Greater Geelong

FLOOD EMERGENCY PLAN

A Sub-Plan of the Municipal Emergency Management Plan

For City of Greater Geelong Council and VICSES Bellarine, Geelong, Corio and South Barwon Units

Version 4.2, August 2022

GREATER GEELONG MEMPC
MUNICIPAL EMERGENCY MANAGEMENT PLANNING COMMITTEE

VICTORIA
State Government

SES

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Distribution of MFEP

Once endorsed and signed the, MFEP should be distributed to all MFEP committee members, MEMPC Chair, council, MEMO, Deputy MEMO, Representatives from; BoM, CMA, DELWP, Parks Victoria, Ambulance Victoria, Department of Transport, DFFH, relevant utilities, FRV, MERC, RERC, Police station, VICSES Units, VICSES Regional office, CFA Brigades, CFA Regional office.

Document Transmittal Form / Amendment Certificate

This Municipal Flood Emergency Plan (MFEP) will be amended, maintained and distributed as required or every 3 years facilitated by VICSES in consultation with the Municipal Emergency Management Planning Committee (MEMPC)

Suggestions for amendments to this Plan should be forwarded to VICSES Regional Office via SouthWest@ses.vic.gov.au.

The VICSES MFEP template 6.0 was used to develop this Plan.

Amendments listed below have been included in this Plan and updated as a new version.

Amendment Number	Date of Amendment	Amendment Entered By	Summary of Amendment
V3.0	May 2013	SES	Incorporated operations documents into report.
V3.1	November 2020	Water Technology	Update into new MFEP template version 6, and incorporate results from recently completed flood studies.
V3.2	March 2021	Clare Mintern	Incorporate results from recently completed flood studies.
V3.3	July 2021	Clare Mintern	Incorporate input from COGG and CCMA
V3.4	22/09/2021	Chris Longmore	Amended references to new legislation, administrative and formatting updates.
V3.5	22/10/2021	Marisha Patton	Sewerage Infrastructure, administrative updates
V4.0	22/10/2021	Chris Longmore	Final version for MEMPC & REMPC endorsement
V4.1	7/06/2022	Ross Butler	Reintroduction of Little River Map in Appendix E and update of Bookmark formatting
	June 2022		Endorsed MFEP by REMPC
V4.2	July 2022	Marisha Patton	MEMPC approved name change of MFEP in line with MEMP naming protocols

This Plan will be maintained on the VICSES website at www.ses.vic.gov.au/get-ready/your-local-flood-information and City of Greater Geelong website https://www.geelong.vic.gov.au/page/HomePage.aspx

List of Abbreviations & Acronyms

The following abbreviations and acronyms are used in the Plan			
AAR	After Action Review	**IMS**	Incident Management System
AEP	Annual Exceedance Probability	**IMT**	Incident Management Team
AHD	Australian Height Datum (the height of a location above mean sea level in metres)	**JSOP**	Joint Standard Operating Procedure
AIDR	Australian Institute of Disaster Resilience	**LSIO**	Land Subject to Inundation Overlay
AIIMS	Australasian Inter-service Incident Management System	**MEMP**	Municipal Emergency Management Plan
AoOCC	Area of Operations Control Centre / Command Centre	**MEMPC**	Municipal Emergency Management Planning Committee
ARI	Average Recurrence Interval	**MERC**	Municipal Emergency Response Coordinator
ARMCANZ	Agricultural & Resource Management Council of Australia & New Zealand	**MEMO**	Municipal Emergency Management Officer
AV	Ambulance Victoria	**MFEP**	Municipal Flood Emergency Plan
BoM	Bureau of Meteorology	**MFPC**	Municipal Flood Planning Committee
CEO	Chief Executive Officer	**MRM**	Municipal Recovery Manager
CERA	Community Emergency Risk Assessment	**PMF**	Probable Maximum Flood
CFA	Country Fire Authority	**RAC**	Regional Agency Commander
CMA	Catchment Management Authority	**RCC**	Regional Control Centre
DELWP	Department of Environment, Land, Water and Planning	**RDO**	Regional Duty Officer
DFFH	Department of Families, Fairness and Housing	**RERC**	Regional Emergency Response Coordinator
DJPR	Department of Jobs, Precincts and Regions	**REMP**	Region Emergency Management Plan
EMLO	Emergency Management Liaison Officer	**SAC**	State Agency Commander
EMV	Emergency Management Victoria	**SBO**	Special Building Overlay
EMT	Emergency Management Team	**SCC**	State Control Centre
ERC	Emergency Relief Centre	**SDO**	State Duty Officer
EO	Executive Officer	**SEMP**	State Emergency Management Plan
FO	Floodway Overlay	**SEWS**	Standard Emergency Warning Signal
FRV	Fire Rescue Victoria	**SOP**	Standard Operating Procedures
IIA	Initial Impact Assessment	**VICPOL**	Victoria Police
EMT	Emergency Management Team	**VICSES**	Victoria State Emergency Service

Part 1. Introduction

1.1 Approval and Endorsement

This Municipal Flood Emergency Plan (MFEP) has been prepared by VICSES, Corangamite CMA, and City of Greater Geelong Council staff with the authority of the Greater Geelong Municipal Emergency Management Planning Committee (Greater Geelong MEMPC) pursuant to Section 20 of the Emergency Management Act 1986 (as amended).

VICSES staff have undertaken consultation with City of Greater Geelong staff, Corangamite CMA staff, Bellarine, Geelong, Corio and South Barwon VICSES Unit members regarding the arrangements contained within this plan.

This MFEP is a sub plan to the Greater Geelong Municipal Emergency Management Plan (MEMP), is consistent with the Victorian State Emergency Management Plan (SEMP) and the Victorian Floodplain Management Strategy (2016), and takes into account the outcomes of the Community Emergency Risk Assessment (CERA) process undertaken by the Greater Geelong MEMPC.

The MFEP is consistent with the South West Regional Flood Emergency Plan (RFEP), a sub-plan of the Regional Emergency Management Plan (REMP).

This MFEP is a result of the cooperative efforts of the Greater Geelong Municipal (Emergency) Flood Management Sub-Committee (MFMC) and its member agencies.

This Plan is submitted by the VICSES Regional Manager as the preparer of the document.

This Plan is approved by the Greater Geelong MEMPC and endorsed by the Barwon South West Regional Emergency Management Planning Committee (REMPC) as a sub-plan to the MEMP.

(For MEMP and MEMP sub-plans) **On behalf of the Municipal Emergency Management Planning Committee:**  Guy Wilson-Browne Chair, Municipal Emergency Management Planning Committee Date: 08/12/2021	*(For sub-plans only, if prepared by an agency on behalf of the MEMPC)* **Nominated representative of preparer:**  Nicholas Cowham Regional Manager, VICSES Date: 10/11/2021

Approved on behalf of the Barwon South West Regional Emergency Management Planning Committee:

Mick McGuinness
Regional Emergency Management Planning Committee
Chair, Fire Rescue Victoria Western District 3 ACFO
Date: 24/06/2022

1.2 Purpose and Scope of this Flood Emergency Plan

The purpose of this MFEP is to detail arrangements agreed for managing a flood emergency before, during and after it occurs or potentially occurs within City of Greater Geelong local government area.

As such, the scope of the Plan is to:

- Identify the local flood risk
- Support the implementation of mitigation and planning measures to minimise the causes and impacts of flooding
- Detail emergency management arrangements
- Identify linkages with Local, Regional and State emergency and wider planning arrangements with a specific emphasis on those relevant to flood.

1.3 Responsibility for Planning, Review & Maintenance of this Plan

This MFEP must be maintained in order to remain effective.

VICSES through the MFMC has responsibility for facilitating the preparation, review, maintenance and distribution of this plan.

The MFMC will meet four times per year. The plan should be reviewed following:

- A new flood study
- A significant change in flood mitigation measures
- After the occurrence of a significant flood event within the Municipality
- Or if none of the above occur, every 3 years.

Part 2. BEFORE: Prevention / preparedness arrangements

2.1 Community Engagement and Awareness

Details of this MFEP will be released to the community through; local media, any Flood Planning engagement initiatives and websites (VICSES and the Municipality) upon formal adoption by VICSES, the MEMPC and REMPC.

VICSES with the support of City of Greater Geelong Council and Corangamite CMA will coordinate targeted community flood engagement programs within the council area.

Refer to **Appendix G**.

2.2 Structural Flood Mitigation Measures

The City of Greater Geelong Council have undertaken an extensive flood mitigation works including construction of levees, upgrading drainage infrastructure (pipes, pits) and the construction of retarding basins.

The City of Greater Geelong Council manage and maintain the levees within Lara and Barwon Heads that have been constructed to protect residential areas. Refer to **Appendix C1** for more details regarding Lara's levees. Refer to **Appendix C4** for more details regarding Barwon Heads levee.

2.3 Non-structural Flood Mitigation Measures

2.3.1 Exercising the Plan

Arrangements for exercising this Plan will be at the discretion of the MEMPC. It is recommended that the MFEP is exercised on an annual basis and reviewed in line with Section 1.3 of this document.

2.3.2 Flood Warning

Arrangements for Bureau issued Flood Watch and Flood Warning products are contained within the SEMP and on the Bureau of Meteorology (BoM) website www.bom.gov.au.

Details on Warnings issued by VICSES through VicEmergency and VICSES channels are outlined in **Appendix D.**

2.3.3 Local Knowledge

Community Observers provide local knowledge to VICSES and the Incident Control Centre regarding local insights and the potential impacts and consequences of an incident and may assist with the dissemination of information to community members.

Specific details of arrangements to capture local knowledge are provided in **Appendix F & G.**

Part 3. DURING: Response arrangements

3.1 Introduction

3.1.1 Activation of Response

Flood response arrangements may be activated by the Regional Duty Officer (RDO) VICSES Barwon South West Region or Regional Agency Commander (RAC).

The VICSES Incident Controller (IC) / RDO will activate agencies as required as documented in the State Flood Sub-plan.

3.1.2 Responsibilities

There are a number of agencies with specific roles that will act in support of VICSES and provide support to the community in the event of a serious flood within the City of Greater Geelong Local Government Area. These agencies will be engaged through the Incident Emergency Management Team (IEMT) when enacted or via the RAC when the IEMT is not enacted.

The general roles and responsibilities of supporting agencies are as agreed within the MEMP and SEMP.

3.1.3 Emergency Coordination Centre or equivalent

If established, liaison with the emergency coordination centre will be through the established Division/Sector Command and through Municipal involvement in the IEMT, in particular the Municipal Emergency Response Coordinator (MERC). The VICSES RDO / Incident Control Centre (ICC) will liaise with the centre directly if no Division/Sector Command is established.

The function, location, establishment and operation of an emergency coordination centre if relevant will be as detailed in the MEMP.

3.1.4 Escalation

Many flood incidents are of local concern and an appropriate response can usually be coordinated using local resources. However, when these resources are exhausted, the State's arrangements provide for further resources to be made available, firstly from neighbouring Municipalities (on a regional basis) and then on a State-wide basis.

Resourcing and event escalation arrangements are described in the SEMP.

3.2 Response Arrangements

Arrangements in this MFEP must be consistent the response arrangements detailed in State and Regional Flood Emergency Sub Plans and the MEMP. For further information, refer to the SEMP.

Specific details of arrangements for this plan are to be provided in **Appendix C.**

3.2.1 Control

The *Victoria State Emergency Service Act 2013 and* The *Emergency Management Act 2013* provides the authority for VICSES to respond to flood and is detailed in the SEMP - Roles and Responsibilities. The SEMP outlines VICSES's responsibility for Flood emergency planning including readiness

The SEMP, prepared under the *Emergency Management Act 2013*, identifies VICSES as the Control Agency for flood. The SEMP identifies DELWP as the Control Agency responsible for "dam safety", reticulated water and wastewater (sewerage) services" and other emergencies. A more detailed explanation of roles and responsibilities is provided in the SEMP.

All flood response activities within the City of Greater Geelong Council including those arising from a dam failure or retarding basin / levee bank failure incident will therefore be under the control of the appointed IC, or delegated representative.

3.2.2 Incident Controller (IC)

As required, the IC will establish an ICC from which to initiate incident response command and control functions. The decision as to if and when the ICC should be activated, rests with the Control Agency (i.e. VICSES).

3.2.3 Pre-determined ICC locations

Pre-determined ICC locations are available in the MEMP.

3.2.4 Divisions and Sectors

To ensure that effective Command and Control arrangements are in place, the IC may establish Divisions and sectors depending upon the complexity of the event and resource capacities.

The following Divisions and Sectors may be established to where applicable to assist with the management of flooding within the Municipality:

Division	Sector
Geelong	South Barwon
	Corio
	Geelong
	Bellarine

3.2.5 Incident Management Team (IMT)

The IC will form an Incident Management Team (IMT).

Refer to the SEMP for guidance on IMTs and Incident Management Systems (IMSs).

3.2.6 Incident Emergency Management Team (IEMT)

The IC will establish a multi-agency Incident Emergency Management Team (IEMT) to assist the flood response. The IEMT consists of key personnel (with appropriate authority) from stakeholder agencies and relevant organisations who need to be informed of strategic issues related to incident control. They are able to provide high level strategic guidance and policy advice to the IC for consideration in developing incident management strategies.

Organisations, including City of Greater Geelong Council, required within the IEMT will provide an Emergency Management Liaison Officer (EMLO) to the ICC if and as required as well as other staff and / or resources identified as being necessary, within the capacity of the organisation.

Refer to the SEMP for guidance on IEMTs.

3.2.7 On Receipt of a Flood Watch / Severe Weather Warning

VICSES SOP008 and SOP009 outline in detail the actions to be undertaken upon receipt of a Flood Watch/Flood Warning or Sever Weather Warning. VICSES RDO (until an incident controller is appointed) or IC will undertake actions as defined within the flood intelligence cards (**Appendix C**). General considerations by the IC/VICSES RDO will be as follows:

- Review flood intelligence to assess likely flood consequences
- Monitor weather and flood information – www.bom.gov.au
- Assess Command and Control requirements.
- Review local resources and consider needs for further resources regarding personnel, property protection, flood rescue and air support
- Notify and brief appropriate officers. This includes Regional Control Centre (RCC) (if established), State Control Centre (SCC) (if established), Council, other emergency services through the EMT.
- Assess ICC readiness (including staffing of IMT and IEMT) and open if required
- Ensure flood warnings and community information is prepared and issued to the community where required
  - Flood (Riverine and flash) Warnings are managed by the RDO/RAC
  - Severe Weather/Thunderstorm warnings are managed by SDO/SAC
- Develop media and public information management strategy
- Monitor watercourses and undertake reconnaissance of low-lying areas
- Ensure flood mitigation works are being checked by owners
- Develop and issue incident action plan, if required
- Develop and issue situation report, if required

3.2.8 On Receipt of the First and Subsequent Flood Warnings

VICSES RDO (until an incident controller is appointed) or IC will undertake actions as defined within the flood intelligence cards **(Appendix C).** General considerations by the IC/VICSES RDO will be as follows:

- Develop an appreciation of current flood levels and predicted levels. Are floodwaters, rising, peaking or falling?
- Review flood intelligence to assess likely flood consequences.
- Consider:
  - What areas may be at risk of inundation?
  - What areas may be at risk of isolation?
  - What areas may be at risk of indirect affects as a consequence of power, gas, water, telephone, sewerage, health, transport or emergency service infrastructure interruption?
  - The characteristics of the populations at risk
- Determine what the at-risk community need to know and do as the flood develops.
- Warn the at-risk community including ensuring that an appropriate warning and community information strategy is implemented including details of:
  - The current flood situation
  - Flood predictions
  - What the consequences of predicted levels may be
  - Public safety advice
  - Who to contact for further information
  - Who to contact for emergency assistance
- Liaise with relevant asset owners as appropriate (i.e. water, power, roads)
- Implement response strategies as required based upon flood consequence assessment.
- Continue to monitor the flood situation – www.bom.gov.au/vic/flood/
- Continue to conduct reconnaissance of low-lying areas
- Liaise with relevant flood mitigation infrastructure managers

3.3 Initial Impact assessment

Initial impact assessments will be conducted in accordance with the SEMP to assess and record the extent and nature of damage caused by flooding. This information may then be used to provide the basis for further needs assessment and recovery planning by DFFH and recovery agencies.

