tool developed by Water Technology for Rosedale. If instantaneous rainfall records were available inside the catchment, they could be cross referenced

with the table to estimate the likely magnitude of the event, this estimate could then be cross referenced with the design map outputs to get an estimate of likely flooding. If a gauge board is established in town, the gauge board level can be tied to this chart and the flood mapping. When using the below chart it is advised to base the estimate on the rainfall total and duration around the peak of the rainfall. If a very short burst is observed over the first two hours this may not lead to the expected flooding because not enough rainfall volume has fallen yet and a lot of that may be lost to the catchment. It is advised to reassess the rainfall totals numerous times during an event which may lead to a revision in the estimated flood magnitude.

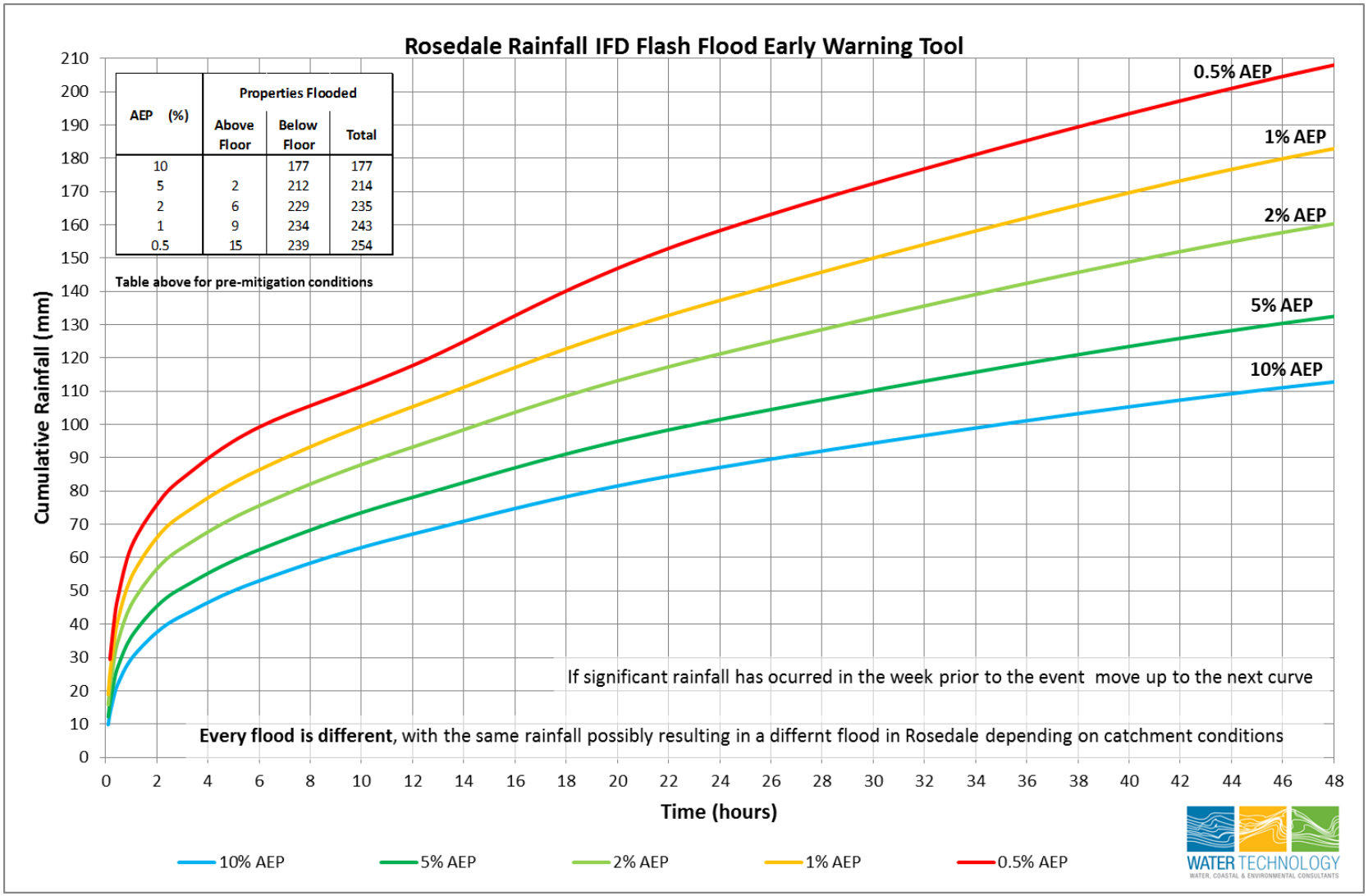

Figure 3-6 Flash Flooding Early Warning Tool

3.5 Land Use Planning

The Victoria Planning Provisions (VPPs) contain a number of controls that can be employed to provide guidance for the use and development of land that is affected by inundation from floodwaters. These controls include the Floodway Overlay (FO), the Land Subject to Inundation Overlay (LSIO), the Special Building Overlay (SBO), the Urban Floodway Zone (UFZ) and the Environmental Significance Overlay (ESO).

Section 6(e) of the Planning and Environment Act 1987 enables planning schemes to 'regulate or prohibit any use or development in hazardous areas, or likely to be hazardous'. As a result, planning schemes contain State planning policy for floodplain management requiring, among other things, that flood risk be considered in the preparation of planning schemes and in land use decisions.

Guidance for applying flood controls to Planning Schemes is available from the Department of Planning and Community Development's (DPCD) Practice Note on Applying Flood Controls in Planning Schemes.

Planning Schemes can be viewed online at http://services.land.vic.gov.au/maps/pmo.jsp. It is recommended that the planning scheme for Rosedale be amended to reflect the flood risk identified by this project. Edwin Irvine of Planning and Environmental Design undertook a detailed review of the Wellington planning scheme in relation to flood risk at Rosedale and made a number of recommendations contained in a separate standalone document. These recommendations are summarised in the Summary Report (R04).

The method used to delineate the proposed FO is broadly based on the new Australian Rainfall and Runoff Project 10 'Appropriate Safety Criteria for People'. Criterion for delineating the Floodway Overlay considers both vehicle and people safety, and are as follows, based on the 1% AEP flood:

- Depth > 0.3 m
- Velocity > 1.5 m/s
- Depth x velocity > 0.3 m^2/s.

The WGCMA Board have approved Floodplain Development Guidelines which adopt a depth threshold of 0.3 metres for safety requirements, and as such the FO has been defined using the above criteria.

The LSIO includes the area outside of FO and bounded by the 1% AEP flood extent. Small disconnected puddles such as farm dams and stormwater flooding were removed from the overlays. Figure 3- shows the proposed FO and LSIO maps based on the criteria adopted by the West Gippsland CMA.

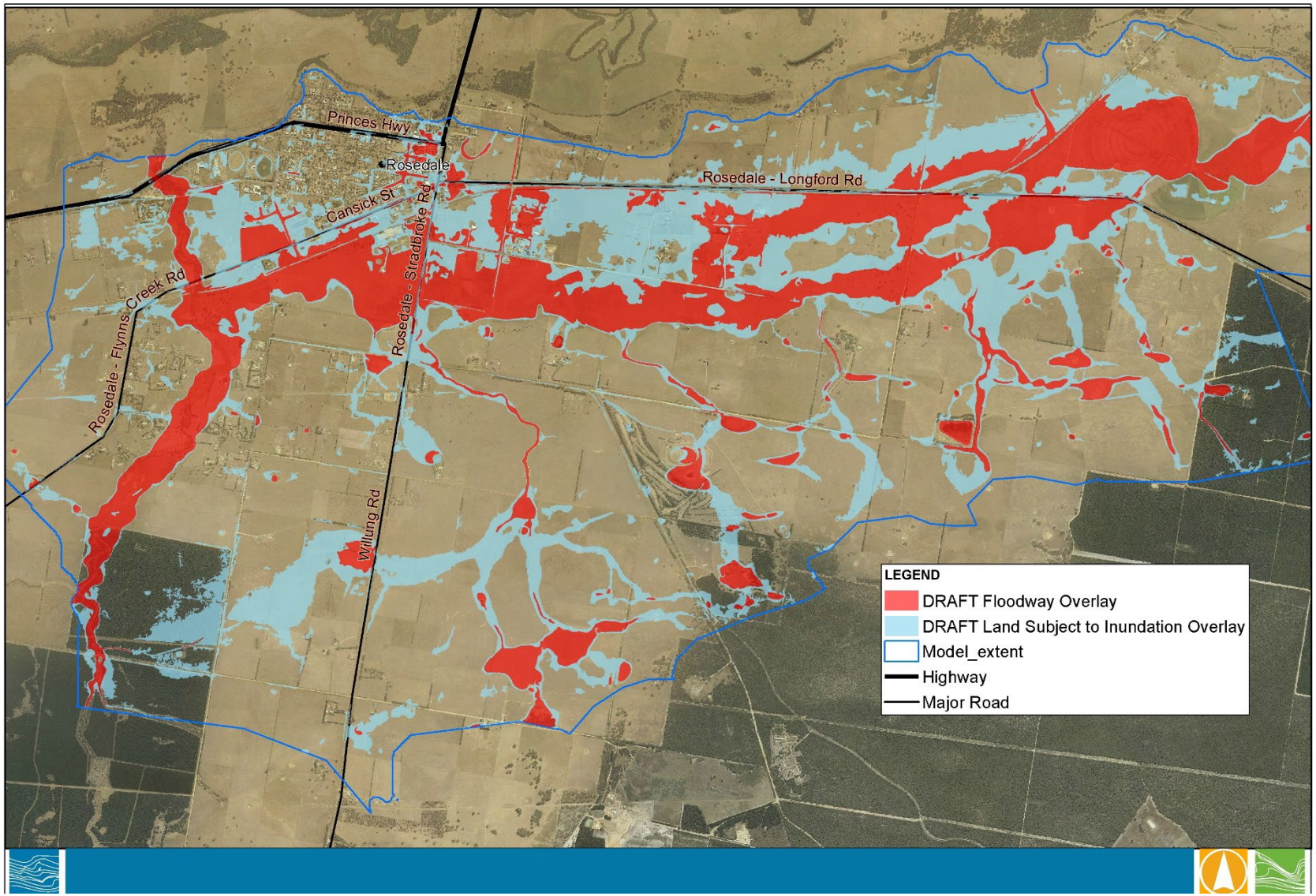

Figure 3-7 Draft LSIO and FO Map for Existing Conditions

4. FLOOD MITIGATION

This section provides an overview of the mitigation options considered to reduce the flood risk and flood damages in Rosedale. The aim of structural mitigation works is to reduce the flood risk in Rosedale and protect, where feasible, vulnerable buildings and infrastructure. Protection from a 1% AEP event is typical, and has been adopted for this study.

Possible mitigation options, detailed in Table 4-1, were derived from suggestions from community members in the community consultation sessions, discussion with the Steering Committee and inspection of the flood modelling results by Water Technology.

Table 4-1 Potential mitigation options initially considered

Option No.	Detail	Assumed Pros/cons
1a	***More flow to the East*** Increase capacity of Friends & Willung Road crossings to increase flow to the east. Formalise a floodway to encourage the land to more effectively drain the land.	Culvert works pretty simple. Floodway works impact a large amount of land. Option would likely flood proof all of the land north of the railway line. This option would force more flood water east potentially impacting landowners within the Blind Joes Creek Floodway. These impacts would need to be addressed in the floodway design
2	***More Flow to the North*** Increase flow north through the main Blind Joes Creek Waterway by opening up the Railway bridge and creating levees on each bank between the railway line and the Princes Highway.	Bridge works very expensive. All land currently zoned for residential, commercial and industrial land use would be protected from riverine flooding.
3	**Floodway Cansick to Cricket St** Create a drainage reserve between Cansick and Cricket streets. Works would likely include creating a channel and a levee on the eastern extent of the works.	Drainage reserve could be used for open space and WSUD if the land north of Cansick street was developed. Connection back to BJC would need to be considered carefully i.e. don't want to create erosion issues etc.
4	***Blind Joes Creek Retarding Basin*** Construct a retarding basin on the Blind Joes Creek south of the township.	Only capture flows from a proportion of the contributing catchment. Land is available. Basin would need to be quite large triggering maintenance and risk management considerations. Flood timing i.e. concurrence with Latrobe flows could be an issue
5	***Blind Joes Creek Diversion*** Construct a diversion on the BJC south of the town. The diversion would likely need to be combined with some floodway works to connect the additional flow back to the BJC's floodplain.	Could result in winners and losers. Only capture flows from a proportion of the contributing catchment. Land available but ownership an unknown.
6	***Longford-Rosedale Road Culverts*** Longford-Rosedale Road creates a barrier stopping flow getting back to the Latrobe. Adding additional culverts along the road may help drain the BJC floodway.	Could result in winners and losers. Easy to trial in the hydraulic model. No obvious locations come to mind looking at the LiDAR.