3.4 Preliminary Deployments

When flooding is expected to be severe enough to cut access to towns, suburbs and/or communities the IC will consult with relevant agencies to ensure that resources are in place if required to provide emergency response. These resources might include emergency service personnel, food items and non-food items such as medical supplies, shelter, assembly areas, relief centres etc.

3.5 Response to Flash Flooding

Emergency management response to flash flooding should be consistent with the guideline for the emergency management of flash flooding contained within the State Flood Sub-plan.

When conducting pre-event planning for flash floods the following steps should be followed, and in the order as given:

1. Determine if there are barriers to evacuation by considering warning time, safe routes, resources available and etc;

2. If evacuation is possible, then evacuation should be the adopted strategy and it must be supported by a public information capability and a rescue contingency plan;

3. Where it is likely people will become trapped by floodwaters due to limited evacuation options safety advice needs to be provided to people at risk. Advice should be given to not attempt to flee by entering floodwater. If people become trapped, it may be safer to seek the highest point within the building and to telephone 000 if they require rescue.

4. For buildings known to be structurally un-suitable an earlier evacuation trigger will need to be established (return to step 1 of this cycle).

5. If an earlier evacuation is not possible then specific preparations must be made to rescue occupants trapped in structurally unsuitable buildings either pre-emptively or as those people call for help.

6. Contact the City of Greater Geelong Council MERC and MEMO at the earliest opportunity to allow for relief preparation to commence.

Due to the rapid development of flash flooding it will often be difficult, to establish relief centres ahead of actually triggering the evacuation. This is normal practice but this is insufficient justification for not adopting evacuation.

Refer to **Appendix C** for response arrangements for flash flood events.

3.6 Evacuation

The IC decides whether to warn people to evacuate or if it is recommended to evacuate immediately.

Once the decision is made VICPOL are responsible for the management of the evacuation process where possible. VICSES and other agencies will assist where practical. VICSES is responsible for the development and communication of evacuation warnings.

VICPOL and/or Australian Red Cross may take on the responsibility of registering people affected by a flood emergency including those who have been evacuated.

Refer to the SEMP and the Evacuation Guidelines for guidance of evacuations for flood emergencies.

Refer to **Appendix D** of this Plan and the MEMP for additional local evacuation considerations for the municipality.

3.7 Flood Rescue

VICSES may conduct flood rescues. Appropriately trained and equipped VICSES units or other agencies that have appropriate training, equipment and support may carry out rescues.

Rescue operations may be undertaken where voluntary evacuation is not possible, has failed or is considered too dangerous for an at-risk person or community. An assessment of available flood rescue resources (if not already done prior to the event) should be undertaken prior to the commencement of Rescue operations.

Rescue is considered a high-risk strategy to both rescuers and persons requiring rescue and should not be regarded as a preferred emergency management strategy. Rescuers should always undertake a dynamic risk assessment before attempting to undertake a flood rescue.

Victoria Police Rescue Coordination Centre should be notified of any rescues that occur: (03) 9399 7500

The following resources are available within City of Greater Geelong Council to assist with rescue Operations:

- A flood Rescue boat is located at the Geelong Unit.
- Geelong and South Barwon Units have a land based Swift Rescue Team.
- HEMS 4 Rescue helicopter is located at the Essendon Airport.

3.8 Aircraft Management

Aircraft can be used for a variety of purposes during flood operations including evacuation, resupply, reconnaissance, intelligence gathering and emergency travel.

Air support operations will be conducted under the control of the IC

The IC may request aircraft support through the State Air Desk located at the SCC will establish priorities.

Suitable airbase facilities are located at:

- Avalon Airport, 80 Beach Road, Lara.
- Barwon Heads Airport, 1405 Barwon Heads Road, Connewarre.

3.9 Resupply

Communities, neighbourhoods or households can become isolated during floods as a consequence of road closures or damage to roads, bridges and causeways. Under such circumstances, the need may arise to resupply isolated communities/properties with essential items.

When predictions/intelligence indicates that communities, neighbourhoods and/or households may become isolated, VICSES will advise businesses and/or households that they should stock up on essential items.

After the impact, VICSES can support isolated communities through assisting with the transport of essential items to isolated communities and assisting with logistics functions.

Resupply operations are to be included as part of the emergency relief arrangements with VICSES working with the relief agencies to service communities that are isolated.

3.10 Essential Community Infrastructure and Property Protection

Essential Community Infrastructure and Property (e.g. residences, businesses, roads, power supply etc.) may be affected in the event of a flood.

Small stocks of sandbags are located in key locations across the municipality (refer to **Appendix H**). The IC will determine the priorities related the use of sandbags, which will be consistent with the strategic priorities.

If VICSES sandbags are becoming limited in supply, then priority will be given to protection of Essential Community Infrastructure. Other high priorities may include for example the protection of historical buildings.

Property may be protected by:

- Sandbagging to minimise entry of water into buildings
- Encouraging businesses and households to lift or move contents
- Construction of temporary levees in consultation with the CMA, LGA and VICPOL and within appropriate approval frameworks.

The IC will ensure that owners of Essential Community Infrastructure are kept advised of the flood situation. Essential Community Infrastructure providers must keep the IC informed of their status and ongoing ability to provide services.

Contact your local VICSES representative for the most current Sandbag Guidelines or download it from IMT Toolbox in EMCOP- Operations.

Refer to **Appendix C** for further specific details of essential infrastructure requiring protection and location of sandbag collection points.

3.11 Disruption to Services

Disruption to services other than essential community infrastructure and property can occur in flood events. Refer to **Appendix C** for specific details of likely disruption to services and proposed arrangements to respond to service disruptions in City of Greater Geelong Council.

3.12 Road Closures

City of Greater Geelong Council and Regional Roads will carry out their formal functions of road closures including observation and placement of warning signs, road blocks etc. to its designated local and regional roads, bridges, walking and bike trails. City of Greater Geelong Council staff should also liaise with and advise Regional Roads as to the need or advisability of erecting warning signs and / or of closing roads and bridges under its jurisdiction. Regional Roads are responsible for designated main roads and highways and councils are responsible for the designated local and regional road network.

Regional Roads and the City of Greater Geelong Council will communicate community information regarding road closures. Information will be updated on the VIC Traffic website: https://traffic.vicroads.vic.gov.au/

Refer to **Appendix C** for specific details of potential road closures.

3.13 Dam Spilling/ Failure

DELWP is the Control Agency for dam safety incidents (e.g. breach, failure or potential breach / failure of a dam), however VICSES is the Control Agency for any flooding that may result.

DELWP have developed Dam Safety Emergency Plans for municipalities where it is applicable.

There are no major dams with potential to cause structural and community damage within the municipality.

3.14 Waste Water related Public Health Issues and Critical Sewerage Assets

Inundation of critical sewerage assets including septic tanks and sewerage pump stations may result in water quality problems within the municipality. Where this is likely to occur or has occurred the responsibility agency for the critical sewerage asset should undertake the following:

Advise VICSES of the security of critical sewerage assets to assist preparedness and response activities in the event of flood;

Maintain or improve the security of critical sewerage assets;

Check and correct where possible the operation of critical sewerage assets in times of flood;

Advise the ICC in the event of inundation of critical sewerage assets.

EPA provides a technical support agency role by, in cooperation with the control agency, providing advice to the community on the harmful effects of pollution and waste and recommended actions to protect public health.

3.15 Access to Technical Specialists

VICSSES Manages contracts with private technical specialists who can provide technical assistance in the event of flood operations or geotechnical expertise. Refer to VICSES SOP061 for the procedure to engage these specialists.

3.16 After Action Review

VICSES will coordinate after action review arrangements of flood operations as soon as practical following an event.

All agencies involved in the flood incident should be represented at the after action review.

Part 4. AFTER: Emergency relief and recovery arrangements

4.1 General

Arrangements for recovery from a flood and/or storm event within the City of Greater Geelong Council are detailed in the Greater Geelong Council MEMP.

4.2 Emergency Relief

The decision to recommend the opening of an emergency relief centre sits with the IC. The IC is responsible for ensuring that relief arrangements have been considered and implemented where required under the SEMP (Refer to “Emergency management phases” section of the SEMP).

The range and type of emergency relief services to be provided in response to a flood event will be dependent upon the size, impact, and scale of the flood. Refer to the SEMP for details of the range of emergency relief services that may be provided.

Suitable relief facilities identified for use during floods are detailed in **Appendix D** and the MEMP.

Details of the relief arrangements are available in the MEMP.

4.3 Animal Welfare

Matters relating to the welfare of livestock and companion animals (including feeding and rescue) are to be referred to Department of Jobs, Precincts and Regions (DJPR (Agriculture Victoria)).

Requests for emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue are passed to DJPR (Agriculture Victoria).

Matters relating to the welfare of wildlife are to be referred to DELWP.

Refer to **Appendix D** for animal shelter compound locations.

4.4 Transition from Response to Recovery

VICSES as the Control Agency is responsible for ensuring effective transition from response to recovery. This transition will be conducted in accordance with existing arrangements as detailed in the SEMP and the MEMP.

Appendix A: Flood threats for the City of Greater Geelong Council

This Appendix is to provide a broad overview of flood risk within the Municipality. Detailed Flood Risk Information for Individual Communities is detailed in **Appendix C.**

Coastal, Stormwater and Riverine Flooding

The City of Greater Geelong Council area is known to be impacted by riverine, stormwater and storm surge flooding. Along the coast, two estuaries that are subject to coastal flooding include the Barwon River Estuary and the Hovells Creek Estuary. For more detail refer the Estuaries section below.

The City of Greater Geelong Council is prone to frequent stormwater flooding and localised flooding, areas impacted include Lara, Ocean Grove, Barwon Heads, Geelong CBD, Highton, Newtown, Belmont, Corio, Norlane, Bell Park, Belmont, Waurn Ponds Grovedale, Newcomb, Moolap, Drysdale, Clifton Springs, Portarlington, St Leonards, Point Lonsdale and Leopold. For more detail refer the Stormwater section and **Appendix C7** below.

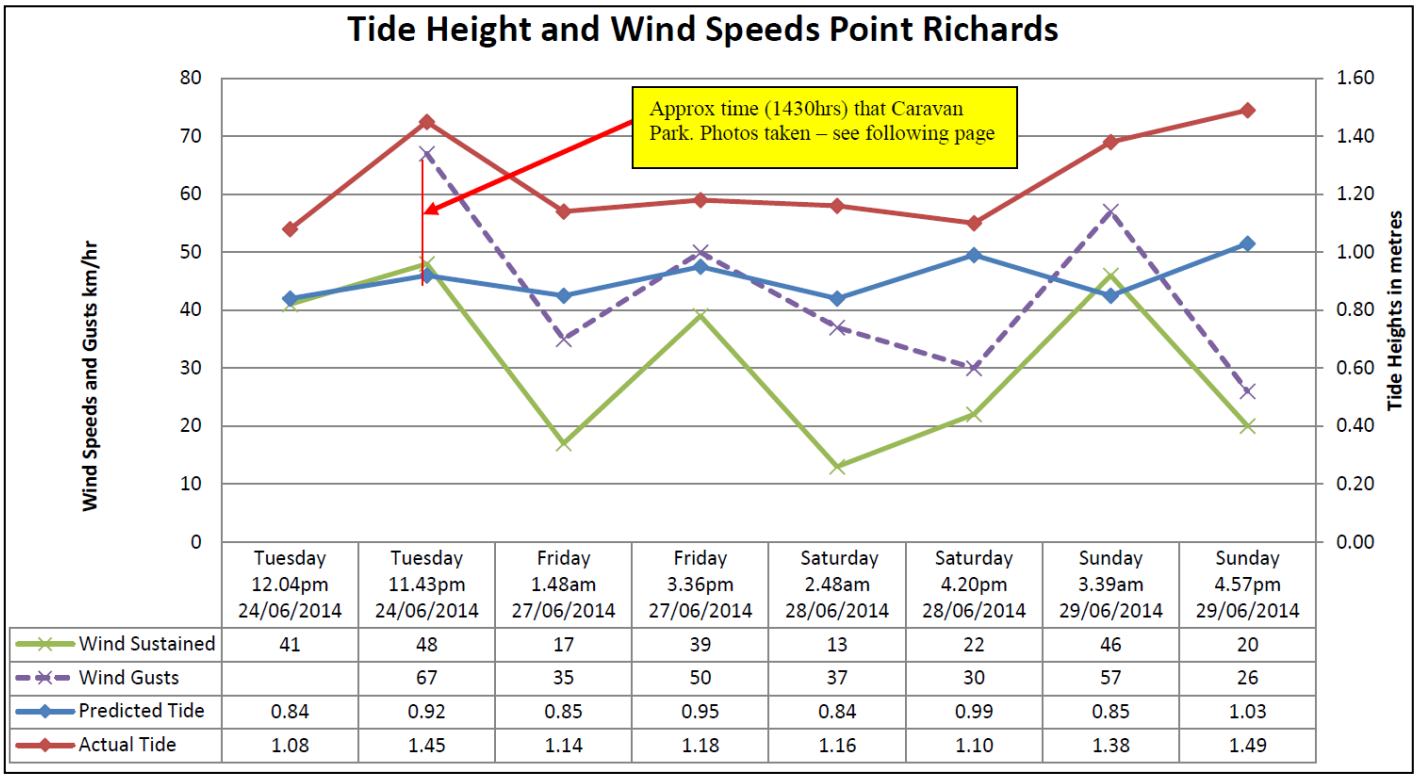
While the City of Greater Geelong Council area has a long history of being impacted by frequent riverine flood events, since the 1995 flood, most flood events have been small (less than 1 in 10 year AEP flood). Areas impacted by riverine flooding include Geelong, Fyansford, Batesford, Lara, Waurn Ponds, Armstrong Creek, Barwon Heads and Ocean Grove. The largest flood event on record was the 1952 flood event, refer to table 1 for significant flood events. Key waterways within the City of Greater Geelong Council area that are prone to flooding include the Barwon River, Leigh River, Moorabool River, Hovells Creek, Waurn Ponds Creek, Armstrong Creek, Yarram Creek, Thompson Creek, Sutherlands Creek, Cowies Creek and Little River. Refer to the map below of these waterways.

Table 1. Significant historic flood events.

Year	Description
April 2017	While this flood event did not cause significant damage to private property in Lara, it did cut access to several roads. 57 mm fell in over 24 hours.
September 2016	Minor flooding in Batesford and Geelong caused only minor impacting low lying farmland, parkland and minor roads and crossings.
January 2011	Minor flooding in Batesford and Geelong caused only minor impacting low lying farmland, parkland and minor roads and crossings.
February 2005	131 mm fell over 36 hours causing flooding in Lara. While no levees were overtopped, flooding was within 800 mm off the levee crests. Flooding caused damage to buildings and cut access to roads.
April 2001	Minor flooding in Batesford and Geelong caused only minor impacting low lying farmland, parkland and minor roads and crossings.
November 1995	This was the largest recent flood event on record for Geelong (between 1 in 50 year and 100 year ARI flood), Barwon Heads, Ocean Grove and Batesford. This flood caused considerable damage to buildings, roads, and other infrastructure. More than 174 buildings where impacted by flooding.
December 1988	This was the largest flood event on record for Lara, between a 1 in 50 and 100 year ARI flood event. Serendip Dam failed contributing to flooding in Lara. 125 mm fell in over 6 hours. This flood caused considerable damage to buildings, roads, and other infrastructure.
February 1973	This was the largest flood event on record for Lara, between a 1 in 20 and 50 year ARI flood event. This flood caused significant damage to buildings, roads, and other infrastructure.
June 1952	This was the largest flood event on record for Geelong, Barwon Heads (between 100 year and 200 year ARI flood), Ocean Grove, Lara, Batesford. 518 mm monthly rainfall recorded in June at Beech Forest, with 306mm over 5 days and 132mm on the 16th of June in the upper Barwon River catchment. This flood caused considerable damage to buildings, roads, and other infrastructure.

4.5 Storm Surge Flooding

Within the City of Greater Geelong Council area storm surge flooding is known to occur in Barwon Heads, Ocean Grove, Point Lonsdale, St Leonards, Indented Head, Portarlington, Newcombe, Moolap, Avalon and Wilsons Point. Low atmospheric depressions can cause flooding due to storm surge, resulting in abnormally high sea levels along the coastline. While there are limited records of historic storm surge events, a significant storm surge event occurred in Ocean Grove, Portarlington, Indented Head and St Leonards between the 24th to 29th of June 2014. The measured peak tide height was 1.49 m at Point Richardson, refer to graph and flood photos below. The normal tide level at Point Richards ranges from 0.5 to 0.7 m. On the 24th of June 2014 the tide height ranged from 1.08 m to 1.49 m.



	Tuesday 12.04pm 24/06/2014	Tuesday 11.43pm 24/06/2014	Friday 1.48am 27/06/2014	Friday 3.36pm 27/06/2014	Saturday 2.48am 28/06/2014	Saturday 4.20pm 28/06/2014	Sunday 3.39am 29/06/2014	Sunday 4.57pm 29/06/2014
Wind Sustained	41	48	17	39	13	22	46	20
Wind Gusts		67	35	50	37	30	57	26
Predicted Tide	0.84	0.92	0.85	0.95	0.84	0.99	0.85	1.03
Actual Tide	1.08	1.45	1.14	1.18	1.16	1.10	1.38	1.49

Figure 1. Tide and Wave measurement at Point Richards during the June 2014 storm surge flood event (COGG 2018).

Assets and roads impacted by storm surge flooding within the City of Greater Geelong Council area include;

- **Portarlington**: at the Portarlington Caravan Park. Open drains that discharge into the bay between Grassy Point Road and Hood Road tend to back up causing some localised flooding along sections of The Esplanade. Flooding also occurs at the rear of yards facing the bay along Ramblers Road (and possible flooding of houses) particularly on the eastern and western ends of Ramblers Road.
- **Indented Head:** at the Yacht Club and the Indented Head Boat Club.
- **St Leonards**: flooding occurs south of the St Leonards Yacht and Motor Squadron, Beach Road, Lower Bluff Road between Bluff Road and Perrrett Street and The Esplanade between the Salt lagoon and 361 The Esplanade.
- **Ocean Grove**: has experienced flooding on Guthridge Street roadway due to backflow within the drainage system. Refer to **Appendix C4** for more detailed information regarding flooding at Ocean Grove.

Figure 2. Storm surge flooding at the Portarlington Caravan Park during the June 2014 storm surge flood event (COGG 2018).

Figure 3. Storm surge flooding at the Portarlington Caravan Park during the June 2014 storm surge flood event (COGG 2018).

4.6 Storm Surge and Sea Level Rise Flood Mapping

4.7 **The City of Greater Geelong Council area has a unique combination of open-ocean and embayed coast along the Bellarine Peninsula and Corio Bay. The Bass Strait coast between Barwon Heads and Point Lonsdale is exposed to ocean waves, has a shallow offshore and cliffs as well as areas with soft beach sand that can reach up to 30m in height. These open ocean dynamics change at the entrance to Port Phillip Bay. While the area between Point Lonsdale and Queenscliff experiences large ocean swells and strong currents, the influence of tides and ocean waves decrease inside Port Phillip Bay. The effects of waves at Geelong or Corio Bay are very different from Point Lonsdale because waves north of Point Edwards are influenced by wind rather than ocean swell.**

4.8 **The Corio Bay area has low coastal energy compared to the rest of the study area. Wind waves are created by strong north easterly winds, typically during winter. The long fetch across the bay allows larger wind waves to develop, occasionally causing temporary inundation of the low lying areas along the northern side of the Bellarine.**

4.9 **The influence of coastal storms lasting for a few hours to a few days are responsible for temporary inundation. While future sea level rise with permanently inundate low lying areas. There are a wide range of studies have forecast rates of sea level rise. DELWP estimate there will be a rise in sea level of 0.2 by 2040, 0.49m by 2070 and 0.82m by 2100 for Victoria (DELWP 2015).**

4.10 **The storm surge and sea level rise mapping undertaken as part of the Bellarine and Corio Bay Local Hazard Assessment in 2015 identified areas prone to flooding, these include;**

- **Barwon Heads and Ocean Grove**
- **Point Lonsdale**
- **St Leonards**
- **Indented Head**
- **Portarlington**
- **Newcombe and Moolap**
- **Avalon and Wilsons Point**

4.11 **The storm surge and sea level rise maps below for the City of Greater Geelong Council area show two scenarios of 0m and 0.8m sea level rise. The 0m sea level rise scenario shows areas that are currently prone to temporary inundation from storm surge as a result of coastal storms.**

4.12 **BOM tidal Information is a good source of local information when there is storm surge potential. For BOM Marine Warnings web page: http://www.bom.gov.au/marine/**

4.13 **Also refer to MetEye for forecast wave height information: http://www.bom.gov.au/australia/meteye/?loc=VIC_FA001**

4.14 **For further general information regarding storm surge, refer to the BOM web page: http://www.bom.gov.au/cyclone/about/stormsurge.shtml**

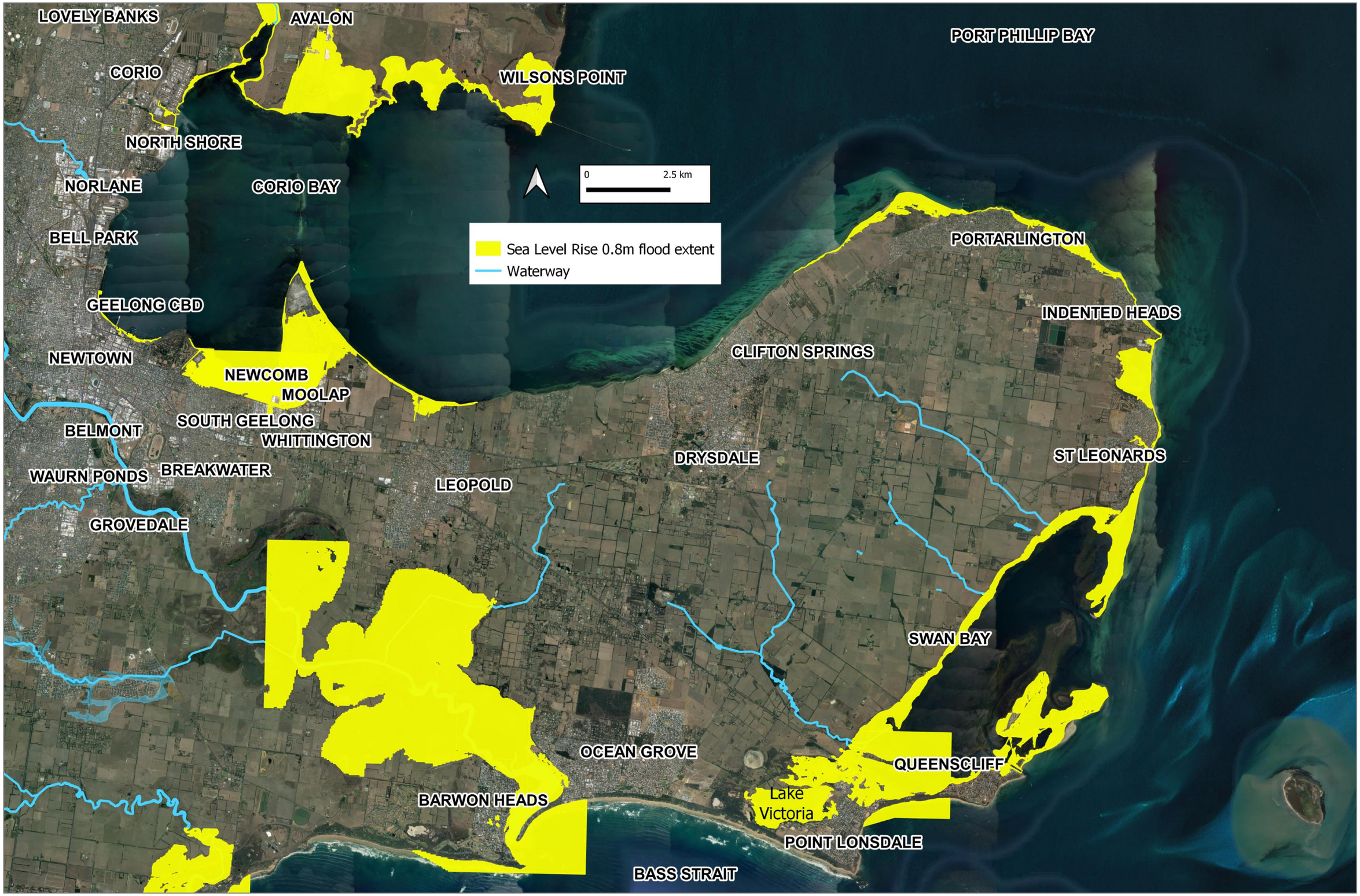
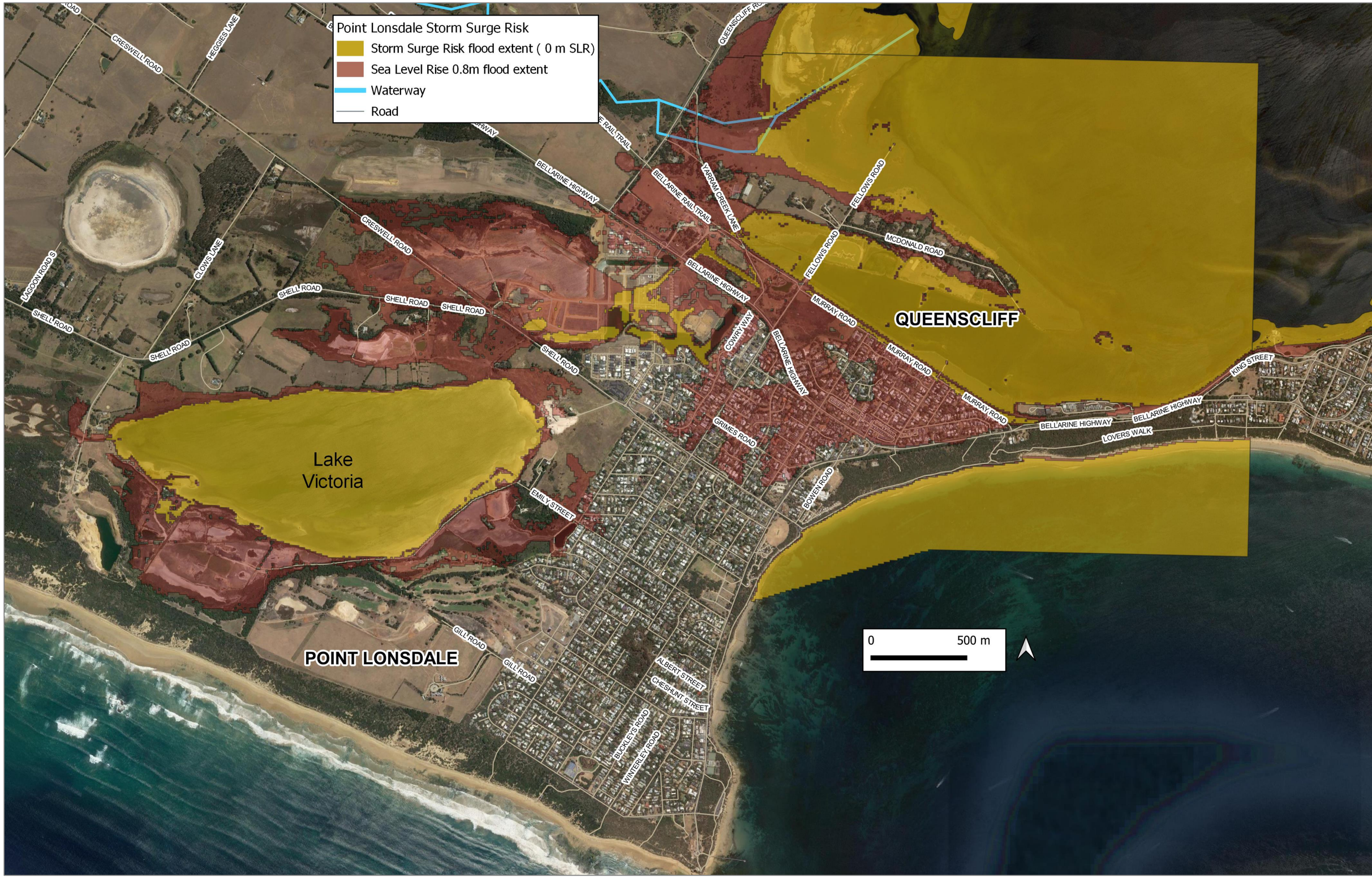
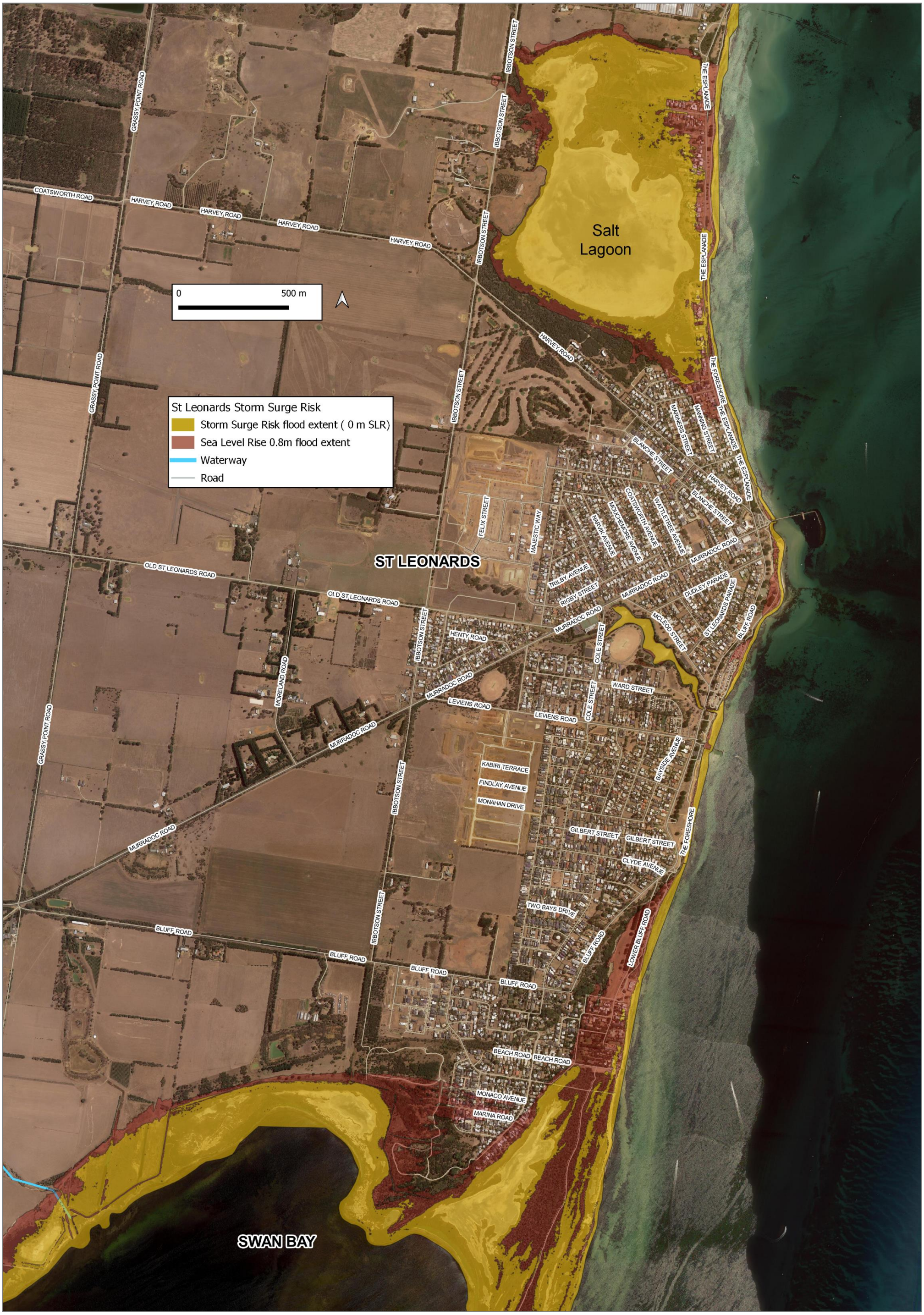


Figure 4. Storm surge and sea level rise flood extent within the City of Greater Geelong Council area (DELWP 2015)



4.15 **Figure 5. Pont Lonsdale storm surge (0 m sea level rise) and sea level rise (0.8m) risk flood extent (DELWP 2015).**

4.16 **Figure 6. Portarlington storm surge (0 m sea level rise) and sea level rise (0.8m) risk flood extent (DELWP 2015).**



4.17 **Figure 7. St Leonards storm surge (0 m sea level rise) and sea level rise (0.8m) risk flood extent (DELWP 2015).**

4.18 Estuaries

Many south west Victorian estuaries close intermittently following the formation of a sand bar at the estuary mouth. Estuaries that intermittently close typically reopen following high rainfall events when there is enough water flowing down the river to flush built-up sand from the estuary mouth. Estuaries that are closed during riverine flood events can significantly increase flood levels on adjacent property.