4.1 Structural Mitigation Option Prefeasibility Assessment

Each mitigation option was assessed against a number of criteria: potential reduction in flood damage, cost of construction, feasibility of construction, and environmental impact. The score for each criterion was based on a ranking system of 1 to 5, with 1 being the worst score and 5 the best. Each criteria score was then weighted according to the weighting shown in Table 4-2. The reduction in flood damage was the most heavily weighted criteria as this is really the main objective for all flood mitigation. Table 4-3 reviews and scores each mitigation option against the four criteria and calculates a total score for each option. The options with the higher scores indicate the more appropriate mitigation solutions for Rosedale. While these options were reviewed and scored individually it is important to consider a combination of options when developing a flood mitigation scheme.

Using the prefeasibility assessment above, the 6 identified mitigation options are listed in order of total weighted score as seen in Table 4-3.

Table 4-2 Ranking score for mitigation criteria

Score	Reduction in Flood Damages	Cost ($)	Feasibility/ Constructability	Environmental Impact
Weighting	2	1	0.5	0.5
5	Major reduction in flood damage	Less than $ 50,000	Excellent (Ease of construction and/or highly feasible option)	None
4	Moderate reduction in flood damage	$ 50,000 – $ 100,000	Good	Minor
3	Minor reduction in flood damage	$ 100,000 – $ 500,000	Average	Some
2	No reduction in flood damage	$ 500,000 – $ 1,000,000	Below Average	Major
1	Increase in flood damage	Greater than $ 1,000,000	Poor (No access to site and/or highly unfeasible option)	Extreme

Table 4-3 Mitigation option prefeasibility results

No.	Mitigation Option	Criteria				Score
		Damage Reduction	Cost	Feasibility/ Constructability	Environmental Impact	
1	*More flow to the East*	5	2	4	4	16
2	*More flow to the North*	5	1	3	3	14
5	*Blind Joes Creek RB*	4	2	3	3	13
3	*Floodway Cansick to Cricket St*	3	3	3	4	12.5
4	*Blind Joes Creek Diversion*	4	3	1	2	12.5
6	*Longford-Rosedale Culverts*	2	4	5	4	10.5

4.2 Structural Mitigation Options Modelled

Preliminary modelling was undertaken to analyse the potential for proposed mitigation options. Two scenarios were modelled, these are listed below and covered in more detail in subsequent sections.

- **More flow to the North:** Increasing the conveyance in the Blind Joes Creek waterway through to the Latrobe River via increasing capacity of the railway bridge and confining riverine flooding to the main waterway using levee banks.

- **More flow to the East:** Allowing the flow which breaks out of Blind Joes Creek south of the railway line to continue to flow east around the back of the main township with reduced constrictions. This would require increasing the capacity of some road crossing and some levees to prevent water flowing into the township.

In modelling these options, the approach was to start with extreme changes to determine if the proposed options could achieve a positive outcome, and then to refine (and downscale) the options accordingly. Given the model run times of the rain-on-grid model (3-4 days) all mitigation work was undertaken using only the direct riverine flows (flows from the ranges south of town). Final mitigation runs were undertaken using the combined riverine and rain-on-grid model. This led to some areas now showing localised ponding from local rainfall. It assumed this could easily be rectified when the concepts are taken to a functional design stage through drainage works.

The mitigation works were costed based on a number of key references:

- Melbourne Water's standard rates for earthworks and pipe/headwall construction costs;
- Rawlinsons Australian Construction Handbook Rates (Rawlisons, 2011);
- The United Kingdom Environmental Agency Temporary and Demountable Flood Protection Guide (EA UK, 2011);
- Costs of other similar projects (e.g. bridge replacements) within the Wellington Shire Council;
- VicRoads cost estimate for the Traralgon By-pass retarding basin option (part of the Traralgon Flood Study 2016);
- Comparison to cost estimates for similar mitigation works for other flood studies undertaken by Water Technology

4.2.1 More Flow to the North Option

This mitigation option was originally proposed in 1995 by both Department of Conservation & Natural Resources and Gutteridge Haskins & Davey (GHD) in independent flood studies. At this time they were not investigated in any detail with flood modelling.

For this mitigation option, we have focused on what was required to get the majority of Blind Joes Creek flows to connect to the Latrobe River floodplain via the primary channel at the western edge of the township. To achieve this, the following works were required.

- Increase the railway bridge opening from 48 m to 112 m wide. This would require earthworks on the railway embankment and the floodplain upstream and downstream of the railway.
- Increase the size of the Cansick Street bridge from 20m to 40m wide. This would require works on the waterway and floodplain upstream and downstream of Cansick Street bridge.
- Construct levees on the left bank (886 m long) and right bank (1,095 m long) of Blind Joes Creek running from the railway bridge through to the Princes Highway. This would include an allowance for 600 mm freeboard. The average height of the levees was around 1.1 m. On the western side levee, the highest location was 2.4 m, it is noted that if the levee was moved slightly west at this location the levee height could be significantly reduced (by over a meter).
- Raise a section of Friends Road (200 m long) by approximately 0.6 m (average depth).
- Raise a section of the Railway line (300 m long) by approximately 0.5 m (average depth).

- Modification to the two new Princes Highway bridges was not included in this mitigation package. It is noted that all existing freeboard in the new Princes Highway bridge designs would likely be lost under this mitigation option. If freeboard was required to be retained, then replacing both structures be required. This is obviously a high cost solution.

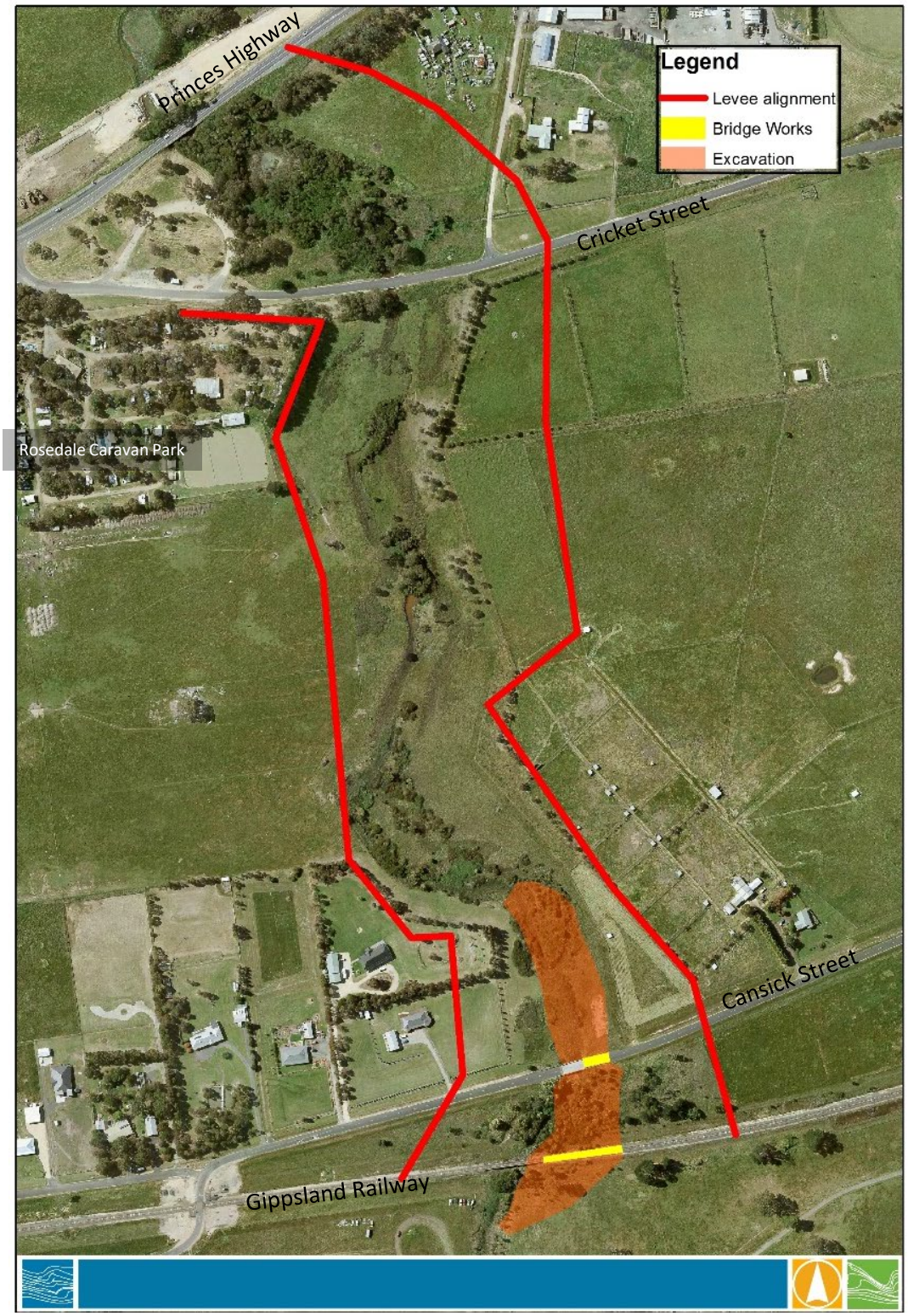

Figure 4-1 Proposed Works – More Flow to the North Option

Results

Increasing the amount of flood water flowing north along the Blind Joes Creek channel significantly reduced ponding on the western side of the township. With these works in place, a large amount of land once heavily inundated (over 500 mm deep) now only receives local stormwater runoff with flood depths reduced by over 400 mm in places (Moore Street, McLeod Court and Chown Court).

Moving east, the impact of the mitigation option was reduced. Willung Road was still over topped in this scenario, allowing some riverine flows to move into the township (albeit a lot less than in existing conditions). East of Willung Road, the Blind Joes Creek floodway peak water levels were typically reduced by around 200 mm. Generally, flood level increases were only observed behind the levee banks, however localised spots e.g. south of the caravan park also showed increases. This was a result of local runoff no longer being able to enter Blind Joes Creek. It is envisaged that this localised ponding could be managed with a pipe solution, possibly with a one-way pipe arrangement or a pumping solution.