Most Estuaries in the Corangamite CMA region are naturally intermittently closed estuaries except for the Barwon River Estuary and the Hovells Creek Estuary, which are artificially kept open.

Estuaries within the City of Greater Geelong Council include;

- Barwon River Estuary (at Barwon Heads and Ocean Grove)
- Hovells Creek Estuary (also referred to as Limebumers Lagoon)

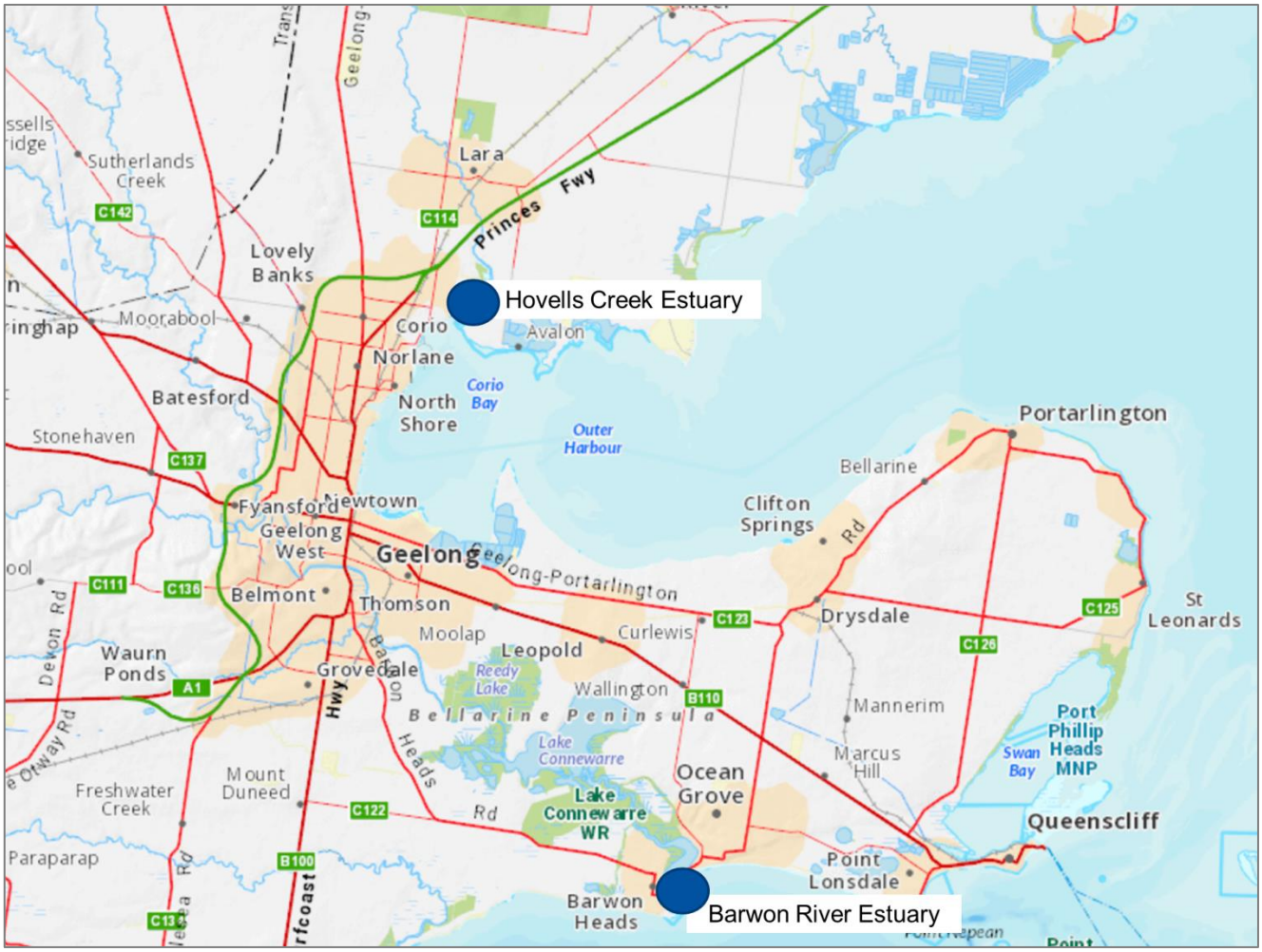


Figure 8. Estuaries within the City of Greater Geelong Council.

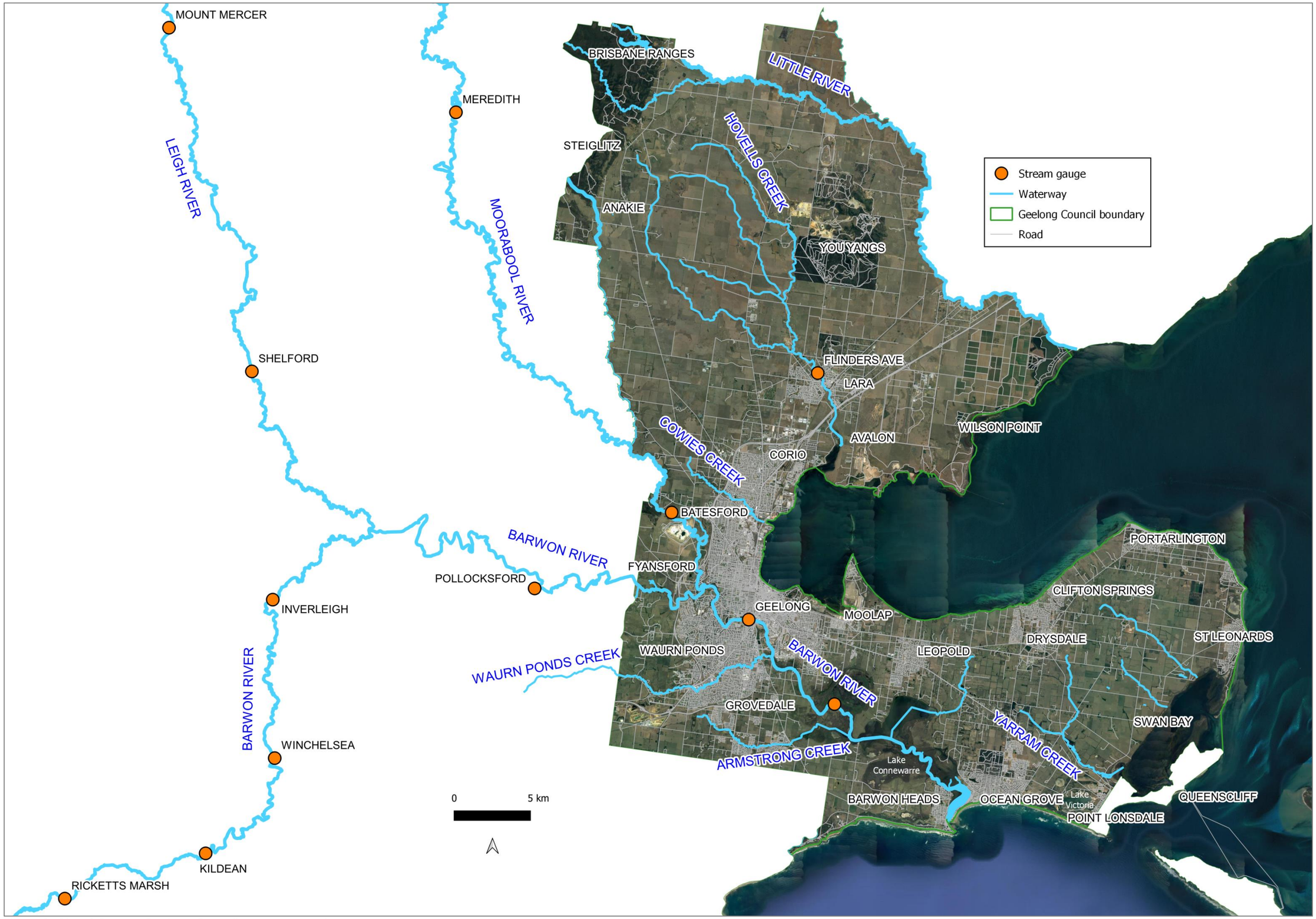


Figure 9. City of Greater Geelong Council waterways and stream gauges.

4.19 Description of Major Waterways

Waterway	Description
Leigh River	The Leigh River joins the Barwon River east of Inverleigh. The upper reaches of the Leigh River is located to the north east of Ballarat, begins as the Yarrowee River and flows through Shelford and Inverleigh. The catchment area of the Leigh River upstream of Inverleigh is approximately 883 km^2. Flooding can occur in Shelford 18 to 28 hours after rainfall in the upper catchment, and in Inverleigh 4 to 8 hours after the flood peak in Shelford. The Leigh River travel time between heavy rainfall in the upper catchment around Ballarat and rise in streamflow at the Mount Mercer gauge is between 4 to 6 hours. The Mount Mercer gauge is expected to peak between 12 to 18 hours after the start of heavy rainfall. The peak travel time between Mount Mercer and Shelford gauges is approximately between 6 to 10 hours.
Barwon River	The upper reaches of the Barwon River drains the eastern Otway Ranges surrounding Forrest, with an approximate catchment area of 2,800 km^2. Barwon River then flows through Birregurra and Winchelsea, Inverleigh, Fyansford, Geelong and Lake Connewarre Wetland Reserve before discharging to the sea at Barwon Heads and Ocean Grove. Flooding can occur in Geelong 1.5 to 2.3 days after rainfall in the upper Barwon River catchment. In addition to the Barwon River receiving flows from the Otway Ranges, the Barwon River also receives flood flows from its tributaries, the Leigh River, Moorabool River, Waurn Ponds Creek and Armstrong Creek. Flooding can occur at different times due to the large size of the combined Barwon River catchment area, approximately 5,130 km^2. The Barwon River has the largest catchment area of approximately 2,800 km^2. Storms can impact different subcatchment areas in isolation. Flooding in the Barwon River at Geelong can be dominated by flood events in either the upper Barwon River, Moorabool River or the Leigh River. The Leigh River joins the Barwon River east of Inverleigh. The Moorabool River joins the Barwon River at Fyansford. The Waurn Ponds Creek and Armstrong Creek inflows into the Barwon River downstream of Geelong. The various catchment area sizes of the major rivers and various tributaries often result in the catchment responding to storm events at different time scales. The smaller urban catchments, such as Waurn Ponds Creek and Armstrong Creek respond quickly to intense storm events. Whereas the larger rural catchments of the Barwon River, Leigh River and Moorabool River respond later with the flood peak occurring long after the smaller catchments. There are eight stream gauges along the Leigh River, Moorabool River and Barwon River that provide early flood warning for Geelong, these include Mt Mercer, Shelford, Morrisons, Ricketts Marsh, Kildean, Winchelsea, Inverleigh, Pollocksford and McIntyre Bridge. Rises in streamflow at Geelong can occur 2.5 to 3 days after rainfall in the upper Barwon River catchment.
Moorabool River	The upper reaches of Moorabool River East and West Branch's drain the southern ranges of the Wombat State Forest, and join to form the Moorabool River 2 km south of the Morrisons stream gauge. Refer to the map below. There are several tributaries of Moorabool River that provides inflow, these include Southerland Creek, Eclipse Creek and Coolebarghurk Creek. The catchment area of Moorabool River is approximately 1,025 km^2. The Moorabool River is a tributary of the Barwon River, provides inflow into the Barwon River 6 km south of Batesford, adjacent to Fyansford. There are two stream gauges along the Moorabool River that provide flood warning for Batesford, these include Morrisons and Batesford, refer to the map below. The estimated travel time between heavy rainfall in the upper Moorabool River catchment to steep rise in streamflow at Batesford may be greater than 24hours. The flood peak travel time between heavy rainfall and flood peak at Batesford varies between 24 to 30 hours.

Hovells Creek	The upper reaches of Hovells Creek catchment begins near Mount Anakie and flows in a south easterly direction through farmland and into the urban area of Lara before flowing into Limeburners Bay, an inlet to Corio Bay. The eastern section of Lara falls within the Avalon catchment. The Avalon catchment begins just to the south of the Little River and flows south. There are no named waterways within the catchment. Flow behaviour in the lower end of the catchment is impacted by a former saltworks located between the Princes Freeway and Corio Bay. The combined area of Hovells Creek and Avalon catchments is approximately 230 km^2. The flood hazard through Lara is typically low, with slow moving water due to the relatively flat terrain. There are two gauges along Hovells Creek that provide flood warning for Lara, these include Flinders Ave and Rennie Street. The estimated travel time between heavy rainfall in the upper Hovells Creek catchment to steep rise in streamflow at Lara is generally greater than 6 hours.
Waurn Ponds Creek	Waurn Ponds has experienced frequent riverine flooding from the Waurn Ponds Creek. The upper reaches of the Waurn Ponds Creek drains the eastern side of Mount Moriac and flows through suburbs of Geelong, including Waurn Ponds, Belmont, Marshall, Grovedale and Highton. The catchment area of Waurn Ponds Creek is small, approximately 42 km^2. Waurn Ponds Creek is a tributary of the Barwon River, joins the Barwon River south of Breakwater Road, refer to the waterway map below. The contribution of flows from Waurn Ponds Creek to the Barwon River during flood events is small, estimated to be between 0.5 to 1 % for design flood events (Water Technology 2018). There are no stream or rainfall gauges within the Waurn Ponds Creek catchment to provide flood warning. There are a number of stream gauge boards located at key road intersections along Waurn Ponds Creek. Rises in streamflow at Waurn Ponds may occur between 3 to 6 hours after heavy rainfall in the upper Waurn Ponds Creek catchment.
Armstrong Creek	Armstrong Creek is located west of the Lake Connewarre Wildlife Reserve and has experienced frequent riverine flooding from the Armstrong Creek. The upper reaches of the Armstrong Creek drains the southern section of the Geelong Ring Road and northern section of Mount Duneed. Armstrong Creek flows through suburbs of Geelong, including the southern section of Waurn Ponds, Mount Duneed and Armstrong Creek. The catchment area of Armstrong Creek is small, approximately 27 km^2. Armstrong Creek discharges to the western reaches of Lake Connewarre wetlands, refer to the waterway map below. During flood events Armstrong Creek contributes flood flow to the Barwon River, when connected to the Lake Connewarre wetland system. There are no stream or rainfall gauges within the Armstrong Creek catchment to provide flood warning. There are a number of stream gauge boards located at key road intersections along Armstrong Creek. Rises in streamflow at Armstrong Creek may occur between 3 to 6 hours after heavy rainfall in the upper Armstrong Creek catchment.

4.21 Building Damages

4.22 **Refer to the table below for property and building damages for design flood events within the City of Greater Geelong Council. The table also provides an indication of when a Level 2 and 3 Incident Control Centre (ICC) will be required, based on the number of above floor damages.**

Table 2. City of Greater Geelong Council building damages.

Annual Exceedance Probability (1 in year)	Total number of properties flooded (buildings flooded above floor)							Total damages for the Geelong Council
	Lara (Appendix C1)	Batesford (Appendix C2)	Geelong (Appendix C3)	Barwon Heads (Appendix C4)	Ocean Grove (Appendix C4)	Waurn Ponds (Appendix C5)	Armstrong * (Appendix C6)	
2	2,498 (6)	0 (0)	1 (1)					2,499 (7)
5	2,857 (19)	0 (0)	16 (12)	0 (0)	0 (0)	0 (0)	0 (0)	2,873 (31)
10	3,122 (24)	0 (0)	33 (24)	0 (0)	0 (0)	0 (0)	3 (0)	3,158 (48)
20	3,339 (33)	8 (4)	60 (45)	0 (0)	0 (0)	1 (0)	8 (5)	3,416 (87)
50	3,691 (43)	13 (5)	133 (118)	0 (0)	0 (0)	1 (0)	11 (10)	3,849 (174)
100	3,924 (58)	31 (18)	224 (174)	11 (0)	11 (2)	12 (1)	15 (13)	4,228 (266)
200	4,101 (83)	45 (25)	374 (312)	95 (1)	95 (15)	24 (1)	22 (23)	4,756 (460)
500	4,341 (120)	54 (35)	535 (451)	179 (12)	179 (76)	40 (3)	42 (35)	5,370 (732)
1000	4,494 (140)	-	-	-	-	-	-	-

*Estimated damages using anecdotal flood information provided by the VICSES Request for Assistance Database and the City of Greater Geelong Council.

Level 2 ICC
Level 3 ICC

4.23 Dam Spill / Failure

4.24 **Significant dams or lakes that influence flooding within City of Greater Geelong Council area are listed below.**

4.25

Table 3. Dams and lakes that influence flooding**.**

Dam	Owner	Full Supply Volume	Comments
West Barwon Reservoir	Barwon Water	21,504 ML	West Barwon Reservoir is located in the Otway Ranges National Park. The catchment which feeds this Reservoir is very small, 51 km² compared with the entire catchment area upstream of Inverleigh is 2,700 km² (Water Technology 2018). Therefore, although the West Barwon Reservoir may contribute spills, it's unlikely to significantly impact flooding in the Barwon River.
Wurdee Boluc Reservoir	Barwon Water	38,100 ML	Given the Wurdee Boluc Reservoir is an off stream storage located south of Winchelsea it is unlikely to significantly impact flooding in the Barwon River.
Lal Lal Reservoir	Central Highlands Water and Barwon Water	59,549 ML	When the Lal Lal Reservoir is not full during a flood event, this storge space attenuates flood flows, providing flood mitigation downstream at Batesford and Geelong. During large flood events the Lal Lal Reservoir can reduce the peak flood flow by 20% (CCMA 2018). During flood events, when Lal Lal Reservoir is full spill flows can range from 9,850 ML/d for a 1 in 5 year flood to 40,522 ML/s for a 1 in 100 year flood. Flood modelling has shown for a 1 in 100 year flood, if the starting water level of Lal Lal Reservoir of 90% full can cause an 11% reduction of the flood peak and a 9 hour delay (CCMA 2018).
Serendip Dam	Parks Victoria	750 ML	Spills from the Serendip Dam contributes to flooding in Lara via a tributary of Hovells Creek. During heavy rainfall events, the Serendip Dam receives significant runoff from the You Yangs Regional Park. The Serendip Dam failed during the 1988 flood event, contributed significant flood flows to Lara. Flood modelling indicates that during a 1 in 100 year flood event, dams upstream of Lara (including the Serendip Dam) can contrite spills of up to 2,160 ML/d resulting in an increase of around 200 mm along Hovells Creek through Lara (Water Technology 2020).
Woolomanata Dam	Private	500 ML	Spills from the Woolomanata Dam contributes to flooding in Lara via Hovells Creek. The Woolomanata Dam is located 6.5 km upstream of Lara along Hovells Creek.
Augustine Retarding Basin	City of Greater Geelong Council	20 ML	If the Augustine Retarding Basin fails when at full capacity, it may cause risk to life to pedestrians and motorist as well as significant impacts to buildings downstream. Refer to further detail below.
Barrabool Road Retarding Basin	City of Greater Geelong Council	30 ML	If the Barrabool Road Retarding Basin fails when at full capacity, it may cause risk to life to pedestrians and motorist as well as significant impacts to buildings downstream. Refer to further detail below.
Lake Connewarre	Parks Victoria	11,000 ML	Lake Connewarre is a large estuarine wetland reserve managed by Parks Victoria. Low water levels in Lake Connewarre significantly reduce the flood magnitude of the flood event downstream at Barwon Heads and Ocean Grove.
Lake Victoria	DELWP	1,390 ML	Lake Victoria is a State Nature Reserve managed by DELWP. The City of Greater Geelong Council have constructed flood mitigation infrastructure to reduce flooding when Lake Victoria Spills.

West Barwon and Wurdee Boluc Reservoirs

The most significant regulated storages within the Barwon River Catchment include the West Barwon and Wurdee Boluc Reservoirs. The West Barwon Reservoir is located in the upper Barwon River Catchment within the Otways, south of Forrest, refer to the map below. The reservoir has a catchment area of 51 km² and has a capacity of 21,504 ML. When capacity of the West Barwon Reservoir is reached excess water spills via a concrete spillway to the West Barwon River, refer to photo below.

Water from West Barwon Reservoir is also diverted to Wurdee Boluc Reservoir via a concrete lined diversion channel. Water is stored at Wurdee Boluc for potable water usage for to the greater Geelong area. Given the Wurdee Boluc Reservoir is an off stream storage, it is unlikely to significantly impact flooding in the Barwon River (Water Technology 2018).

The catchment which feeds the West Barwon Reservoir is very small, 51 km² compared with the entire catchment area upstream of Inverleigh is 2,700 km² (Water Technology 2018). Therefore, although the West Barwon Reservoir may contribute spills, it's unlikely to significantly impact flooding in the Barwon River.

Figure 10. Location of West Barwon and Wurdee Boluc Reservoirs (source Water Technology 2018a)

Figure 11. West Barwon Reservoir spillway.

Figure 12. West Barwon Reservoir spillway, July 2021.

A minor spill of the West Barwon Reservoir of 1ML/d in July 2021 caused minor flood impacts to downstream farmland adjacent and cut access to Boundary Road. Refer to flood impact photo below.

Figure 13. Deep flooding caused by the West Barwon Reservoir spill in July 2021, cutting access to Boundary Road, along the Barwon River West Branch.

Lal Lal Reservoir

The Lal Lal Reservoir is located on the West Branch of the Moorabool River with a catchment area of approximately 293 km^2. The Lal Lal Reservoir is the largest storage in the upper Moorabool River catchment, with a storage capacity of 59,540 ML (the full supply volume). The Lal Lal Reservoir receives inflows from the Moorabool River West Branch, refer to the map below. The site is approximately 26km south-east of Ballarat.

When the Lal Lal Reservoir is not full at the beginning of a flood event, this storage space will provide attenuation of flood flows, flood mitigation downstream of the Lal Lal Reservoir. An analysis undertaken by the Corangamite CMA determined that in large flood events the upstream storages results in a reduction of approximately 20% of the peak flow at Batesford (Corangamite CMA 2018). Flows released or spilled from the storage cannot be diverted away from the West Moorabool River due to the steep terrain by which it is surrounded.

Only very small releases can be made from the Lal Lal Reservoir of up to 150 ML/d can be made to the West Moorabool River via a 600 mm outlet pipe that exists within the dam tunnel. Releases are made to the Moorabool River routinely for the purposes of Geelong Water Supply (Barwon Water), passing flows or environmental water releases. Water is also pumped from the outlet to the Lal Lal Treatment Plant for Ballarat and surrounding region water supply. It is a standard operational procedure of the Lal Lal Reservoir, when flooding is likely, environmental flows are stopped (to ensure environmental flow don't contribute to downstream flooding).

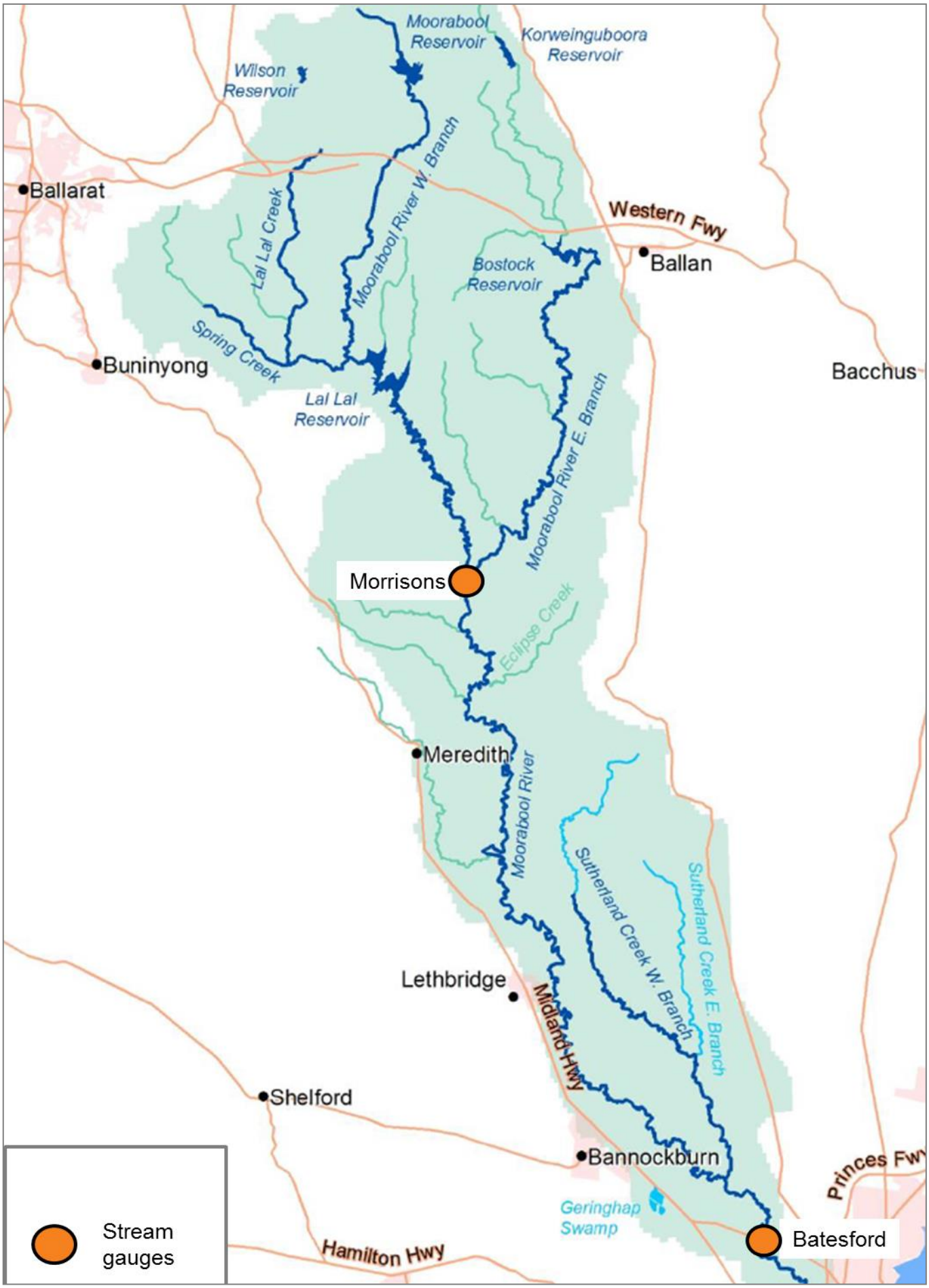


Figure 14. Location of Lal Lal Reservoir (source Water Technology 2018).

A summary of the storage levels in the graph below shows that over the limited monitoring record available, the Lal Lal Reservoir has not spilled often. The graph also shows that from the 6th February 2010 to the 8th March 2011 the Lal Lal Reservoir received more than 51,462 ML of inflows, rapidly increased the storage level from 3,920 ML to 55,382 ML over 30 days. The graph also indicated it's likely that spills occurred in 2011, 2012, 2016, 2019 and 2020. The spill volume is unknown given historical spillway flow data is not measured or captured by Central Highlands Water.

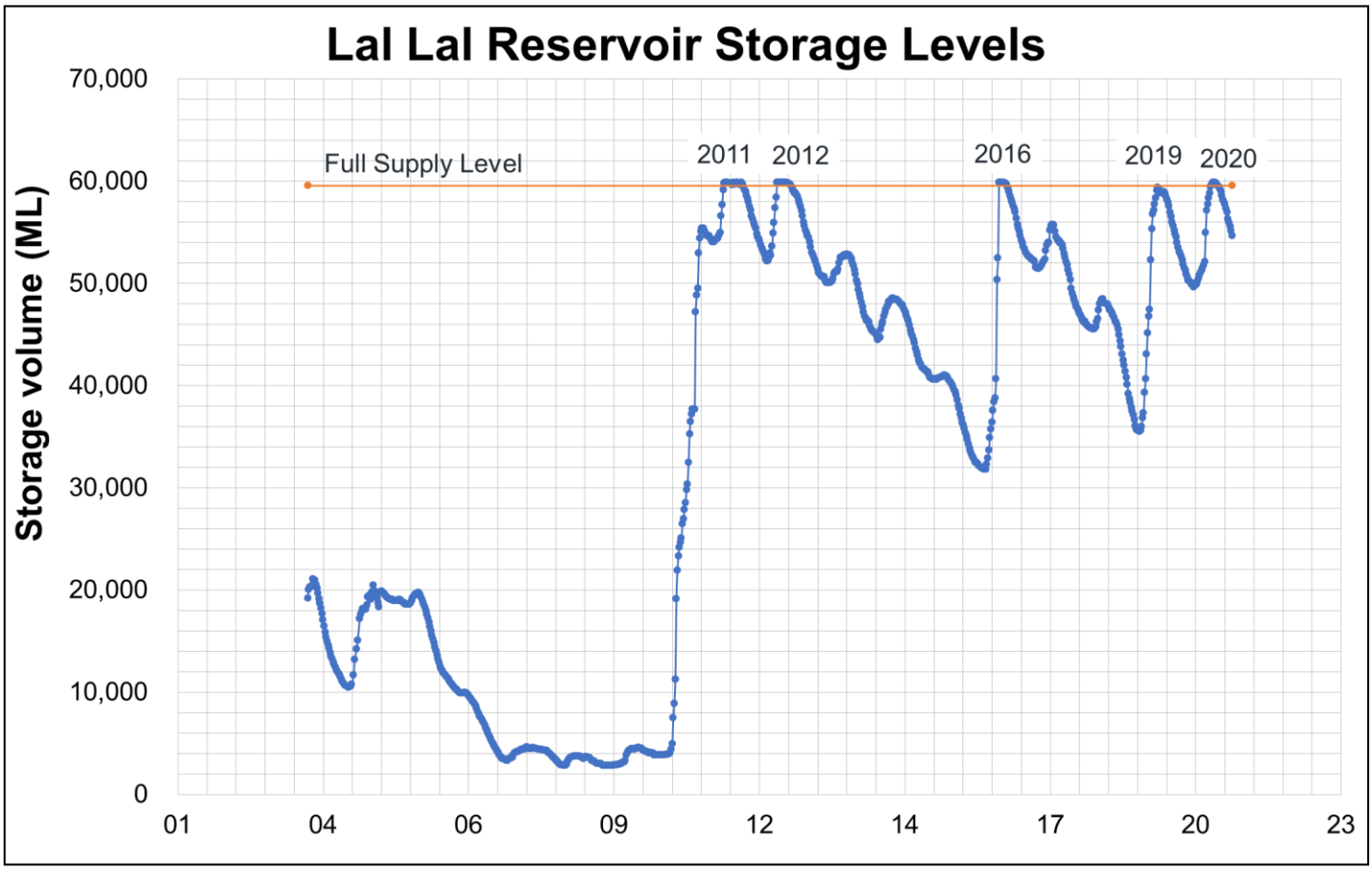


Figure 15. Historic Lal Lal Reservoir storage levels.