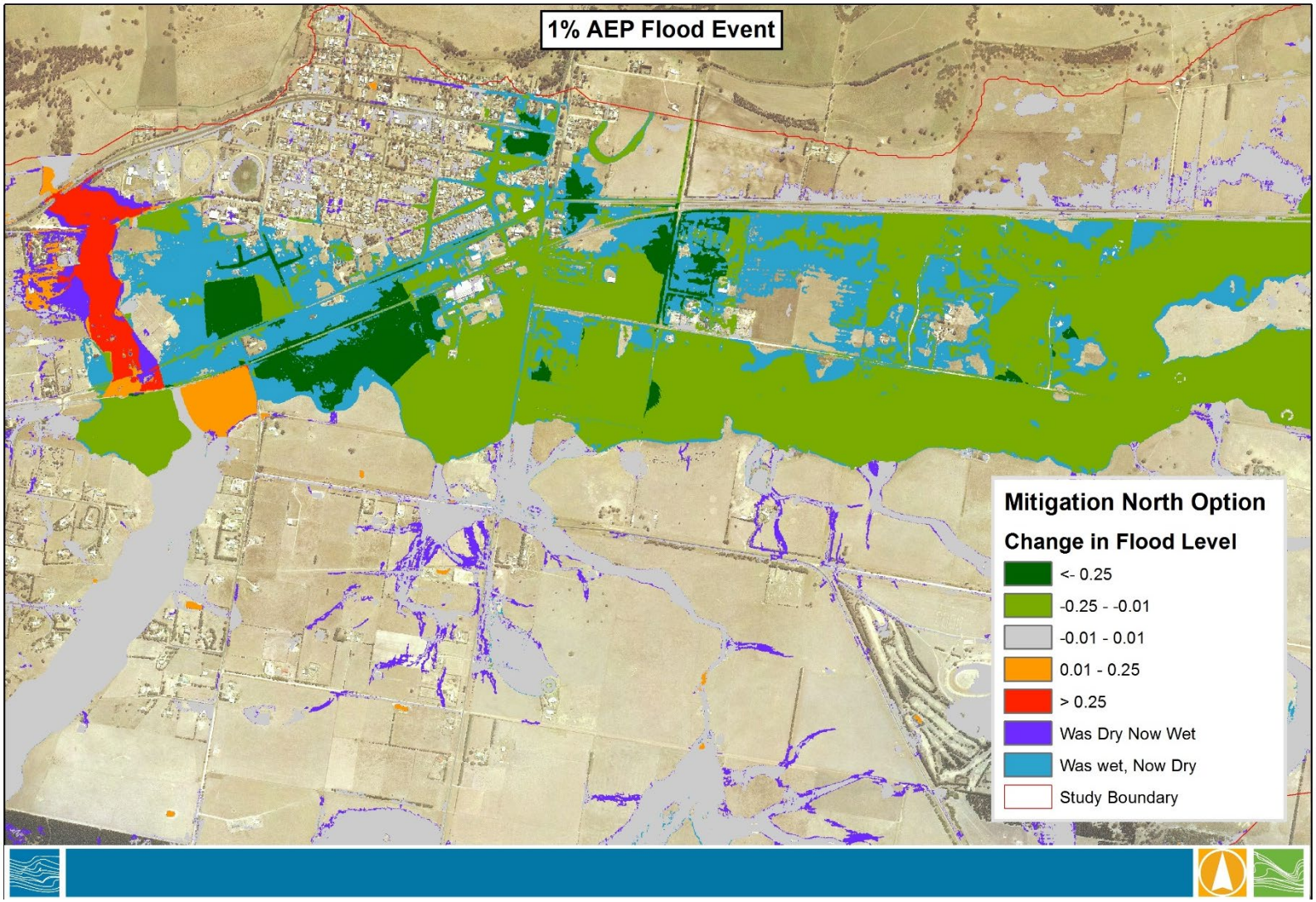

Figure 4-2 More Flow to the North Option - 1% AEP Water Level Difference Plot

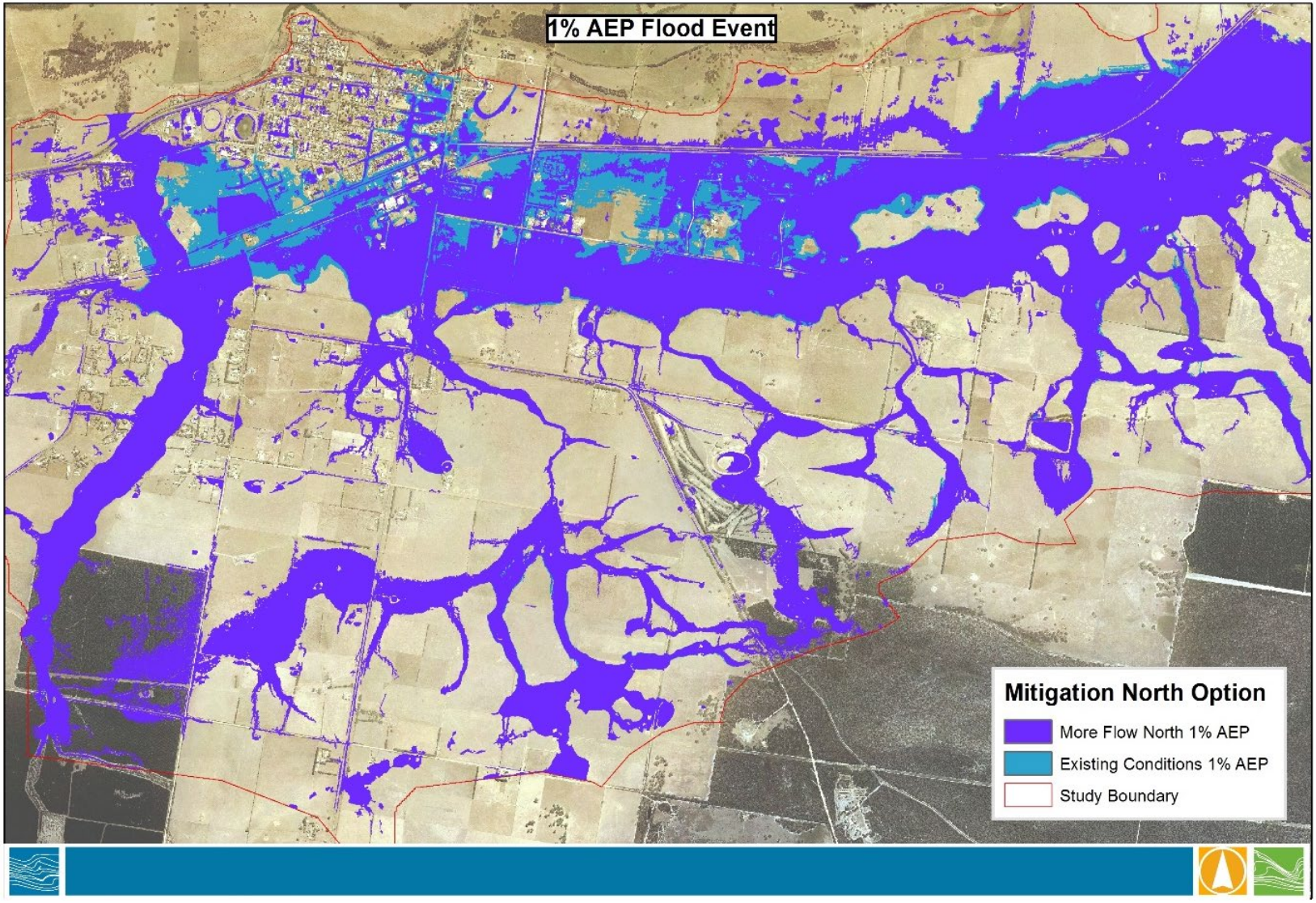

Figure 4-3 More Flow to the North Option - 1% AEP Flood Extent Comparison

Table 4-4 More Flow to the North Costs

Component	Quantity	Cost
Railway Bridge Works	112 m widening	$ 5,330,000
Excavation work within the waterway	22,841 m^3	$ 1,890,000
Cansick Street Bridge Works	40 m widening	$ 1,670,000
Levee Work	5,809 m^3	$ 420,000
Raise Friends Road	200 m length	$ 270,000
Raise Railway Line	300 m length	$ 680,000
Total Costs		**$ 10,990,000**

Cost associated with the More Flow to the North option are shown in Table 4-4. Railway bridge costs were scaled from the Traralgon by-pass bridge estimate by VicRoads. It would be recommended that VicTrack be engaged to confirm if this preliminary estimate was accurate. The other works in the package are assumed to be accurately costed.

4.2.2 More Flow to the East Option

This option to move more flood water east along the existing floodway has also been discussed in previous flood studies. This mitigation option involved more modest works and avoided major bridge works where possible. It does still require road works to increase the capacity of crossings, but they are on smaller Council roads. Ultimately the following works were found to significantly reduce flood impacts in Rosedale Township.

- Block off a small open drain between the railway line and Cansick Street on the right bank of Blind Joes Creek. In large floods, this open drain allows flood water to move up Cansick Street and into the residential area of the township.
- Remove the culvert crossing and lower Friends road to create a floodway allowing significantly more flow to break out and flow east down the Blind Joes Creek floodway.
- Provide temporary blockage solutions for two VicTrack culvert crossings between Friends road and Willung Road.
- Create a small levee around the Tannery from the railway line on the west connecting to Willung road on the east.
- Remove the culvert crossing and lower a section of Willung Road to create a floodway allowing significantly more flow to flow east down the Blind Joes Creek floodway.
    - It is noted that this option would potentially isolate residents south of the Blind Joes Creek floodway for a period of time during a flood event (consistent with what happens now). A solution to reduce this risk maybe to raise Willung road and create a large low level bridge structure. In the interest of finding a cost effective option this concept was not costed as part of the initial mitigation solution.
- Create a levee along Huffers Lane to stop flood water entering the land zoned low density residential north of Huffers Lane.
- Minor earth works in the Blind Joes Creek floodway to accommodate the additional overland flow moving east.
- Increase the culvert capacity under Rosedale-Stradbroke Road.

It is noted that a low bridge solution for Willung Road may be favourable to a floodway. This option could be investigated if this mitigation solution was taken to the next design phase.

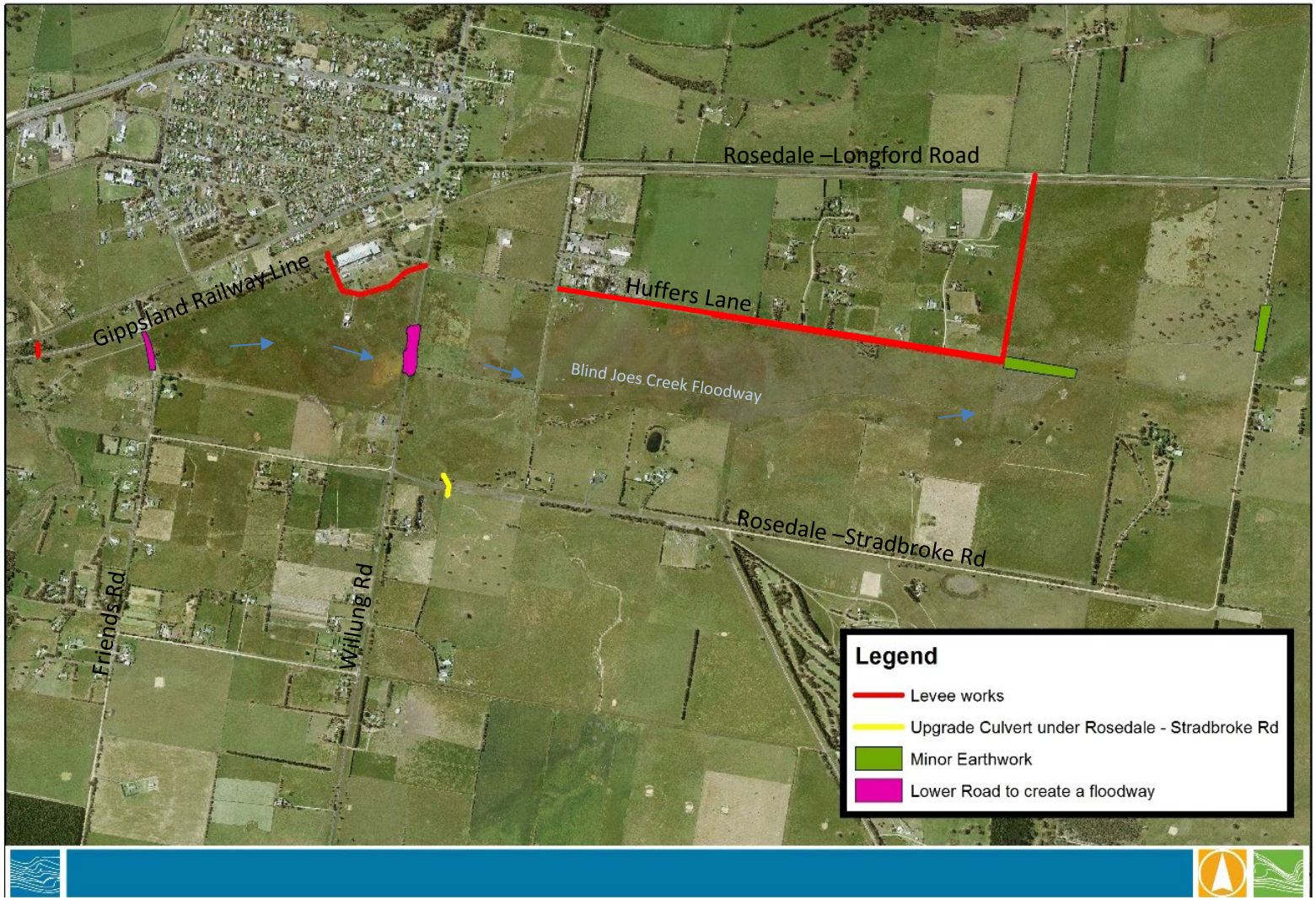

Figure 4-4 Proposed Works – More Flow to the East Option

Results

Increasing the amount of flood water flowing east along the Blind Joes Creek floodway significantly reduced ponding on the western side of the township. With these works in place, a large amount of land once heavily inundated (over 500 mm deep) now only receives local stormwater runoff with flood depths reduced by over 400 mm in places (Moore Street, McLeod Court and Chown Court). The riverine flood impact has been removed from the protected area north of the floodway, with the only impact now from stormwater.

Moving east, the impact of the mitigation option was continued with much of the land east of Willung Road and North of Huffers Lane now only suffering the impacts of stormwater flooding. The major breakout which once allowed flood water from Blind Joes Creek to move north at Willung Road into town over the railway line was now removed. Localised stormwater issues are noted behind the Huffers Lane levee. These are isolated to two locations and could likely be managed with local stormwater infrastructure (not the focus of this study).

With significantly more water allowed to flow east, flood levels within the Blind Joes Creek floodway have increased. East of Willung Road these increases tend to be less than 150 mm. Flood extents are not dramatically increased by the mitigation works. The roads and farm land along the Blind Joes Creek floodway are regularly inundated under current conditions. The proposed option doesn't change the frequency of inundation, it just removes some of the obstructions at the upstream end of the floodway. It therefore lowers levels upstream of these obstructions close to town and allows more flow to move east. It is likely that road users and farmers along the floodway would not notice any significant change, however these people would need to be consulted with as part of the process. Land owners directly affected would need to be identified and have a negotiated outcome between them and the WGCMA. If the change in flooding was not accepted, then a design response would be required (e.g. deepening of the floodway to remove afflux) this would add additional costs to the mitigation option.

It is also assumed that, with the flow restrictions of Friends and Willung Road removed, agricultural land west of these road crossings in the Blind Joes Creek floodway would drain more efficiently, reducing the time the land is unusable after a flood event. These works could form part of a formal drainage scheme, providing dual benefit of flood mitigation and rural drainage. Cost associated with package two are shown in Table 4-5.

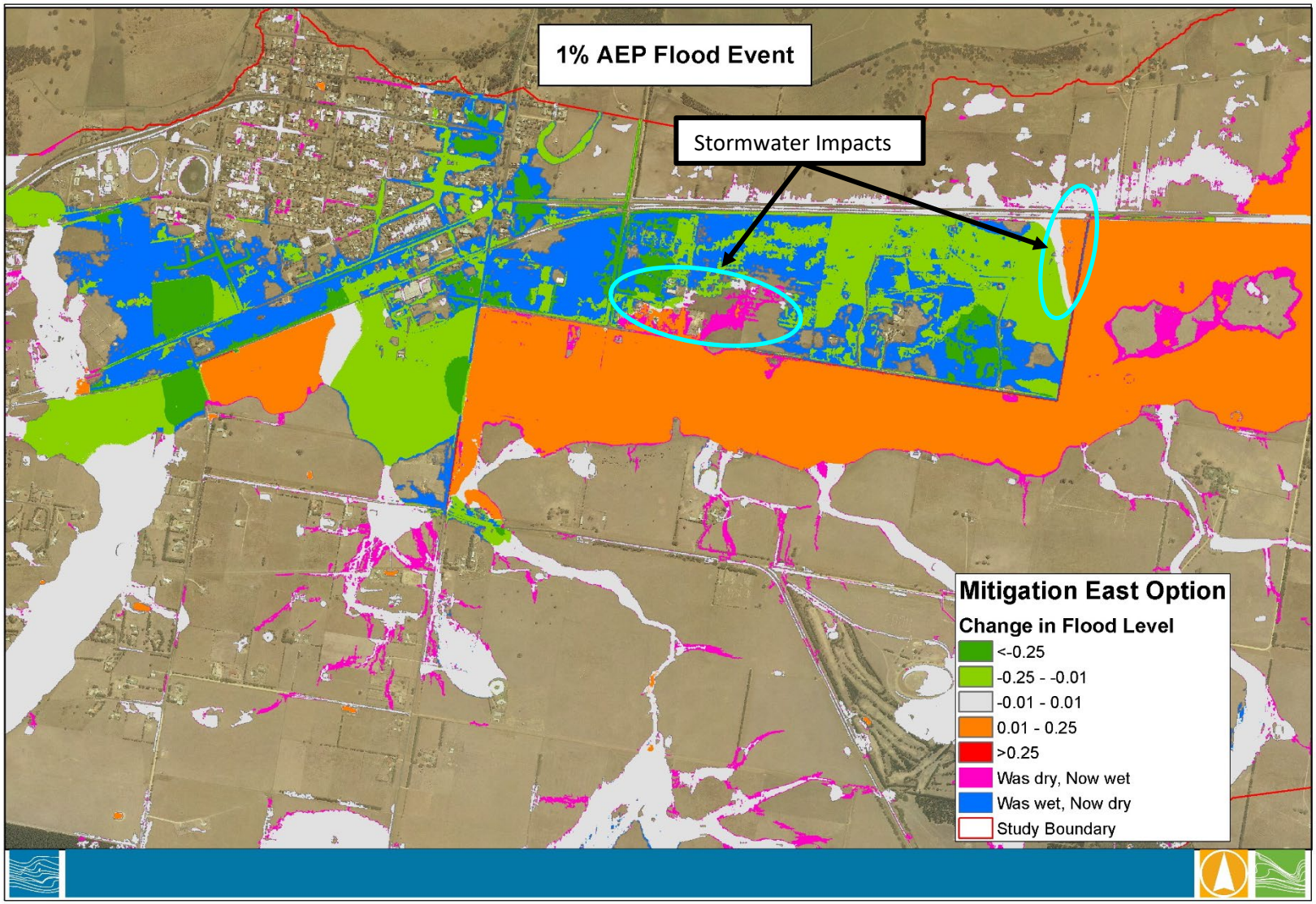

Figure 4-5 More flow East Option - 1% AEP Difference Plot

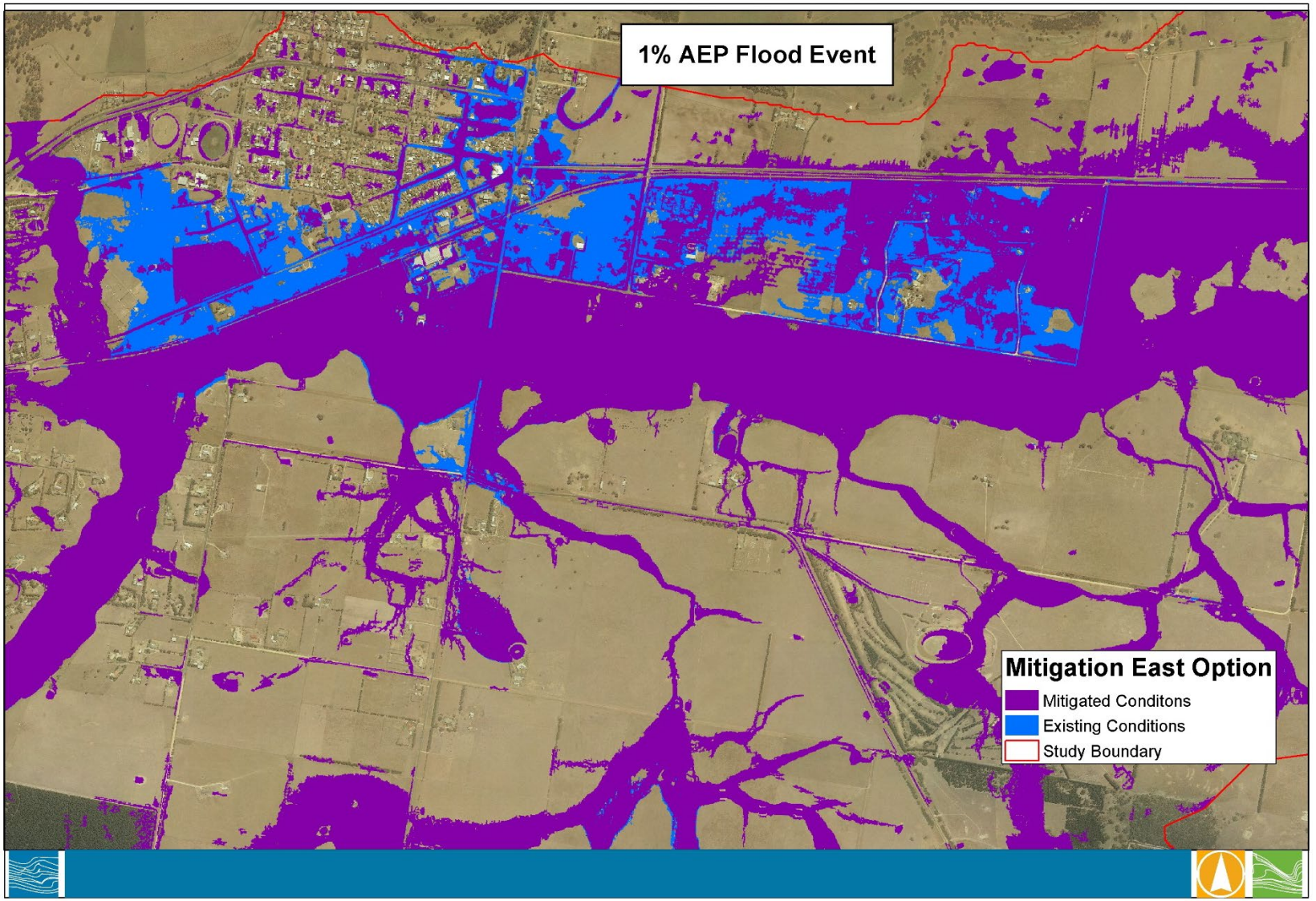

Figure 4-6 More flow East Option - 1% AEP Flood Extent Comparison.

Table 4-5 More Flow to the East Costs

Component	Quantity	Cost
Embankment between Railway & Cansick St	50m	$ 8,000
Culvert works (VicTrack Land)		$ 11,000
Levee around the Tannery	112 m	$ 57,000
Lower Friends Road	220m	$ 550,000
Culvert Works Rosedale –Stradbroke Rd		$ 80,000
Huffers Lane Levee	2700m	$ 280,000
Lower Willung Road	555m	$792,000
Earth works within the Floodway	8000 m^3	$233,000
Total Cost		$ 2,011,000

Costs associated with the More Flow to the East option are shown in Table 4-5. Avoiding major crossings or bridge works on VicRoads and VicTrack land has significantly reduced the more flow east option costs when compared to the more flow north option. One trade-off for this is the observed flood level increases on privately owned land within the Blind Joes Creek floodway. Additional costs to manage localised stormwater impacts have not been costed as part of this project.

5. FLOOD DAMAGES

5.1 Overview

A flood damages assessment was undertaken for the study area under existing conditions. The flood assessment determined the monetary flood damages for design floods (20%, 10%, 5%, 2%, 1% and 0.5% AEP events). The flood damage assessment was also undertaken for the final mitigation package.

Water Technology has developed an industry best practice damage assessment methodology that has been utilised for a number of studies in Victoria, combining aspects of the Rapid Appraisal Method, ANUFLOOD, more recent damage curves from the NSW Office of Environment and Heritage and other relevant flood damage literature. The model results for all mapped flood events were processed to calculate the numbers and locations of properties affected. This included properties with buildings inundated above floor, properties with buildings inundated below floor and properties where the building was not impacted but the grounds of the property were. In addition to the flood affected properties, lengths of flood affected roads for each event were also calculated. Note that rural agricultural damages have not been included in this study as the focus for mitigation is on the township. Details of all properties inundated within the study area are provided in Appendix A.

5.2 Existing Conditions

A flood damages assessment was undertaken on existing conditions and is shown in Table 5-1. The 1% AEP damage calculated was **$ $1,431,000** with 2 residential properties flooded above floor and 7 commercial properties also flooded above floor. The average annual damage (AAD), a measure of the flood damage, per year over an extended period was estimated for existing conditions to be **$ 76,000**. The AAD is an estimate of the cost of flooding to the community that includes both public and privately owned assets.

Table 5-1 Existing Conditions Flood Damages Summary

EXISTING CONDITIONS					
ARI (years) AEP	200yr 0.005	100yr 0.01	50yr 0.02	20yr 0.05	10yr 0.1
Residential Buildings Flooded Above Floor	7	2	1	1	0
Commercial Buildings Flooded Above Floor	8	7	5	1	0
Properties Flooded Below Floor	239	234	229	212	177
Total Properties Flooded	**254**	**243**	**235**	**214**	**177**
Direct Potential External Damage Cost	$975,000	$834,710	$692,023	$406,527	$171,178
Direct Potential Residential Damage Cost	$329,788	$102,545	$69,906	$65,330	$0
Direct Potential Commercial Damage Cost	$323,104	$263,366	$215,941	$7,695	$0
Total Direct Potential Damage Cost	**$1,627,892**	**$1,200,621**	**$977,870**	**$479,552**	**$171,178**
Total Actual Damage Cost *(0.8*Potential)*	**$1,302,314**	**$960,497**	**$782,296**	**$383,642**	**$136,942**
Infrastructure Damage Cost	**$571,352**	**$470,626**	**$407,191**	**$314,058**	**$201,785**
Indirect Clean Up Cost Indirect Residential Relocation Cost Indirect Emergency Response Cost **Total Indirect Cost**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Cost	**$1,873,666**	**$1,431,123**	**$1,189,487**	**$697,699**	**$338,728**

5.3 More Flow to the North

Flood damages were costed for the more flow to the north option. This option aims to reduce flooding north of the railway line and Huffers Lane. The results (Table 5-2) showed that the number of residential properties flooded in a 1% AEP event remains at 2, however all commercial properties were protected from flooding above floor level in the 1% AEP event. This reduced the flood damage estimate for a 1% AEP flood event to **$735,000**. The AAD was also reduced to **$41,000**.

Table 5-2 Mitigation Flood Damages Summary for More Flow to the North

ARI (years) AEP	200yr 0.005	100yr 0.01	50yr 0.02	20yr 0.05	10yr 0.1
Residential Buildings Flooded Above Floor	2	2	1	0	0
Commercial Buildings Flooded Above Floor	4	0	0	0	0
Properties Flooded Below Floor	213	198	178	168	143
Total Properties Flooded	**219**	**200**	**179**	**168**	**143**
Direct Potential External Damage Cost	$492,724	$362,442	$252,626	$208,110	$142,861
Direct Potential Residential Damage Cost	$114,036	$99,572	$27,689	$0	$0
Direct Potential Commercial Damage Cost	$127,986	$0	$0	$0	$0
Total Direct Potential Damage Cost	**$734,746**	**$462,014**	**$280,315**	**$208,110**	**$142,861**
Total Actual Damage Cost *(0.8*Potential)*	**$587,797**	**$369,611**	**$224,252**	**$166,488**	**$114,289**
Infrastructure Damage Cost	**$444,361**	**$365,376**	**$305,512**	**$224,765**	**$142,179**
Indirect Clean Up Cost					
Indirect Residential Relocation Cost					
Indirect Emergency Response Cost					
Total Indirect Cost	**$0**	**$0**	**$0**	**$0**	**$0**
Total Cost	**$1,032,158**	**$734,988**	**$529,764**	**$391,253**	**$256,468**

5.4 More Flow to the East

Flood damages were costed for the more flow to the east option. Similar to the other mitigation option it aims to reduce flooding north of the railway line and Huffers Lane. The results (Table 5-3) showed that the number of residential properties flooded in a 1% AEP event remains at 2, however all commercial properties were protected from flooding above floor level in the 1% AEP event. One of the residential properties inundated in this scenario is from localised rainfall. This reduced the flood damage estimate for a 1% AEP flood event to **$703,000**. The AAD was also reduced to **$42,000**.