Given the Lal Lal Reservoir's potential significant spill volumes it is critically important to check its storage volume before a flood event occurs. Checking the storage level will provide an indication of the storage space available for inflows and enable an assess the risk of spills occurring, contributing to flooding in Batesford, Fyansford and Geelong. Refer to this website for Lal Lal Reservoir storage levels: https://www.chw.net.au/community/water-storage-levels/.

Refer to **Appendix C2** (Batesford) and **Appendix C3** (Geelong) for details regarding the downstream flood impacts of the Lal Lal Reservoir.

Augustine Retarding Basin

The Augustine Regarding Basin, located on the corner of South Valley Road and Augustine Drive has a full capacity of 20 ML, and is managed by the City of Greater Geelong Council.

Consequence mapping of failure of the Augustine Retarding Basin dam wall when full (DELWP 2018) shows that a significant number of buildings will be impacted by flooding. Refer to the flood extent map below. If the dam wall failure occurs, the flood depth may range from 0.2 to 0.5 m depth and peak flood velocity may reach between 8 to 10 m/s.

Figure 16. Failure of the Augustine Retarding Basin dam wall downstream flood risk area (DELWP 2018).

Barrabool Road Retarding Basin

The Barrabool Road Retarding Basin, located on the corner of Barrabool Road and Scenic Road has a full capacity of 30 ML, and is managed by the City of Greater Geelong Council.

Consequence mapping of the failure of the Barrabool Road Retarding Basin dam wall when full (DELWP 2018) shows that a significant number of buildings will be impacted by flooding. Refer to the flood extent map below. If the dam wall failure occurs, the depth of flooding may range between 0.2 to 0.5m depth, and peak flood velocity may reach between 8 to 10 m/s.

Figure 17. Failure of the Barrabool Road Regarding Basin dam wall downstream flood risk area (DELWP 2018).

Lake Victoria

Lake Victoria is a shallow saline lake, part of the Point Lonsdale Nature Reserve managed by DELWP. High water levels in Lake Victoria reduce the available storage and may cause flooding at Point Lonsdale (SKM 2011). Local runoff significantly contributes to raising the water levels in the Lake Victoria (SKM 2011). Normal Lake levels range between 0.2m to 0.3m. Works undertaken at the Lake Victoria outlet allows water levels above 0.3m to drain to Swan Bay.

Flood Mitigation Works

The City of Greater Geelong Council have undertaken an extensive flood mitigation works including construction of levees, upgrading drainage infrastructure (pipes, pits) and the construction of retarding basins. The City of Greater Geelong Council are currently undertaking flood mitigation works along the Elcho Drain in Lara. For more detail refer to Lara **Appendix C1**.

The City of Greater Geelong Council are also exploring other flood mitigation options in that include improvements to the local drainage network surrounding Lara, Clifton Springs, Ocean Grove, Cowies Creek, Rippleside and other areas to address nuisance flooding and improve flood protection during more frequent storm events. Details regarding stormwater retarding basins within the City of Greater Geelong Council area are in the Stormwater section of this Plan, **Appendix C7**.

4.26 Levees

The City of Greater Geelong Council manage and maintain the levees within Lara and Barwon Heads that have been constructed to protect residential areas. Within Lara there are 2.62 km of earthen levees along Hovells Creek. The protection level of these levees is up to or greater than a 1 in 100 year flood event. Refer to **Appendix C1** Lara for more details.

The Barwon Heads Plummer Bank earthen levee is approximately 1.75 km long and provides flood protection to the north of Barwon Heads. The Plummer Bank levee starts to provide protection during a 1 in 20 year AEP flood event. The protection level of this levee is greater than a 1 in 500 year AEP. Refer to **Appendix C4** Barwon Heads for more details.

There are an additional nine levees within Geelong that are listed in the Flood Levee Operational Management Plan (COGG 2020), these include;

1. Belmont Council Depot Operations Centre Levee, Barwon Heads Road, Belmont (managed by COGG).
2. 162 Barrabool Road, Belmont (managed by COGG).
3. Landy Sports Field, South Geelong (managed by COGG).
4. Geelong Rifle Club, 64 Gundog Lane (managed by Geelong Rifle Club).
5. 573 Lake Road, Connewarre (private levee).
6. Barwon Valley Caravan Park, Barrabool Road, Belmont (managed by Barwon Valley Caravan Park).
7. Brearleys Lane, Grove Road, Charlemont (private levee).
8. La Trobe Terrace, south of James Harrison Bridge (managed by Vic Roads).
9. Breakwater Road Bridge, Breakwater Road (managed by Vic Roads).

There is little technical information regarding the location and flood protection level of these levees. For more information refer to the City of Greater Geelong Council Flood Levee Operational Management Plan (COGG 2020).

4.27 Flood Gates

The City of Greater Geelong Council have installed flood gates and flood warning signs at a number of roads where deep flooding cuts access (floodways), these include:

- Windemere Road (north of Lara)
- Flinders Road (Lara)
- Rennie Street (Lara, has automatic lights where flooding occurs)
- Investigator Avenue (Lara)
- Moorabool Street (South Geelong)
- Gundog Lane (South Geelong)
- Barrabool Road (Belmont)

An example of the flood gates and flood warning signs are shown in the photo below of Rennie Street.

Figure 18. Rennie flood gate and flood warning signs at the Hovells Creek floodway south of Lara, adjacent to the Princes Freeway.

Additional floodways within the City of Greater Geelong Council area that don't have flood gates installed (not included in Section C of this report) include;

- Bluestone Bridge Road, Lovely Banks
- Evan Road, Lovely Banks
- Old Boundary Road, Anakie
- Pringles Road, Anakie
- Little River Ripley Road
- O'Neils Road
- Ashworth Street, Drysdale
- Ramblers Road, Point Richards
- Portarlington Road and Queenscliff Road, at Yarram Creek crossing.
- Knights Road, impacted by overflow from Yarram Creek
- Yarram Creek Road
- Warner Road, Moorabool
- Lovely Banks Road, Moorabool

4.28 Sewerage Infrastructure

Barwon water has a number of sewerage emergency relief structures, including overflow tanks and basins which may be used to capture waste water overflow from the sewer systems impacted by storm flooding events.

Barwon water has identified Sewer pump stations and other assets in the network that may be more likely impacted by flood events and monitor these in the lead up to and throughout storm activity.

Where impact to the water/wastewater system/assets is expected or actual, Barwon Water can activate their internal Emergency Management processes including the Environmental Response Procedure.

These processes provide for escalation and response coordination with external stakeholders such as EPA, SES, DELWP and the incumbent ICC.

Sewer Emergency Relief Points

There are Sewer Emergency Relief Points that are likely to be affected by floodwater conditions should they be activated. The Barwon Water Operator EMLO/Duty Officer can be contacted on Phone 1300 656 007 for information on any recent or planned releases at a Sewer Emergency Relief Point as part of a Dynamic Risk Assessment (DRA) if work is to be conducted at or downstream of the outlet.

Appendix B: Typical flood peak travel times and stream gauges

Table 4. Flood peak travel times.

From Location	To Location	Typical Travel Time	Comments	Duration
Armstrong Creek (Armstrong Creek)				
Localised heavy rainfall	Armstrong Creek (stormwater flooding)	0.5 – 6 hours	Stormwater flood impacts develop quickly	6 – 12 hours
Start of rainfall (upper catchment)	Armstrong Creek	3 - 6 hours	Begin to rise from normal levels	6 to 32 hours
Start of rainfall (upper catchment)	Armstrong Creek	6 -12 hours	To peak	
Waurn Ponds (Waurn Ponds Creek)				
Localised heavy rainfall	Waurn Ponds (stormwater flooding)	0.5 – 6 hours	Stormwater flood impacts develop quickly	6 – 12 hours
Start of rainfall (upper catchment)	Armstrong Creek	3 - 6 hours	Begin to rise from normal levels	6 to 32 hours
Start of rainfall (upper catchment)	Armstrong Creek	6 -12 hours	To peak	
Lara (Hovells Creek)				
Localised heavy rainfall	Lara (stormwater flooding)	0.5 – 6 hours	Stormwater flood impacts develop quickly	1 to 2 days
Start of rainfall (upper catchment)	Lara	6-12 hours	To steep rise for minor flood (2017 flood).	
Start of rainfall (upper catchment)	Lara	2 - 6 hours	To steep rise for major flood (1988 flood).	
Start of rainfall (upper catchment)	Flinders Avenue gauge	10 - 24 hours	Minor flood peak (2017 flood).	
Start of rainfall (upper catchment)	Flinders Avenue gauge	6 - 10 hours	Major flood peak (1988 flood).	
Batesford (Moorabool River)				
Start of rainfall (upper catchment)	Batesford	24 hours +	To steep rise from normal levels.	4 to 5 days
Morrisons gauge	Batesford	18 – 24 hours	Peak	
Batesford	Barwon River/Moorabool River confluence at Fyansford	5 – 16 hours	Peak	

Start of rainfall (upper catchment)	Barwon River/Moorabool River confluence at Fyansford	23 – 40 hours	To steep rise from normal levels.	
Geelong (Leigh Rivers flood peak travel time to the Barwon River)				
Start of rainfall (upper catchment)	Mt Mercer gauge	4 - 6 hours	Begin to rise from normal levels	2 days
Start of rainfall (upper catchment)	Mt Mercer gauge	10 - 18 hours	To peak	
Mt Mercer gauge	Shelford gauge	4 - 6 hours	To peak	
Shelford gauge	Inverleigh (Leigh River /Barwon River confluence)	8 - 12 hours	To peak	
Start of rainfall (upper catchment)	Inverleigh (Leigh River /Barwon River confluence)	22 - 36 hours	To peak	
Geelong (Barwon River)				
Localised heavy rainfall	Geelong (stormwater flooding)	0.5 – 6 hours	Stormwater flood impacts develop quickly	6 – 12 hours
Ricketts Marsh gauge	Kildean Lane gauge	14 hours	To peak	4 to 6 days
Kildean Lane gauge	Winchelsea gauge	6 – 8 hours	To peak	
Winchelsea gauge	Inverleigh gauge	10 -12 hours	To peak	
Inverleigh gauge	Inverleigh	4 - 6 hours	To Peak	
Inverleigh	Pollocksford gauge	4 - 6 hours	To peak	
Pollocksford gauge	Barwon River/Moorabool River confluence	6 - 8 hours	To peak	
Barwon River/Moorabool River confluence	Geelong McIntyre Bridge gauge	3 hours	To peak	
Start of rainfall (upper catchment)	Geelong McIntyre Bridge gauge	1.5 - 2.3 days	To steep rise from normal levels.	
Barwon Heads / Ocean Grove (Barwon River)				
Geelong McIntyre Bridge gauge	Barwon Heads/Ocean Grove	36 hours	Minor flood peak.	4 to 6 days
Geelong McIntyre Bridge gauge	Barwon Heads/Ocean Grove	30 hours	Moderate flood peak.	
Geelong McIntyre Bridge gauge	Barwon Heads/Ocean Grove	24 hours	Major flood peak.	
Start of rainfall (upper catchment)	Barwon Heads/Ocean Grove	2.5 – 3.8 days	To peak	

Flood Warning Flood Class Levels and stream gauges

There are two forecast stream gauges at Geelong McIntyre Bridge and Shelford that are used to provide flood warning for Geelong. These gauges provide quantitative prediction of what the flood peak stream gauge height will be in 6-9 hours and refers to the flood class level.

There are three information gauges at Mt Mercer, Pollocksford and Ricketts Marsh that provide the real time gauge height (not a prediction of the peak height) and refers to the flood class level.

There are seven data gauges at Inverleigh, Kildean Lane, Winchelsea, Lal Lal Reservoir, Morrisons, Lara and Moolap. These gauges provide the real time gauge height.

Table 5. City of Greater Geelong Council stream gauges (BOM 2020)

River	Location	Forecast/ Information/ Data	Number	Flood Class Level (m)			Target Warning lead time		70% of peak forecasts within
				Minor	Moderate	Major	Time	Trigger height (m)	
Barwon River	Geelong McIntyre Bridge	Forecast	233217	6.0	7.0	8.0	9 hrs	>2.3	+/- 0.3m
Barwon River	Ricketts Marsh	Information	233224	3.0	6.0	6.7	-	-	-
Barwon River	Pollocksford	Information	233200	3.5	4.5	6.5	-	-	-
Barwon River	Inverleigh	Data	233218	-	-	-	-	-	-
Barwon River	Kildean Lane	Data	233247	-	-	-	-	-	-
Barwon River	Winchelsea	Data	233201	-	-	-	-	-	-
Leigh River	Shelford	Forecast	233213	2.3	3.1	4.3	6 hrs	>6.0	+/- 0.3m
Leigh River	Mt Mercer	Information	233215	2.0	3.0	4.0	-	-	-
Moorabool River	Lal Lal Reservoir	Data	232210	-	-	-		-	-
Moorabool River	Morrisons	Data		-	-	-	-	-	-
Hovells Creek	Lara Flinders Ave	Data	232802	-	-	-	-	-	-
?	Moolap	Data	233719	-	-	-	-	-	-

Appendix C1: Lara Flood Emergency Plan

Lara is impacted by riverine flooding from Hovells Creek and stormwater flooding from within the urban area. Lara has experienced frequent riverine flooding from Hovells Creek. The upper reaches of Hovells Creek catchment begins near Mount Anakie and flows in a south easterly direction through farmland and into the urban area of Lara before flowing into Limeburners Bay, an inlet to Corio Bay. The eastern section of Lara falls within the Avalon catchment. The Avalon catchment begins just to the south of the Little River and flows south. There are no named waterways within the catchment. Flow behaviour in the lower end of the catchment is impacted by a former saltworks located between the Princes Freeway and Corio Bay. The combined area of Hovells Creek and Avalon catchments is approximately 230km^2. The flood hazard through Lara is typically low, with slow moving water due to the relatively flat terrain.

Flood modelling (Water Technology 2020) for a 1 in 100 AEP event, shows there are 23 buildings identified to have above floor flooding from the riverine flooding, and 48 buildings identified to have above floor flooding from stormwater flooding. Four of these buildings are at risk of being flooded above floor from both stormwater and riverine flooding. There is also an isolated area of buildings on the Avalon Foreshore Road which have been identified at risk from coastal inundation.

The December 1988 flood event was the largest recent flood event recorded in Lara, approximately a 1 in 100 year AEP flood. 125mm of rainfall was recorded in parts of the catchment within 6 hours on the night of the 9th of December and into the early hours of the 10th of December. The intense rainfall resulted in a rapid rise of Hovells Creek water levels, with the levees being overtopped in several locations along Ponds Drive and Wingara Drive. This event caused considerable damages to buildings, roads, bridges and other infrastructure in Lara. Deep flooding impacted more than 26 buildings above floor and hundreds of properties. The Serendip Dam failed, contributing in excess of 2,160 ML/d to Lara, significantly exacerbating flooding (Water Technology 2019). Deep flooding cut access to minor and major roads including Rennie Street, Flinders Avenue, Bacchus Marsh Road, Windermere Road, Kees Road, Carrs Road, Old Melbourne Road, Forest Road North, Peak School Road, Branch Road, Station Lake Road and the Princes Highway (southbound and northbound).

During significant rainfall events, the catchment to the northwest and north of Lara begin to contribute runoff which accumulates and flows towards Lara. While there is significant flow along Hovells Creek, there is also accumulation of shallow flows across agricultural properties. Significant portions of the Hovells Creek floodplain and Lara township are inundated even in smaller magnitude events (1 in 2 and 5 year AEP event). In smaller magnitude events, a large portion of the flood extent is shallow widespread water due to the relatively flat terrain across most of the study area. This is due to a combination of both urban flash flooding and flows from the Hovells Creek breaking out and entering the town.

There are two gauges along Hovells Creek that provide flood warning for Lara, these include Flinders Ave and Rennie Street. The estimated travel time between heavy rainfall in the upper Hovells Creek catchment to steep rise in streamflow at Lara is generally greater than 6 hours.