Table 5-3 Mitigation Flood Damages Summary for More Flow to the East

ARI (years) AEP	200yr 0.005	100yr 0.01	50yr 0.02	20yr 0.05	10yr 0.1
Residential Buildings Flooded Above Floor	3	2	1	0	0
Commercial Buildings Flooded Above Floor	2	0	0	0	0
Properties Flooded Below Floor	216	197	182	169	145
Total Properties Flooded	**221**	**199**	**183**	**169**	**145**
Direct Potential External Damage Cost	$498,387	$329,375	$252,733	$215,589	$154,358
Direct Potential Residential Damage Cost	$172,157	$77,615	$27,689	$0	$0
Direct Potential Commercial Damage Cost	$70,442	$0	$0	$0	$0
Total Direct Potential Damage Cost	**$740,986**	**$406,990**	**$280,422**	**$215,589**	**$154,358**
Total Actual Damage Cost *(0.8*Potential)*	**$592,789**	**$325,592**	**$224,338**	**$172,471**	**$123,486**
Infrastructure Damage Cost	**$447,532**	**$377,192**	**$325,632**	**$236,948**	**$150,395**
Indirect Clean Up Cost					
Indirect Residential Relocation Cost					
Indirect Emergency Response Cost					
Total Indirect Cost	**$0**	**$0**	**$0**	**$0**	**$0**
Total Cost	**$1,040,321**	**$702,784**	**$549,969**	**$409,419**	**$273,881**

6. BENEFIT COST ANALYSIS

A Benefit Cost Analysis was undertaken for both mitigation options modelled (results shown in Table 6-1). This analysis showed clearly that both options have limited financial benefit when considering existing flooding conditions. This is because the existing flood damages are quite low through Rosedale compared to the cost of the considered mitigation options. The analysis didn't consider the potential economic benefit of releasing flood prone land for development. To better understand these conditions, a detailed benefit cost analysis would need to be undertaken by an economist.

The Benefit Cost Analysis showed that if the more flow to the north option was implemented it would actually cause a net annual liability (cost) of around $117,000. More flow east showed better results but not at a level which would likely attract State and Federal funding. This option may be further considered if development north of the railway line and Huffers Lane is required into the future to enable growth within Rosedale.

Table 6-1 Mitigation Impacts and Cost - Benefit

	More Flow North	More Flow East
Average Annual Damage	**$41,000**.	**$42,000**
Annual Maintenance Cost*	$152,000	$28,000
Annual Cost Saving	-$117,000	$6000
Net Present Value (6%)	-$1,642,000	$81,000
Capital Cost of Mitigation	$10,989,000	$2,011,000
Benefit – Cost Ratio	-0.15	0.04

* Annual maintenance costs estimated at ~3% of the capital works cost

Mitigation costings for these options are considered conservative however given the results of the benefit cost analysis, it is unlikely that more accurate costing would render either option viable. Mitigation options analysed in this study considered large scale works to flood proof the whole township. It is envisaged that smaller more modest works could be implemented to flood proof smaller areas within the town. This analysis does not consider a number of indirect and non-economic benefits discussed in section 6.1.

6.1 Non-Economic Flood Damages

The previous discussion relating to flood damages has concentrated on monetary damages, that is, damages that are easily quantified. In addition to those damages, it is widely recognised that individuals and communities also suffer significant non-monetary damage, i.e. emotional distress, health issues, etc. There has been extensive research undertaken and documented in the scientific literature relating to the individuals and communities response to natural disasters. A recent publication entitled *"Understanding floods: Questions and Answers"* by the Queensland Floods Science Engineering and Technology Panel, when discussing the large social consequences floods have on individuals and communities states:

Floods can also traumatise victims and their families for long periods of time. The loss of loved ones has deep impacts, especially on children. Displacement from one's home, loss of property and disruption to business and social affairs can cause continuing stress. For some people the psychological impacts can be long lasting.

The *"Disaster Loss Assessment Guidelines"* (EMA, 2002) make the following key points:

- *Intangibles are often found to be more important than tangible losses.*
- *Most research shows that people value the intangible losses from a flooded home—principally loss of memorabilia, stress and resultant ill-health—as at least as great as their tangible dollar losses.*
- *There are no agreed methods for valuing these losses.*

There is no doubt that the intangible non-monetary flood related damage in Rosedale is high. The benefit-cost analysis presented earlier in this report has not considered this cost. Nor has the additional benefits gained from land that could be developed if the mitigation options were adopted been considered. Anecdotal stories reveal that a number of properties in this area have had trouble getting home insurance as a result of the current LSIO planning layer, the same residences are concerned that this may also devalue their homes. The cost benefit analysis also has not taken into account the possibility for land currently zoned within the flood overlay or land subject to inundation which may have the flood risk significantly reduced as a result of the mitigation options discussed. Any decisions made that are based on the benefit-cost ratios need to understand that the true cost of floods in Rosedale is far higher than the economic damages alone. This would have the effect of increasing the benefit cost ratio, improving the argument for approving a mitigation scheme at Rosedale.

7. CONCLUSION AND RECOMMENDATIONS

The hydraulic modelling undertaken for the Rosedale flood study has allowed for locations within Rosedale that pose a high flood risk to be identified. The modelling has also identified potential mitigation options to reduce flood risk, with demonstrated benefits in terms of reducing the frequency and magnitude of flooding. The mitigation options identified along with the updated planning information aim to treat the existing risk within the Rosedale Township.

Further detailed assessment of the More Flow to the East mitigation option would be required to proceed to the next stage of implementation. It could be that this option can be carried out into the future in cooperation between Wellington Shire Council, West Gippsland CMA and potential land developers. Based on the current analysis, it is considered unlikely that the mitigation option would be able to attract full government funding to cover the construction costs. It may be possible to cover the costs through developer contributions into the future if the land protected is to be developed.

Smaller scale mitigation options that are complementary to other council projects might be more viable from a cost benefit perspective (e.g. Huffers Lane works), similarly works which unlock flood prone land for development and match current township scale strategies for growth may also warrant further investigation (e.g. west of the township).

The proposed planning scheme amendments require Wellington Shire Council to run a planning scheme amendment process in consultation with affected landholders.

A key theme through the project and through the steering committee and community meetings was the fact that there is very limited data for residents and authorities to use to undertake flood warning and emergency management within the Rosedale area. Given this and the catchment's relatively short response time (8-12hrs), it is recommended that 2 instantaneous rain gauges with telemetry services be investigated for installation in the Blind Joes Creek catchment, one inside the Rosedale Township and one in the upper catchment of Blind Joes Creek.

Data from these stations could be combined with flood risk analysis in this study to create a flash flood warning system for the town. As the town is prone to flash flooding, the responsibility for management of any early warning system becomes the responsibility of Wellington Shire Council. It is expected that the Bureau of Meteorology and DELWP would provide assistance in the development of the system and the supply of software, as well as the supply of severe weather warnings and flood watches.

Considering these points, it is recommended that Wellington Shire Council investigate and document the feasibility of a flash flood warning service. Wellington Shire Council can seek assistance in this investigation from the Bureau of Meteorology, the West Gippsland CMA and DELWP.

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APPENDIX A – PROPERTIES & ROADS INUNDATED

Easting	Northing	Floor Level	Ground Level	Building Type	Address	0.5% AEP Depth Above Floor	1% AEP Depth Above Floor	2% AEP Depth Above Floor	5% AEP Depth Above Floor	10% AEP Depth Above Floor
481058.2	5776811	17.508	17.506	COM	47 CANSICK ST	-0.221	-0.256	-0.279	-0.307	-0.312
481384.5	5777335	17.564	17.225	COM	29 PRINCE ST	-0.506	-0.506	-0.506	-0.506	-0.508
481340.3	5777344	17.312	17.172	COM	37-39 PRINCE ST	-0.352	-0.374	-0.386	-0.387	-0.387
481519.8	5777314	17.063	16.993	COM	1 PRINCE ST	-0.118	-0.134	-0.154	-0.313	-0.514
481368.3	5777387	17.121	17.021	COM	34B PRINCE ST	-0.264	-0.274	-0.279	-0.279	-0.28
481373.9	5777386	17.13	17.078	COM	34A PRINCE ST	-0.237	-0.241	-0.242	-0.243	-0.232
481385.2	5777384	17.155	17	COM	30-32 PRINCE ST	-0.227	-0.228	-0.23	-0.23	-0.224
480977	5777402	17.729	17.761	COM	89 PRINCE ST	-0.158	-0.159	-0.159	-0.16	-0.158
481409.4	5777380	16.944	16.891	COM	26-28 PRINCE ST	-0.162	-0.209	-0.245	-0.365	-0.352
481340.4	5777391	17.161	17.055	COM	40 PRINCE ST	-0.308	-0.312	-0.312	-0.312	-0.311
481486.5	5777367	16.824	16.799	COM	12 PRINCE ST	0.034	-0.019	-0.065	-0.241	-0.24
481346	5777390	17.15	17.046	COM	38B PRINCE ST	-0.254	-0.255	-0.254	-0.255	-0.254
481351.5	5777389	17.152	17.046	COM	38A PRINCE ST	-0.246	-0.246	-0.246	-0.247	-0.238
481444.6	5777327	16.866	16.893	COM	17-19 PRINCE ST	0.078	0.063	0.042	-0.116	-0.335
481516	5777298	17.078	17.031	COM	26 LYONS ST	-0.129	-0.146	-0.168	-0.328	-0.435
481400.5	5777334	17.642	17.105	COM	25-27 PRINCE ST	-0.541	-0.542	-0.542	-0.543	-0.545
481436.2	5777376	16.896	16.911	COM	22 PRINCE ST	-0.073	-0.124	-0.169	-0.393	-0.393
481423.5	5777330	17.079	17.013	COM	21-23 PRINCE ST	-0.135	-0.15	-0.171	-0.29	-0.296
480883.9	5777425	17.801	17.755	COM	95-99 PRINCE ST	-0.275	-0.283	-0.286	-0.291	-0.298

481420.3	5777378	16.958	16.918	COM	24 PRINCE ST	-0.158	-0.209	-0.254	-0.491	-0.505
481372.4	5777339	17.202	17.134	COM	31 PRINCE ST	-0.246	-0.267	-0.29	-0.331	-0.332
481477.7	5777321	16.807	16.764	COM	11 PRINCE ST	0.136	0.122	0.101	-0.057	-0.361
481007.5	5777402	17.7	17.666	COM	87 PRINCE ST	-0.172	-0.178	-0.182	-0.188	-0.195
481485.3	5777320	16.743	16.696	COM	9 PRINCE ST	0.201	0.186	0.165	0.007	-0.431
481464.1	5777323	16.819	16.826	COM	15 PRINCE ST	0.124	0.109	0.089	-0.069	-0.322
481472.6	5777322	16.825	16.746	COM	13 PRINCE ST	0.118	0.104	0.083	-0.075	-0.341
481360.6	5777392	17.142	17.079	COM	36 PRINCE ST	-0.215	-0.188	-0.189	-0.189	-0.22
481021.4	5777400	17.658	17.624	COM	85 PRINCE ST	-0.13	-0.136	-0.14	-0.146	-0.153
480983.6	5777591	17.768	17.666	COM	50 QUEEN ST	-0.38	-0.38	-0.381	-0.381	-0.381
482025.8	5776621	16.462	16.432	COM	145 MILL LANE	0.143	0.07	-0.012	-0.107	-0.159
481028.4	5775492	21.543	21.22	COM	164 WILLUNG RD	-0.471	-0.471	-0.471	-0.472	-0.48
481012.6	5775486	21.583	21.506	COM	164 WILLUNG RD	-0.304	-0.305	-0.305	-0.305	-0.302
482074.3	5776711	16.457	16.433	COM	133 MILL LANE	0.128	0.052	-0.039	-0.162	-0.181
481796	5776735	16.999	16.958	COM	29 HUFFERS LANE	-0.372	-0.385	-0.385	-0.385	-0.383
480121	5777025	18.571	18.496	COM	CRICKET ST	-0.579	-0.586	-0.59	-0.593	-0.593
480173.6	5777035	18.672	18.658	COM	CRICKET ST	-0.338	-0.338	-0.339	-0.339	-0.324
480147.2	5776991	18.507	18.419	COM	CRICKET ST	-0.306	-0.306	-0.306	-0.306	-0.305
479886.5	5777228	18.74	18.662	COM	2194 PRINCES HWY	-0.404	-0.404	-0.405	-0.405	-0.408
479780.8	5777182	18.701	18.672	COM	2188 PRINCES HWY	-0.258	-0.261	-0.265	-0.27	-0.275
479358.9	5776898	18.268	17.824	COM	73-97 CRICKET ST	-0.546	-0.546	-0.546	-0.546	-0.507
481388.1	5776946	17.218	17.209	COM	5-13 CANSICK ST	-0.151	-0.152	-0.152	-0.152	-0.166