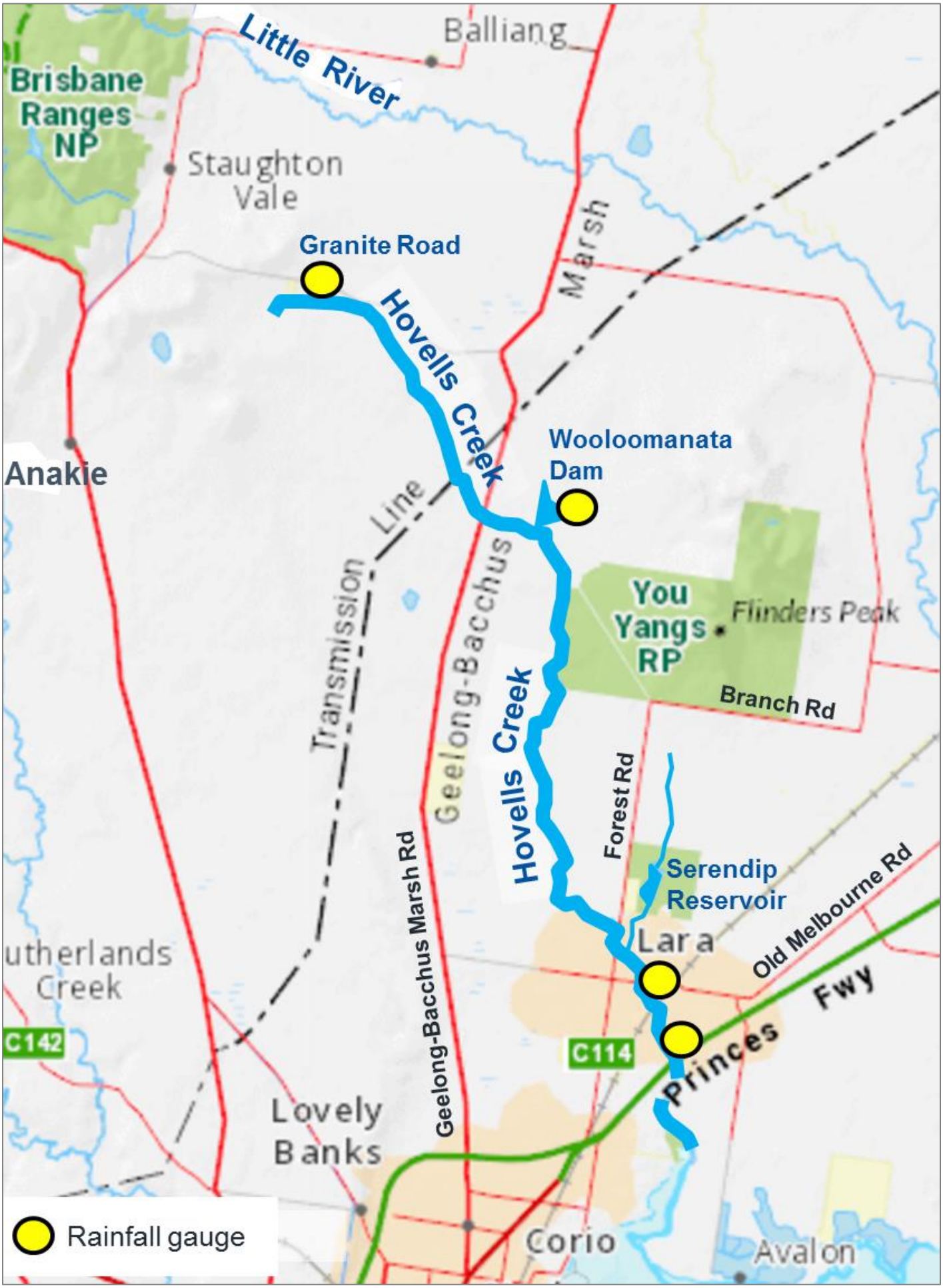


Figure 19. Lara waterways.

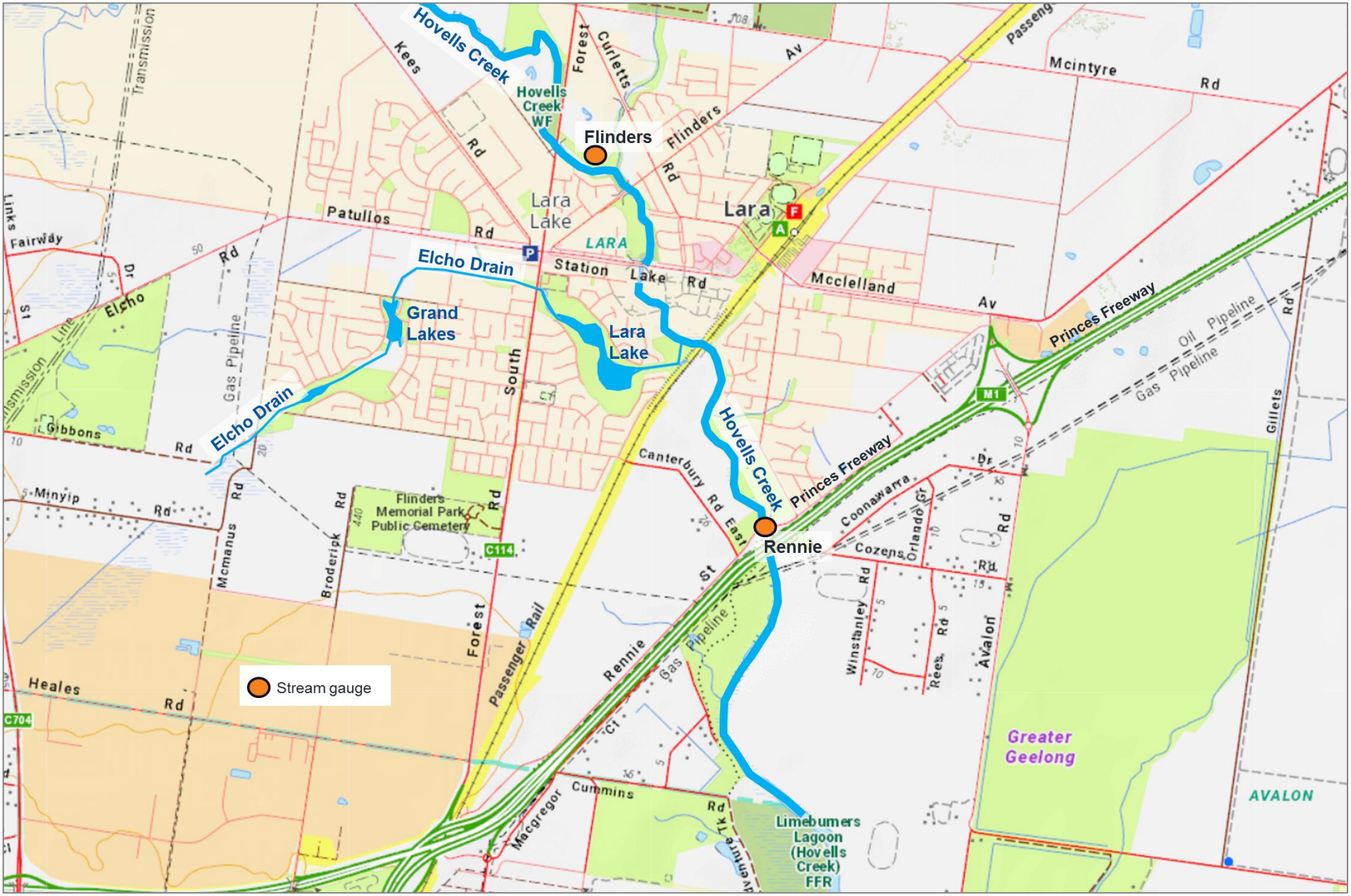


Figure 20. Lara waterways and stream gauges.

Historic Riverine Floods

Lara has experienced frequent flood events, refer to graph below. Significant flood events have occurred in 1971, 1973, 1974, 1978, 1983, 1987, 1988, 2001, 2005, 2011, 2016 and 2017. The largest flood event on record was in 1988, refer to flood photos below.

Given the short rainfall record available for the Hovells Creek gauges, the Anakie and Little River rainfall gauges were used to indicate when flood events have occurred in Lara.

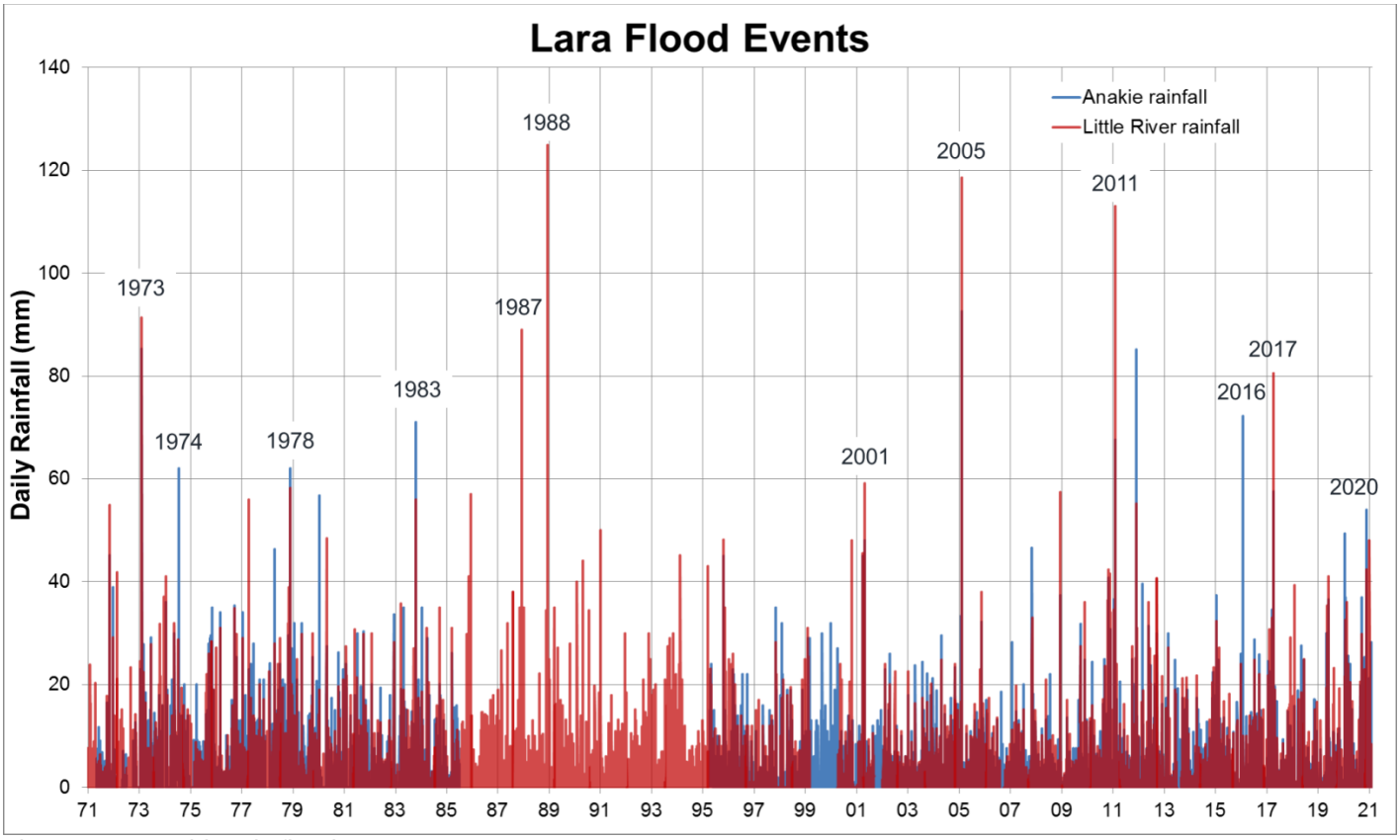


Figure 21. Lara historic flood events.

December 1988 flood event

The December 1988 flood event was Lara's largest recent flood event on record, estimated to be approximately a 1 in 100 year AEP event. During this event Lara experienced a high intensity, short duration rainfall event, with 125mm recorded in 6 hours, approximately 21 mm per hour. With 50 to 70 mm of rain falling over parts of the catchment. Significant flooding occurred in Lara on the 10th of December 1988. The flooding lasted for a day, with parts of Lara impacted for several days.

This flood event caused considerable damages to buildings above floor, roads, bridges and other infrastructure, refer to the flood photos below. The Serendip Dam failed, contributed approx 2,160 ML/d to Lara (Water Technology 2020), significantly exacerbated flooding. Deep flooding impacted more than 26 buildings above floor and hundreds of properties. Minor and major roads were impacted by flooding within and surrounding Lara. Flooding impacted Flinders Avenue and Rennie Street almost immediately. Deep flooding cut access to minor and major roads including Rennie Street, Flinders Avenue, Bacchus Marsh Road, Windermere Road, Kees Road, Carrs Road, Old Melbourne Road, Forest Road North, Peak School Road, Branch Road, Station Lake Road and the Princes Highway (southbound and northbound). Forest Road South Bridge came very close to being overtopped.

Initially localised rainfall caused stormwater to build up against the levees. When the flood peak arrived in Lara the levees were overtopped in several locations including along Ponds Drive, with minor overtopping of the levee located to the North West of Wingara Drive. Following the 1988 flood, the crest height of several Lara levees were raised by approximately 600 mm.

Figure 22. Flooding impacting the Rennie Street floodway during the 2011 flood event (Water Technology 2019).


Figure 23. Flooding impacting Station Lake Road, Lara during the 1988 event (Water Technology 2019).

Figure 24. Flooding impacting Flinders Avenue during the 1988 flood event (approx gauge height 7.85 mAHD) (Water Technology 2019).

Figure 25. Deep flooding along Windermere Road during the January 2011 event (Water Technology 2019).

Figure 26. Flooding impacting the Princes Highway, Lara during the 2000 event (Water Technology 2019).

Figure 27. Flooding impacting Kyema Drive, Lara during the 1988 flood event (Water Technology 2019).

Figure 28. Flooding impacting Flinders Avenue during the 2011 event (Water Technology 2019).

Figure 29. Flooding impacting Lara during the 1973 flood event (Water Technology 2019).

Riverine flood behaviour

During significant rainfall events, the catchment to the northwest and north of Lara begins to contribute runoff which accumulates and flows towards Lara. While there is significant flow along Hovells Creek, there is also accumulation of shallow flows across agricultural properties.

Significant portions of the Hovells Creek floodplain and Lara township are inundated even in smaller magnitude events (1 in 2 and 5 year AEP event). In smaller magnitude events, a large portion of the flood extent is shallow widespread water due to the relatively flat terrain across most of the study area. This is due to a combination of both urban flash flooding and flows from the Hovells Creek breaking out and entering the town.

4.29

4.30 **Flooding throughout the Avalon catchment is generally widespread and shallow, with deeper flooding through several wetland areas and where waters are backed up behind roadways and the railway line which act as hydraulic controls running perpendicular to the main flow paths. Downstream of the Princes Freeway, flooding from earthen drains spread into the former saltworks.**

Flood Mitigation Works

Drainage assets in the town range from roadside open swale drains within wide road reserves, to pit and pipe networks within the urban areas. Hovells Creek and the Elcho Drain make their way through the town. Elcho Drain runs through several man-made lake/retarding basin systems and in parts is channelised and has underground low-flow pipes before out falling to Hovells Creek.

The City of Greater Geelong Council are currently undertaking flood mitigation works along the Elcho Drain. Flood mitigation works will include deepening and widening of the open drain from Bacchus Marsh Road through to McManus Road. An upgrade of the existing retarding basin east of McManus Road will be undertaken to increase the storage volume of the basin, providing a new syphon outlet to the Elcho Drain at Gibbons Road.

Modelling undertaken (Water Technology 2020) shows that the proposed Elcho Drain upgrade was incorporated into the model and showed a widespread decrease in flood levels downstream of Bacchus Marsh Road (150 -300mm) and extended further downstream to the Grand Lakes estate where a decrease of 10-20 mm was observed. Increases appeared in the Elcho Road and Patullos Road area, as expected due to increased run-off from development. There was no inclusion of flow retardation was incorporated into the model. Elsewhere, increases were generally less than 20mm. This suggests that even with higher flow rates (as a result of future development), the Elcho Drain widening provides a positive impact on flood risk.