481209.9	5777019	17.438	16.772	RES	1 DAWSON ST	-0.421	-0.458	-0.485	-0.532	-0.522
481214.9	5776926	18.032	17.399	RES	26 CANSICK ST	-0.875	-0.92	-0.968	-0.996	-0.991
481190.6	5776912	18.021	17.27	RES	30 CANSICK ST	-0.85	-0.897	-0.939	-0.959	-0.959
481178.4	5776902	17.959	17.329	RES	32 CANSICK ST	-0.776	-0.824	-0.873	-0.978	-1.018
481027.1	5776801	17.962	17.419	RES	51 CANSICK ST	-0.64	-0.671	-0.697	-0.735	-0.794
480907.1	5776940	18.328	17.576	RES	28 DAWSON ST	-0.81	-0.811	-0.811	-0.812	-0.813
481162	5776901	18.041	17.389	RES	34 CANSICK ST	-0.847	-0.895	-0.945	-0.982	-0.978
481138.3	5776892	17.944	17.282	RES	38 CANSICK ST	-0.731	-0.78	-0.831	-0.891	-0.893
481076.7	5776862	18.004	17.247	RES	46 CANSICK ST	-0.762	-0.808	-0.855	-0.954	-0.96
481230.5	5776928	17.948	17.213	RES	24 CANSICK ST	-0.799	-0.845	-0.897	-0.92	-0.924
481052.2	5776855	18.077	17.254	RES	48 CANSICK ST	-0.814	-0.86	-0.903	-0.97	-0.97
480949.6	5776956	18.062	17.285	RES	22 DAWSON ST	-0.63	-0.633	-0.635	-0.637	-0.631
481142.1	5776990	17.506	16.786	RES	11 DAWSON ST	-0.474	-0.479	-0.481	-0.481	-0.479
481104	5776878	18.108	17.291	RES	42 CANSICK ST	-0.878	-0.925	-0.97	-1.001	-1.003
481121.5	5776882	17.989	17.319	RES	40 CANSICK ST	-0.765	-0.814	-0.862	-0.976	-0.975
481032.3	5776908	18.094	17.411	RES	7 LATROBE ST	-0.87	-0.873	-0.873	-0.873	-0.873
481097.9	5776968	17.495	16.595	RES	17 DAWSON ST	-0.354	-0.355	-0.356	-0.357	-0.357
481157.7	5776997	17.448	16.74	RES	9 DAWSON ST	-0.41	-0.426	-0.443	-0.464	-0.44
481009.6	5776795	17.609	17.441	RES	53 CANSICK ST	-0.261	-0.295	-0.323	-0.364	-0.405
481251.6	5776938	17.993	17.255	RES	22 CANSICK ST	-0.875	-0.914	-0.959	-0.995	-0.983
481039.8	5776808	17.992	17.41	RES	49 CANSICK ST	-0.689	-0.722	-0.746	-0.779	-0.87
481116.8	5776979	17.43	16.705	RES	15 DAWSON ST	-0.366	-0.367	-0.368	-0.369	-0.371

481146.5	5776895	18.066	17.323	RES	36 CANSICK ST	-0.858	-0.908	-0.959	-0.992	-0.976
481170.9	5777002	17.437	16.742	RES	7 DAWSON ST	-0.418	-0.45	-0.491	-0.538	-0.576
481209.1	5776921	18.017	17.142	RES	28 CANSICK ST	-0.853	-0.903	-0.948	-0.985	-0.992
481125.6	5776983	17.407	16.822	RES	13 DAWSON ST	-0.375	-0.406	-0.407	-0.407	-0.407
481045.1	5776950	18.057	17.377	RES	25 DAWSON ST	-0.85	-0.863	-0.873	-0.873	-0.872
481060.6	5776958	18.057	17.339	RES	23 DAWSON ST	-0.94	-0.963	-0.979	-0.981	-0.982
481126.6	5777028	17.384	17.007	RES	10 DAWSON ST	-0.366	-0.396	-0.404	-0.41	-0.415
481089.2	5776874	18.155	17.425	RES	44 CANSICK ST	-0.918	-0.965	-1.011	-1.058	-1.061
481181.9	5777004	17.369	16.775	RES	5 DAWSON ST	-0.354	-0.393	-0.427	-0.463	-0.474
481201.6	5777012	17.452	16.781	RES	3 DAWSON ST	-0.442	-0.478	-0.517	-0.606	-0.612
481288	5776956	17.599	17.269	RES	2 HOOD ST	-0.548	-0.578	-0.59	-0.59	-0.589
480922.4	5776943	18.208	17.474	RES	26 DAWSON ST	-0.741	-0.741	-0.742	-0.742	-0.734
481072.3	5776961	17.468	16.781	RES	21 DAWSON ST	-0.368	-0.382	-0.388	-0.389	-0.384
481084.5	5776965	17.524	16.617	RES	19 DAWSON ST	-0.433	-0.448	-0.449	-0.45	-0.453
480937.7	5776949	18.188	17.351	RES	24 DAWSON ST	-0.789	-0.788	-0.789	-0.79	-0.795
480872.3	5776738	17.668	17.446	RES	69 CANSICK ST	-0.146	-0.205	-0.262	-0.347	-0.456
480892	5776742	18.289	17.472	RES	67 CANSICK ST	-0.776	-0.822	-0.877	-0.973	-1.037
481404.3	5777202	17.839	16.896	RES	9 ALBERT ST	-0.87	-0.895	-0.92	-1.042	-1.264
481169.5	5777242	17.608	17.445	RES	31 ALBERT ST	-0.436	-0.438	-0.439	-0.441	-0.444
481420.8	5777112	17.474	17.334	RES	4-6 DUKE ST	-0.446	-0.446	-0.447	-0.447	-0.448
481444	5777112	17.305	17.201	RES	4-6 DUKE ST	-0.319	-0.345	-0.375	-0.397	-0.398
481414.2	5777134	17.535	17.407	RES	4-6 DUKE ST	-0.386	-0.387	-0.388	-0.389	-0.388

481439.6	5777140	17.651	17.534	RES	4-6 DUKE ST	-0.45	-0.451	-0.451	-0.452	-0.441
481451.2	5777130	17.499	17.414	RES	4-6 DUKE ST	-0.351	-0.351	-0.352	-0.352	-0.322
481302.3	5777160	17.87	17.116	RES	21 HOOD ST	-0.886	-0.914	-0.944	-1.041	-1.085
480819.3	5776760	17.678	17.556	RES	66 CANSICK ST	-0.132	-0.194	-0.254	-0.294	-0.293
481373.9	5777206	17.568	16.597	RES	13 ALBERT ST	-0.599	-0.624	-0.649	-0.771	-1.1
480935.7	5776809	17.963	17.535	RES	56 CANSICK ST	-0.497	-0.55	-0.597	-0.611	-0.612
481321.2	5777124	17.933	17.141	RES	14 DUKE ST	-0.944	-0.972	-1.003	-1.087	-1.1
480903.6	5776794	18.365	17.469	RES	60 CANSICK ST	-0.871	-0.928	-0.983	-1.062	-1.072
480903.4	5776752	17.643	17.444	RES	65 CANSICK ST	-0.143	-0.201	-0.256	-0.343	-0.449
480918.3	5776756	17.988	17.419	RES	63 CANSICK ST	-0.494	-0.55	-0.604	-0.689	-0.726
481218	5777144	17.574	17.086	RES	20 DUKE ST	-0.585	-0.614	-0.646	-0.744	-0.753
480779.4	5776702	17.855	17.733	RES	79 CANSICK ST	-0.294	-0.358	-0.418	-0.507	-0.546
481538.6	5776940	17.796	17.387	RES	3 LYONS ST	-0.652	-0.653	-0.653	-0.654	-0.654
481347.3	5777120	17.377	17.294	RES	12 DUKE ST	-0.388	-0.398	-0.398	-0.398	-0.393
481348.5	5777146	17.811	17.316	RES	12 DUKE ST	-0.797	-0.798	-0.799	-0.802	-0.803
481259.8	5777137	17.237	16.987	RES	18 DUKE ST	-0.248	-0.277	-0.308	-0.416	-0.574
481453.3	5777236	17.309	17.151	RES	8 ALBERT ST	-0.344	-0.367	-0.392	-0.489	-0.489
481264.9	5777160	17.549	16.809	RES	14 HOOD ST	-0.563	-0.591	-0.622	-0.732	-0.937
480854.6	5776728	17.556	17.438	RES	71 CANSICK ST	-0.024	-0.084	-0.143	-0.228	-0.332
480837.1	5776722	17.58	17.431	RES	73 CANSICK ST	-0.036	-0.098	-0.158	-0.245	-0.369
480636.8	5776628	18.593	17.905	RES	89 CANSICK ST	-0.884	-0.929	-0.936	-0.936	-0.937
481543.6	5776965	17.594	17.388	RES	5-7 LYONS ST	-0.62	-0.625	-0.625	-0.625	-0.65

480937.4	5776765	17.706	17.455	RES	61 CANSICK ST	-0.227	-0.281	-0.333	-0.415	-0.498
481402.2	5777073	17.367	16.986	RES	7 DUKE ST	-0.379	-0.407	-0.437	-0.53	-0.675
481116.2	5777164	17.765	17.456	RES	30 DUKE ST	-0.557	-0.561	-0.563	-0.563	-0.571
480704.6	5776661	18.266	17.598	RES	85 CANSICK ST	-0.648	-0.709	-0.768	-0.844	-0.854
481543.2	5777019	17.559	17.046	RES	9 LYONS ST	-0.671	-0.704	-0.757	-0.834	-0.885
481266	5777180	17.232	17.073	RES	16 HOOD ST	-0.248	-0.276	-0.307	-0.418	-0.513
481267.1	5777229	17.422	17.292	RES	21 ALBERT ST	-0.417	-0.435	-0.436	-0.437	-0.471
481372.5	5777120	17.494	17.166	RES	10 DUKE ST	-0.506	-0.534	-0.564	-0.607	-0.604
481474	5777237	17.138	17.1	RES	6 ALBERT ST	-0.177	-0.199	-0.223	-0.37	-0.401
481341.3	5777252	17.287	17.109	RES	18 ALBERT ST	-0.32	-0.344	-0.369	-0.472	-0.478
481388.3	5777118	17.653	17.147	RES	8 DUKE ST	-0.665	-0.693	-0.723	-0.808	-0.829
481474.5	5777102	17.376	17.108	RES	12 LYONS ST	-0.403	-0.426	-0.452	-0.51	-0.568
480522	5776583	18.22	17.909	RES	109 CANSICK ST	-0.399	-0.451	-0.498	-0.564	-0.647
481422.3	5777204	17.538	16.906	RES	7 ALBERT ST	-0.569	-0.594	-0.619	-0.741	-0.958
480921.1	5776800	17.886	17.613	RES	58 CANSICK ST	-0.409	-0.461	-0.507	-0.507	-0.512
480974.1	5776826	18.48	17.557	RES	52 CANSICK ST	-1.111	-1.141	-1.17	-1.184	-1.174
481396.8	5777206	17.519	16.882	RES	11 ALBERT ST	-0.55	-0.575	-0.6	-0.723	-0.967
481304.1	5777128	17.461	17.065	RES	16 DUKE ST	-0.47	-0.5	-0.532	-0.633	-0.647
481323.3	5777254	17.402	17.073	RES	20 ALBERT ST	-0.429	-0.455	-0.481	-0.542	-0.59
481137.2	5777287	17.886	17.578	RES	36 ALBERT ST	-0.57	-0.575	-0.579	-0.581	-0.584
481267.7	5777189	17.48	16.981	RES	18 HOOD ST	-0.498	-0.526	-0.555	-0.668	-0.76
480953.1	5776771	17.57	17.359	RES	59 CANSICK ST	-0.109	-0.161	-0.209	-0.286	-0.438

481526	5776916	17.374	17.262	RES	1 LYONS ST	-0.354	-0.364	-0.373	-0.384	-0.389
481432.9	5777245	17.673	17.275	RES	10 ALBERT ST	-0.7	-0.715	-0.716	-0.717	-0.714
481465.5	5777059	17.337	17.072	RES	10 LYONS ST	-0.357	-0.38	-0.407	-0.456	-0.532
481507.8	5777285	16.427	16.145	RES	24 LYONS ST	0.523	0.505	0.483	0.323	-0.393
480481.3	5776995	18.569	18.027	RES	28 GEORGE ST	-0.752	-0.752	-0.753	-0.753	-0.752
480769.9	5777010	18.694	18.07	RES	18 WOOD ST	-0.886	-0.889	-0.89	-0.891	-0.892
480443.6	5776963	18.316	18.138	RES	31 GEORGE ST	-0.501	-0.502	-0.502	-0.503	-0.503
481591.4	5777210	17.61	17.64	RES	23 LYONS ST	-0.395	-0.395	-0.396	-0.396	-0.403
481567.2	5777133	17.525	16.802	RES	15 LYONS ST	-0.684	-0.724	-0.789	-0.844	-0.853
481391.4	5777379	17.259	16.985	RES	30-32 PRINCE ST	-0.418	-0.426	-0.431	-0.437	-0.407
480634.5	5776970	18.598	18.135	RES	16 GEORGE ST	-0.704	-0.709	-0.713	-0.714	-0.729
481763.5	5777018	17.084	16.942	RES	50 ROSEDALE-LONGFORD RD	-0.275	-0.302	-0.347	-0.533	-0.554
480444.8	5777004	18.384	18.114	RES	32 GEORGE ST	-0.63	-0.634	-0.641	-0.653	-0.667
481568.3	5777118	17	17.136	RES	13 LYONS ST	-0.159	-0.199	-0.264	-0.368	-0.373
480468.5	5776960	18.247	18.164	RES	29 GEORGE ST	-0.442	-0.442	-0.442	-0.442	-0.441
481559.7	5777097	17.74	17.138	RES	11 LYONS ST	-0.851	-0.867	-0.893	-0.906	-0.909
481607.1	5777157	17.529	16.814	RES	19 LYONS ST	-0.689	-0.728	-0.793	-1.031	-1.004
481577	5777163	17.704	17.268	RES	19 LYONS ST	-0.756	-0.757	-0.758	-0.759	-0.759
480399.2	5777146	19.073	18.11	RES	5 AYRES CT	-1.268	-1.272	-1.274	-1.275	-1.284
480466.8	5777002	18.543	18.069	RES	30 GEORGE ST	-0.799	-0.804	-0.805	-0.805	-0.825
480614.1	5776973	18.598	18.114	RES	18 GEORGE ST	-0.707	-0.708	-0.708	-0.709	-0.696
480527.6	5776998	18.304	17.978	RES	24-26 GEORGE ST	-0.535	-0.536	-0.537	-0.538	-0.52

481742.2	5777006	17.462	16.773	RES	44 ROSEDALE-LONGFORD RD	-0.624	-0.653	-0.703	-0.913	-0.93
481572.3	5777151	17.238	17.255	RES	17 LYONS ST	-0.393	-0.404	-0.406	-0.407	-0.409
481581.9	5777180	17.618	17.566	RES	21 LYONS ST	-0.468	-0.468	-0.469	-0.469	-0.469
481584.8	5777013	17.313	16.903	RES	30 ROSEDALE-LONGFORD RD	-0.437	-0.468	-0.522	-0.624	-0.639
481189.8	5777509	16.627	16.298	RES	29 QUEEN ST	-0.332	-0.596	-0.596	-0.599	-0.612
481229.5	5777539	17.158	16.556	RES	28 QUEEN ST	-0.864	-0.974	-0.974	-0.974	-0.969
480462.6	5777270	18.267	18.06	RES	86 DUKE ST	-0.389	-0.387	-0.39	-0.388	-0.382
481382.5	5777461	17.525	16.784	RES	31-33 HOOD ST	-0.854	-0.884	-0.91	-1	-1.02
480344.9	5776789	18.086	17.914	RES	22 MOORE ST	-0.224	-0.264	-0.304	-0.356	-0.389
480316.9	5776872	18.235	18.104	RES	30 MOORE ST	-0.37	-0.399	-0.428	-0.434	-0.434
480489	5777263	18.152	18.075	RES	84 DUKE ST	-0.435	-0.44	-0.443	-0.446	-0.451
480465.3	5776826	18.211	18.111	RES	5 ROSEMONT AVE	-0.35	-0.389	-0.43	-0.479	-0.479
480249.6	5776813	18.581	17.918	RES	6 MCLEOD CT	-0.724	-0.763	-0.804	-0.856	-0.908
480443.9	5777359	18.184	18.054	RES	97 ALBERT ST	-0.388	-0.394	-0.399	-0.402	-0.406
480437.3	5777335	18.259	18.19	RES	97 ALBERT ST	-0.46	-0.466	-0.472	-0.476	-0.481
481396.6	5777472	17.352	16.705	RES	13 QUEEN ST	-0.81	-0.828	-0.85	-0.925	-0.926
481232.5	5777499	17.057	15.975	RES	25 QUEEN ST	-0.762	-1.177	-1.19	-1.195	-1.2
480309.5	5776887	18.129	18.09	RES	32 MOORE ST	-0.268	-0.307	-0.336	-0.342	-0.338
480371.2	5776838	18.243	18.102	RES	31 MOORE ST	-0.381	-0.412	-0.426	-0.434	-0.403
480364.5	5776856	18.2	18.064	RES	33 MOORE ST	-0.338	-0.378	-0.419	-0.431	-0.427
480195.9	5776763	18.228	18.065	RES	13 MCLEOD CT	-0.363	-0.389	-0.413	-0.445	-0.421

480318.2	5776839	18.329	17.979	RES	28 MOORE ST	-0.468	-0.508	-0.549	-0.602	-0.64
480518.8	5777466	18.038	17.895	RES	129 PRINCE ST	-0.366	-0.368	-0.371	-0.376	-0.382
480490.4	5777402	18.688	17.985	RES	90 ALBERT ST	-0.965	-0.965	-0.965	-0.965	-0.954
480328.9	5776813	18.336	17.925	RES	24 MOORE ST	-0.475	-0.51	-0.546	-0.592	-0.609
480459.8	5777359	18.286	18.112	RES	95 ALBERT ST	-0.499	-0.499	-0.5	-0.5	-0.5
480244.3	5776868	18.301	18.069	RES	5 WIDDOWSON CT	-0.435	-0.439	-0.453	-0.455	-0.455
480455.1	5776846	18.262	18.128	RES	3 CHOWN CT	-0.386	-0.403	-0.403	-0.403	-0.371
480283.1	5776828	18.362	18.25	RES	4 MCLEOD CT	-0.451	-0.458	-0.46	-0.46	-0.457
480459.8	5777460	18.519	17.838	RES	131-133 PRINCE ST	-0.793	-0.793	-0.794	-0.794	-0.794
480444.5	5776867	18.273	18.041	RES	5 CHOWN CT	-0.408	-0.422	-0.423	-0.423	-0.422
480353	5776769	18.381	17.963	RES	20 MOORE ST	-0.518	-0.558	-0.599	-0.644	-0.644
480380	5776816	18.205	18.114	RES	29 MOORE ST	-0.343	-0.383	-0.424	-0.476	-0.487
480457.4	5776886	18.267	18.142	RES	6 CHOWN CT	-0.389	-0.406	-0.41	-0.41	-0.413
480474.4	5776880	18.338	18.044	RES	8 CHOWN CT	-0.454	-0.476	-0.488	-0.495	-0.488
481205.2	5777546	16.535	16.371	RES	30 QUEEN ST	-0.439	-0.525	-0.525	-0.525	-9999.99
480540.1	5777459	18.32	17.904	RES	127 PRINCE ST	-0.627	-0.627	-0.629	-0.629	-0.619
480211	5776805	18.223	18.083	RES	2 WIDDOWSON CT	-0.366	-0.405	-0.44	-0.478	-0.503
480204.4	5776878	18.199	18.041	RES	10 WIDDOWSON CT	-0.337	-0.368	-0.402	-0.435	-0.455
480223.2	5776767	18.193	17.951	RES	11 MCLEOD CT	-0.335	-0.375	-0.415	-0.455	-0.457
481245.5	5777494	17.215	16.325	RES	23 QUEEN ST	-0.92	-1.191	-1.184	-1.184	-1.194
480241.3	5776774	18.185	18.172	RES	9 MCLEOD CT	-0.326	-0.363	-0.39	-0.417	-0.411
480199.1	5776866	18.208	18.029	RES	8 WIDDOWSON CT	-0.352	-0.391	-0.431	-0.467	-0.469

480585.4	5777309	18.19	18.069	RES	17 MACKAY ST	-0.614	-0.613	-0.613	-0.614	-0.627
480211	5776826	18.226	17.879	RES	4-6 WIDDOWSON CT	-0.369	-0.409	-0.449	-0.502	-0.551
479505.1	5772309	49.766	49.412	RES	FRIENDS RD	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
481906.2	5773088	40.846	40.695	RES	472 FAIRLEYS RD	-0.306	-0.306	-0.306	-0.307	-0.304
482052.2	5776570	17.192	16.842	RES	61 HUFFERS LANE	-0.586	-0.586	-0.586	-0.586	-0.579
482035	5777589	14.898	14.354	RES	41 MILL LANE	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
482040.1	5777454	17.145	16.606	RES	38 MILL LANE	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
482061.4	5776638	16.536	16.483	RES	FAWKES RD	0.058	-0.016	-0.102	-0.234	-0.258
481522.7	5776629	17.283	16.625	RES	9 HUFFERS LANE	-0.428	-0.446	-0.47	-0.52	-0.634
481892.2	5777620	15.494	15.168	RES	45 MILL LANE	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
482213.4	5776681	16.652	16.522	RES	LOT 14 FAWKES RD	-0.096	-0.167	-0.252	-0.355	-0.337
480077.8	5774913	35.034	34.776	RES	5 BELLE VIEW CT	-0.282	-0.288	-0.296	-0.313	-0.35
482031.2	5776485	17.611	16.76	RES	58 HUFFERS LANE	-0.964	-1.001	-1.012	-1.018	-1.019
483638.6	5776701	15.226	15.104	RES	45 KYLE ST	-0.134	-0.3	-0.383	-0.385	-0.38
479895	5776111	19.259	18.888	RES	18 FRIENDS RD	0.005	-0.098	-0.218	-0.404	-0.567
481224.5	5775850	19.611	19.516	RES	124 WILLUNG RD	-0.38	-0.381	-0.381	-0.381	-0.379
483154.7	5776489	16.497	16.027	RES	171 HUFFERS LANE	-0.718	-0.729	-0.729	-0.73	-0.707
482433.2	5775729	26.128	25.982	RES	105 ROSEDALE-STRADBROKE RD	-0.202	-0.205	-0.207	-0.209	-0.222
479421.6	5776258	19.665	19.554	RES	105 SHAWS LANE	-0.25	-0.25	-0.25	-0.25	-0.218
479624.5	5776394	18.59	18.434	RES	206 ROSEDALE-FLYNNS CREEK RD	-0.391	-0.408	-0.426	-0.461	-0.476
483659.4	5776535	15.528	15.353	RES	24 KYLE ST	-0.39	-0.497	-0.51	-0.51	-0.523

483674.8	5776397	15.233	15.227	RES	12 KYLE ST	0.032	-0.035	-0.162	-0.3	-0.309
480234.1	5776108	19.69	19.63	RES	34 FRIENDS RD	-0.037	-0.038	-0.038	-0.039	-0.037
483200.5	5776602	15.804	15.713	RES	24 MERRIMAN ST	-0.174	-0.284	-0.334	-0.334	-0.334
483851.1	5776823	15.193	14.881	RES	61 KYLE ST	-0.244	-0.386	-0.485	-0.485	-0.49
483874.8	5776844	14.85	14.779	RES	61 KYLE ST	0.058	-0.089	-0.217	-0.239	-0.244
479365.4	5776287	19.666	19.408	RES	99 SHAWS LANE	-0.442	-0.449	-0.451	-0.455	-0.458
483161.2	5776773	15.906	15.555	RES	48 MERRIMAN ST	-0.283	-0.41	-0.548	-0.557	-0.558
481266.6	5775974	19.468	18.539	RES	112 WILLUNG RD	-0.921	-0.966	-0.992	-0.999	-1.021
480844.2	5774385	32.929	32.545	RES	276 WILLUNG RD	-0.71	-0.72	-0.734	-0.743	-0.74
483567.3	5776779	14.996	14.83	RES	46 KYLE ST	0.14	-0.027	-0.193	-0.276	-0.291
483151	5776860	15.74	15.596	RES	47 MERRIMAN ST	-0.106	-0.222	-0.276	-0.358	-0.378
482972	5776669	16	15.747	RES	35 MERRIMAN ST	-0.243	-0.377	-0.461	-0.47	-0.452
479962.9	5776421	18.628	18.087	RES	166 ROSEDALE-FLYNNS CREEK RD	-0.604	-0.636	-0.667	-0.703	-0.74
480701.7	5772735	49.723	49.182	RES	440 WILLUNG RD	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
480855.1	5772556	51.161	50.326	RES	451 WILLUNG RD	-9999.99	-9999.99	-9999.99	-9999.99	-9999.99
482930.9	5776455	16.307	16.212	RES	149 HUFFERS LANE	-0.284	-0.335	-0.344	-0.344	-0.341
479481.3	5776329	19.197	18.751	RES	212 ROSEDALE-FLYNNS CREEK RD	-0.636	-0.636	-0.636	-0.636	-0.63
483191.9	5776843	16.616	15.396	RES	59 MERRIMAN ST	-1.037	-1.158	-1.219	-1.272	-1.305
479566	5776324	19.004	18.87	RES	208 ROSEDALE-FLYNNS CREEK RD	-0.457	-0.458	-0.458	-0.46	-0.456
480196.9	5776459	18.525	18.159	RES	2 FRIENDS RD	-0.501	-0.51	-0.52	-0.535	-0.544

480279.8	5776462	18.699	18.585	RES	133 ROSEDALE-FLYNNS CREEK RD	-0.514	-0.514	-0.515	-0.515	-0.533
479337.9	5776262	20.197	19.777	RES	97 SHAWS LANE	-0.62	-0.62	-0.62	-0.621	-0.622
479492.3	5775335	24.288	24.164	RES	29 ASHTON CT	0.049	0.016	-0.011	-0.04	-0.067
479329.6	5775870	25.38	25.19	RES	9 BOYD CT	-0.551	-0.556	-0.561	-0.568	-0.582
479247.9	5776121	21.309	20.716	RES	236 ROSEDALE-FLYNNS CREEK RD	-0.827	-0.829	-0.833	-0.834	-0.841
479492.2	5775581	28.631	28.013	RES	60 BOYD CT	-0.713	-0.714	-0.714	-0.714	-0.725
479649.4	5776342	18.417	18.154	RES	196 ROSEDALE-FLYNNS CREEK RD	-0.144	-0.178	-0.214	-0.277	-0.365
479636	5776339	18.387	18.335	RES	196 ROSEDALE-FLYNNS CREEK RD	-0.097	-0.131	-0.169	-0.229	-0.278
479744.7	5777062	18.05	17.449	RES	BYES LANE	-0.707	-0.768	-0.769	-0.769	-0.775
480098.8	5776748	18.236	18.131	RES	15 MCLEOD CT	-0.355	-0.372	-0.387	-0.4	-0.399
480412.2	5777432	18.526	18.033	RES	96-98 ALBERT ST	-0.722	-0.724	-0.724	-0.725	-0.726
480514.4	5776814	18.117	17.951	RES	14 ROWLEY CL	-0.257	-0.296	-0.335	-0.357	-0.345
480441.8	5776788	18.181	17.961	RES	6 ROWLEY CL	-0.319	-0.358	-0.396	-0.446	-0.479
480422.5	5776778	18.013	17.852	RES	4 ROWLEY CL	-0.151	-0.19	-0.231	-0.283	-0.336
483595.7	5776453	15.408	15.335	RES	17 KYLE ST	-0.144	-0.212	-0.288	-0.356	-0.343
480536.4	5776825	18.276	18.092	RES	16 ROWLEY CL	-0.408	-0.421	-0.432	-0.448	-0.439
480500	5776836	18.187	17.936	RES	9 ROWLEY CL	-0.326	-0.366	-0.407	-0.457	-0.479
480475.7	5776802	18.15	17.947	RES	10 ROWLEY CL	-0.289	-0.328	-0.369	-0.421	-0.468
480495	5776811	18.088	17.892	RES	12 ROWLEY CL	-0.227	-0.266	-0.307	-0.36	-0.412
483672.2	5776774	15.447	14.712	RES	47 KYLE ST	-0.374	-0.537	-0.663	-0.687	-0.697

480519.6	5776846	18.176	18.018	RES	11 ROWLEY CL	-0.316	-0.355	-0.395	-0.411	-0.39
480557	5776828	18.278	18.061	RES	18 ROWLEY CL	-0.418	-0.425	-0.429	-0.43	-0.428
480343.5	5776978	18.498	18.388	RES	39-45 GEORGE ST	-0.416	-0.417	-0.417	-0.42	-0.423
483440.8	5776348	15.52	15.365	RES	203 HUFFERS LANE	-0.01	-0.1	-0.246	-0.401	-0.406
480573.4	5776844	18.205	18	RES	20 ROWLEY CL	-0.347	-0.347	-0.347	-0.348	-0.347
483717	5776698	15.279	14.574	RES	48 KYLE ST	-0.229	-0.392	-0.544	-0.768	-0.791
480401.2	5776771	18.177	18.066	RES	2 ROWLEY CL	-0.315	-0.355	-0.384	-0.444	-0.468
480456.6	5776796	18.162	18.039	RES	8 ROWLEY CL	-0.301	-0.34	-0.38	-0.433	-0.485
480556.3	5776860	18.26	18.109	RES	15 ROWLEY CL	-0.384	-0.409	-0.418	-0.422	-0.42
480541.6	5776861	18.215	17.994	RES	13 ROWLEY CL	-0.352	-0.373	-0.389	-0.392	-0.395
481209.9	5777019	17.438	16.772	RES	1 DAWSON ST	-0.421	-0.458	-0.485	-0.532	-0.522

AEP Design Event	Flood Consequences Red text denotes a road not inundated in the previous AEP event

10% AEP

Street	Length (m)	Peak depth (m)
MERRIMAN STREET	140.3	0.2
HOOD STREET	181.9	0.2
MILL LANE	110.4	0.2
MCPHERSONS LANE	156.1	0.2
WALTON STREET	69.9	0.2
LATROBE STREET	168.9	0.2
FARRELL LANE	374.6	0.2
WILLUNG ROAD	208.6	0.2
WILLIAMS ROAD	131.1	0.2
FRIENDS ROAD	361.7	0.2
HOOPERS ROAD	389.1	0.2
DAWSON STREET	212.3	0.2
GEORGE STREET	190.3	0.2
DUKE STREET	244.8	0.3
ASHTON COURT	138.5	0.3
CANSICK STREET	98.6	0.3
BUDGES LANE	227.3	0.3
HUFFERS LANE	389.3	0.3
ROSEDALE-STRADBROKE ROAD	505.0	0.4
KYLE STREET	161.5	0.4
AYRES COURT	123.5	0.4
CRICKET STREET	153.7	0.4
MOORE STREET	442.8	0.5
MULLOCKY LANE	1003.6	0.5
ROWLEY CLOSE	175.5	0.5
MCLEOD COURT	180.5	0.7
WIDDOWSON COURT	87.2	0.8
FARLEYS ROAD	329.0	1.4
ROSEDALE-FLYNNS CREEK ROAD	617.9	1.5
PRINCES HIGHWAY	324.2	1.7
Residential Buildings Flooded Above Floor	**0**	
Commercial Buildings Flooded Above Floor	**0**	
Properties Flooded Below Floor	**177**	

5% AEP

Street	Length (m)	Peak Depth (m)
ALBERT STREET	419.0	0.3
ASHTON COURT	144.5	0.3
AYRES COURT	129.7	0.4
BUDGES LANE	399.2	0.6
BYES LANE	32.6	0.3
CANSICK STREET	530.3	0.4
CHOWN COURT	55.4	0.5
CRICKET STREET	225.1	0.5

	DAWSON STREET	314.5	0.4
	DUKE STREET	343.5	0.5
	FARLEYS ROAD	430.4	1.6
	FARRELL LANE	426.1	0.2
	FRIENDS ROAD	529.9	0.2
	GEORGE STREET	220.6	0.3
	HOOD STREET	412.3	0.4
	HOOPERS ROAD	426.7	0.2
	HUFFERS LANE	633.1	0.4
	KYLE STREET	216.3	0.4
	LATROBE STREET	271.6	0.2
	MCLEOD COURT	180.5	0.8
	MCPHERSONS LANE	195.3	0.2
	MOORE STREET	478.5	0.5
	MULLOCKY LANE	1033.2	0.8
	PRINCES HIGHWAY	334.9	1.8
	ROSEDALE-FLYNNS CREEK ROAD	930.6	1.6
	ROSEDALE-STRADBROKE ROAD	742.9	0.3
	ROWLEY CLOSE	191.5	0.6
	WALTON STREET	87.1	0.2
	WIDDOWSON COURT	87.2	0.8
	WILLIAMS ROAD	272.6	0.2
	WILLUNG ROAD	1252.0	0.3
	Residential Buildings Flooded Above Floor	**1**	
	Commercial Buildings Flooded Above Floor	**1**	
	Properties Flooded Below Floor	**212**	

	Street	Length (m)	Peak Depth (m)
2% AEP	ALBERT STREET	506.1	0.5
	ASHTON COURT	157.8	0.3
	AYRES COURT	134.5	0.5
	BUDGES LANE	419.8	0.7
	CANSICK STREET	857.3	0.4
	CHOWN COURT	55.4	0.5
	CRICKET STREET	337.5	0.6
	DAWSON STREET	347.5	0.5
	DUKE STREET	382.4	0.6
	EVERGREEN ROAD	556.5	0.2
	FARLEYS ROAD	516.2	1.7
	FARRELL LANE	432.4	0.3
	FAWKES ROAD	177.3	0.3
	FRIENDS ROAD	597.1	0.3
	GEORGE STREET	220.4	0.3
	HOOD STREET	488.6	0.5
	HOOPERS ROAD	426.6	0.2
	HUFFERS LANE	1023.1	0.6
	KYLE STREET	676.3	0.6

	LATROBE STREET	403.2	0.3
	MCLEOD COURT	180.5	0.8
	MCPHERSONS LANE	222.0	0.3
	MILL LANE	354.0	0.4
	MOORE STREET	514.2	0.6
	MULLOCKY LANE	1064.8	1.0
	PRINCES HIGHWAY	407.6	1.9
	QUEEN STREET	413.1	0.2
	ROSEDALE-FLYNNS CREEK ROAD	1148.6	1.7
	ROSEDALE-LONGFORD ROAD	911.0	0.2
	ROSEDALE-STRADBROKE ROAD	803.4	0.4
	ROWLEY CLOSE	193.6	0.6
	WALTON STREET	99.6	0.3
	WIDDOWSON COURT	87.2	0.9
	WILLIAMS ROAD	365.9	0.3
	WILLUNG ROAD	1349.3	0.3
	WOOD STREET	172.0	0.2
	Residential Buildings Flooded Above Floor	**1**	
	Commercial Buildings Flooded Above Floor	**5**	
	Properties Flooded Below Floor	**219**	

	Street	Length (m)	Peak Depth (m)
1% AEP	ALBERT STREET	531.6	0.5
	ASHTON COURT	165.4	0.3
	AYRES COURT	136.5	0.5
	BUDGES LANE	437.8	0.8
	BYES LANE	63.2	0.6
	CANSICK STREET	937.9	0.5
	CHOWN COURT	55.4	0.6
	CRICKET STREET	442.8	0.7
	DAWSON STREET	351.6	0.6
	DUKE STREET	458.7	0.6
	EVERGREEN ROAD	577.6	0.2
	FARLEYS ROAD	593.0	1.8
	FARRELL LANE	430.2	0.3
	FAWKES ROAD	177.3	0.4
	FRIENDS ROAD	619.6	0.3
	GEORGE STREET	224.9	0.3
	HOOD STREET	520.0	0.5
	HOOPERS ROAD	435.5	0.2
	HUFFERS LANE	1123.5	0.6
	KYLE STREET	781.5	0.7
	LATROBE STREET	411.5	0.3
	MACKAY STREET	146.0	0.2
	MCLEOD COURT	180.5	0.9
	MCPHERSONS LANE	259.3	0.3

	MERRIMAN STREET	580.3	0.3
	MILL LANE	409.4	0.5
	MOORE STREET	535.0	0.6
	MULLOCKY LANE	1079.1	1.1
	PRINCES HIGHWAY	430.7	2.0
	QUEEN STREET	454.5	0.3
	ROSEDALE-FLYNNS CREEK ROAD	1198.3	1.8
	ROSEDALE-LONGFORD ROAD	1320.4	0.2
	ROSEDALE-STRADBROKE ROAD	808.0	0.4
	ROWLEY CLOSE	193.6	0.7
	WALTON STREET	102.5	0.3
	WIDDOWSON COURT	87.2	0.9
	WILLIAMS ROAD	369.2	0.3
	WILLUNG ROAD	1384.0	0.4
	WOOD STREET	216.1	0.3
	Residential Buildings Flooded Above Floor	**2**	
	Commercial Buildings Flooded Above Floor	**7**	
	Properties Flooded Below Floor	**234**	

	Street	Length (m)	Peak Depth (m)
0.5% AEP	ALBERT STREET	638.4	0.5
	ASHTON COURT	221.1	0.3
	AYRES COURT	139.4	0.5
	BUDGES LANE	541.9	0.8
	BYES LANE	115.0	1.3
	CANSICK STREET	972.4	0.5
	CHOWN COURT	55.4	0.6
	CRICKET STREET	646.6	1.2
	DAWSON STREET	436.6	0.6
	DUCK COURT	86.8	0.3
	DUKE STREET	615.6	0.6
	EVERGREEN ROAD	765.7	0.2
	FARLEYS ROAD	1052.1	1.9
	FARRELL LANE	796.3	0.3
	FAWKES ROAD	177.3	0.5
	FRIENDS ROAD	909.8	0.3
	GEORGE STREET	315.8	0.3
	HOOD STREET	591.5	0.5
	HOOPERS ROAD	505.0	0.2
	HUFFERS LANE	1288.9	0.6
	KYLE STREET	789.1	0.9
	LATROBE STREET	525.9	0.4
	MACKAY STREET	317.1	0.2
	MCLEOD COURT	180.5	0.9
	MCPHERSONS LANE	425.9	0.4
	MERRIMAN STREET	584.5	0.4
	MILL LANE	497.6	0.6

	MOORE STREET	551.7	0.7
	MULLOCKY LANE	1323.7	1.1
	PRINCES HIGHWAY	503.4	3.2
	QUEEN STREET	707.2	0.7
	ROSEDALE-FLYNNS CREEK ROAD	1371.3	1.9
	ROSEDALE-LONGFORD ROAD	1508.4	0.3
	ROSEDALE-STRADBROKE ROAD	1365.2	0.4
	ROWLEY CLOSE	193.6	0.7
	WALTON STREET	169.6	0.4
	WIDDOWSON COURT	87.2	0.9
	WILLIAMS ROAD	406.1	0.3
	WILLUNG ROAD	1675.6	0.4
	WOOD STREET	272.9	0.3
	Residential Buildings Flooded Above Floor	**7**	
	Commercial Buildings Flooded Above Floor	**8**	
	Properties Flooded Below Floor	**239**	