Council are also exploring other flood mitigation options including improvements to the local drainage network surrounding Kyema Drive to address nuisance flooding and improve flood protection during more frequent storm events.

Given that Lara is experiencing significant growth especially on the western side, the City of Greater Geelong Council have planed flood mitigation works to support this future development. Manzeene Village is currently under construction and is proposed to include detention and water quality treatment within the development. Several new retarding basins are planned to be constructed west of Ohallorans Road, in Lovely Banks. Future drainage reserves, water quality treatment and detention basins are also planned west of Bacchus Marsh Road. Refer to the map below showing the conceptual layout of the additional retarding basins.

The St Lawrence Park Retirement Village have proposed to undertake flood mitigation works to remove their buildings from the floodplain. The St Lawrence Park Retirement Village, located at 90 Station Lake Road is adjacent to levee one (refer to the levee map below, figure 32). These flood mitigation works to infill the St Lawrence Park Retirement Village site, are estimated cost $2 million dollars.

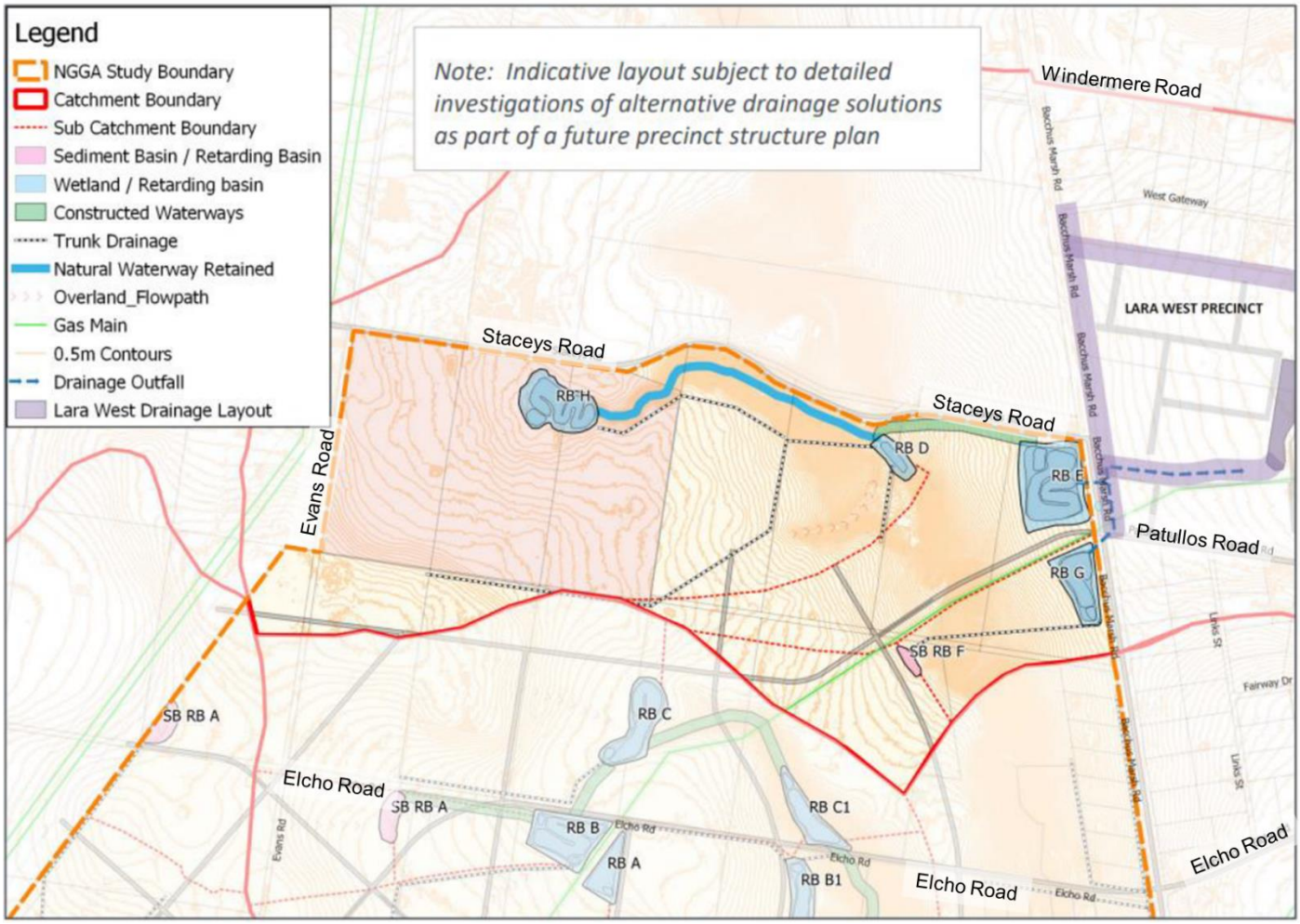
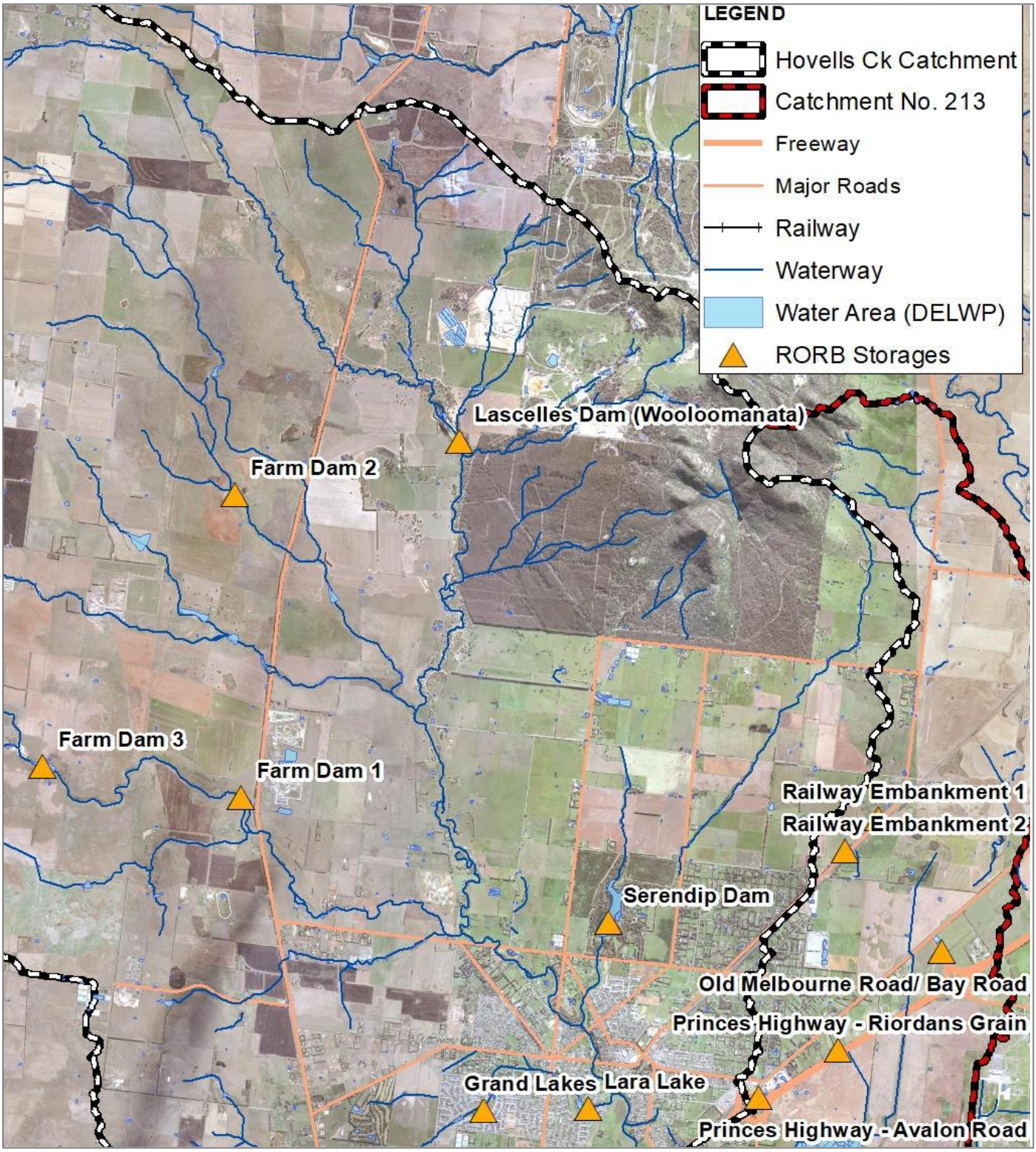


Figure 30. Proposed retarding basins planned west of Lara, Lovely Banks new residential development areas (Water Technology 2020).

Contribution of upstream storages to flooding in Lara

4.31 **There are several storages upstream of Lara the have contributed flood flows to Lara during historic flood events, these include Serendip, Woolomanata Dam and other smaller dams. Refer to the map below for the location of these storages.**

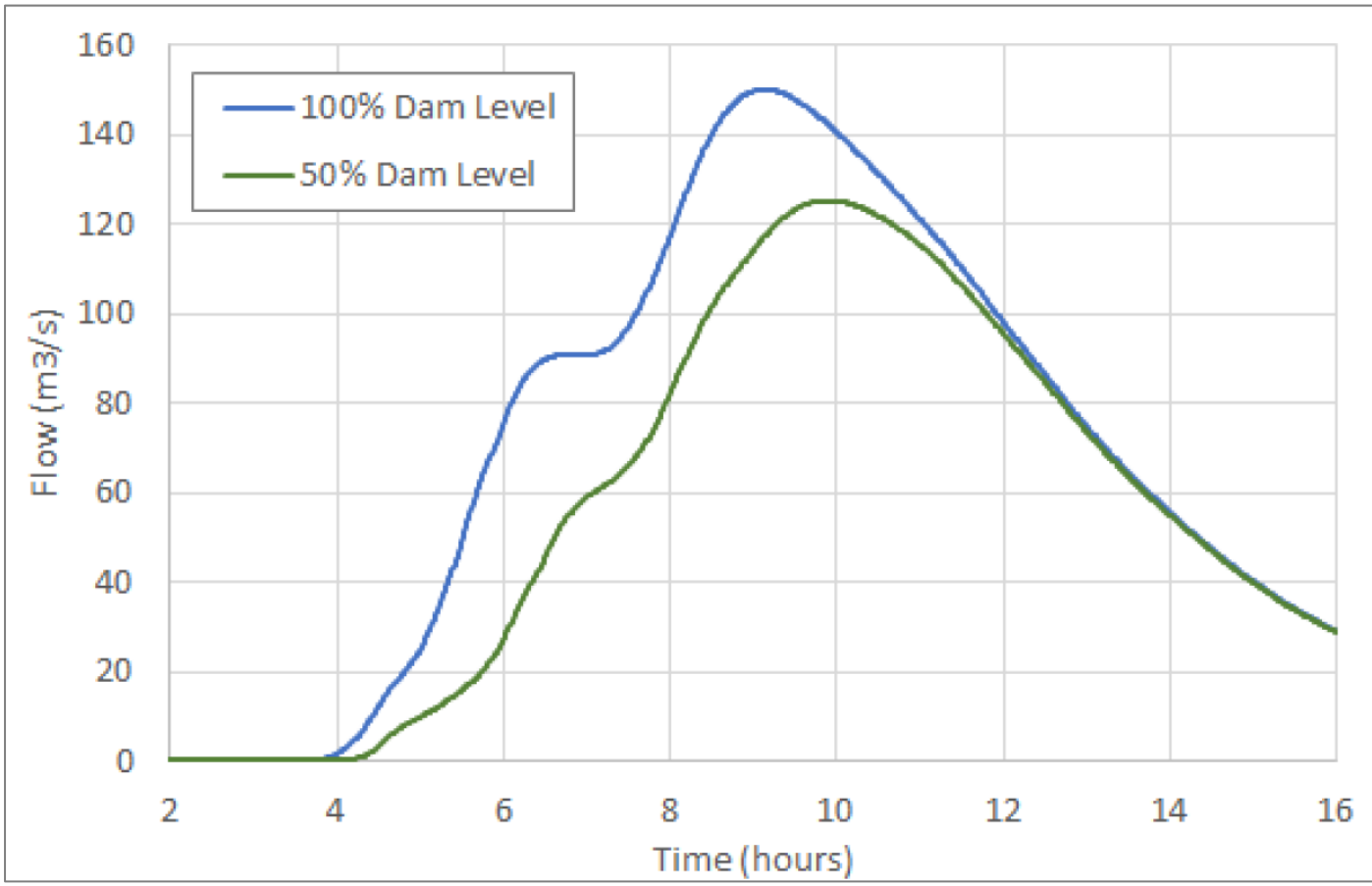
4.32



4.33 **Figure 31. Major storages upstream of Lara.**

Flood modelling undertaken as part of the Lara Flood Study (Water Technology 2020) shows the impact when major storages within the catchment are full and provide no available storage at the start of the storm event 1 in 100 year AEP event. This does not result in an increase in peak flood level (or flow) through Lara in the 48 hour event, but a faster rise in the rising limb. Flood sensitivity modelling (Water Technology 2020) shows the 6 hour event showed with the storage removed, the peak flow increased by 2,160ML/d resulting in an increase in flood levels of around 200 mm along Hovells Creek through Lara. Refer to the graph below. This modelling shows how the impact of the antecedent conditions can impact the peak flood levels as well as the timing of when flooding is likely to start impacting the town as well as the peak flooding the town.

4.34



4.35

4.36 **Figure 32. Comparison of flow rates with catchment storages at 50% and 100% capacity (Water Technology 2020).**

Lara Levees

Residential areas adjacent to Hovells Creek in Lara are protected by the earthen levee system which was initially installed in the mid 80's and designed to provide a level of protection to above the 1973 flood. Refer to the photo below. The flood levee crest levels were lifted in 1990 by a further 600 mm after the 1988 flood event. During the 1988 event the levees were overtopped in a number of locations along Ponds Drive, with minor overtopping of the levee located to the North West of Wingara Drive. It is noted that the 1988 flood event is the largest on record and is estimated to be close to a 1 in 100 year AEP event. Some levee sections are more than two metres high.

Figure 33. Earthen levee along Station Lake Road, adjacent to St Lawrence Park (Levee 1).

There are four levees within Lara;

- Levee one: east side of Hovells Creek, at St Laurence Park (there are proposed mitigation works by St Laurence Park to infill this land to remove these buildings from the floodplain)
- Levee two: east side of Hovells Creek, upstream of the Station Lake Road Bridge
- Levee three: west side of Hovells Creek, upstream of the Station Lake Road Bridge
- Levee four: southwest side of creek, upstream of Flinders Ave

Refer to the map below for the location of these levees.

Levee one: east side of Hovells Creek, at St Laurence Park

Two existing drainage outfalls are likely to cause flooding via backwater into St Laurence Park at events above 1 in 20 year AEP. The levee is also likely to be overtopped above 1 in 100 year AEP events in multiple locations. Survey work conducted in 1996 measured the crest level at the southernmost point is 7.65 m AHD.

Levee two: east side of Hovells Creek, upstream of the Station Lake Road Bridge

This levee was overtopped prior to 1 in 100 year AEP event at low spot near 11 Wingara Drive and opposite 8 Wingara Drive. Survey work conducted in 2015 measured the crest level at 8.20 m AHD near 11 Wingara Drive.

Levee three: west side of Hovells Creek, upstream of the Station Lake Road Bridge

This area is likely to be impacted first from flood waters entering from Flinders Ave from the north during a 1 in 100 year AEP flood. This levee may be overtopped during a 1 in 500 year AEP event. Survey work conducted in 1996 measured the crest level at 8.56 m AHD near pump pit closest to Station Lake Road.

Levee four: southwest side of creek, upstream of Flinders Ave.

This area is likely to be impacted first at 24-30 Ponds Drive in events larger than a 1 in 100 year AEP flood. Survey work conducted in 2015 measured the crest level at 9.46 m AHD near Flinders Avenue.

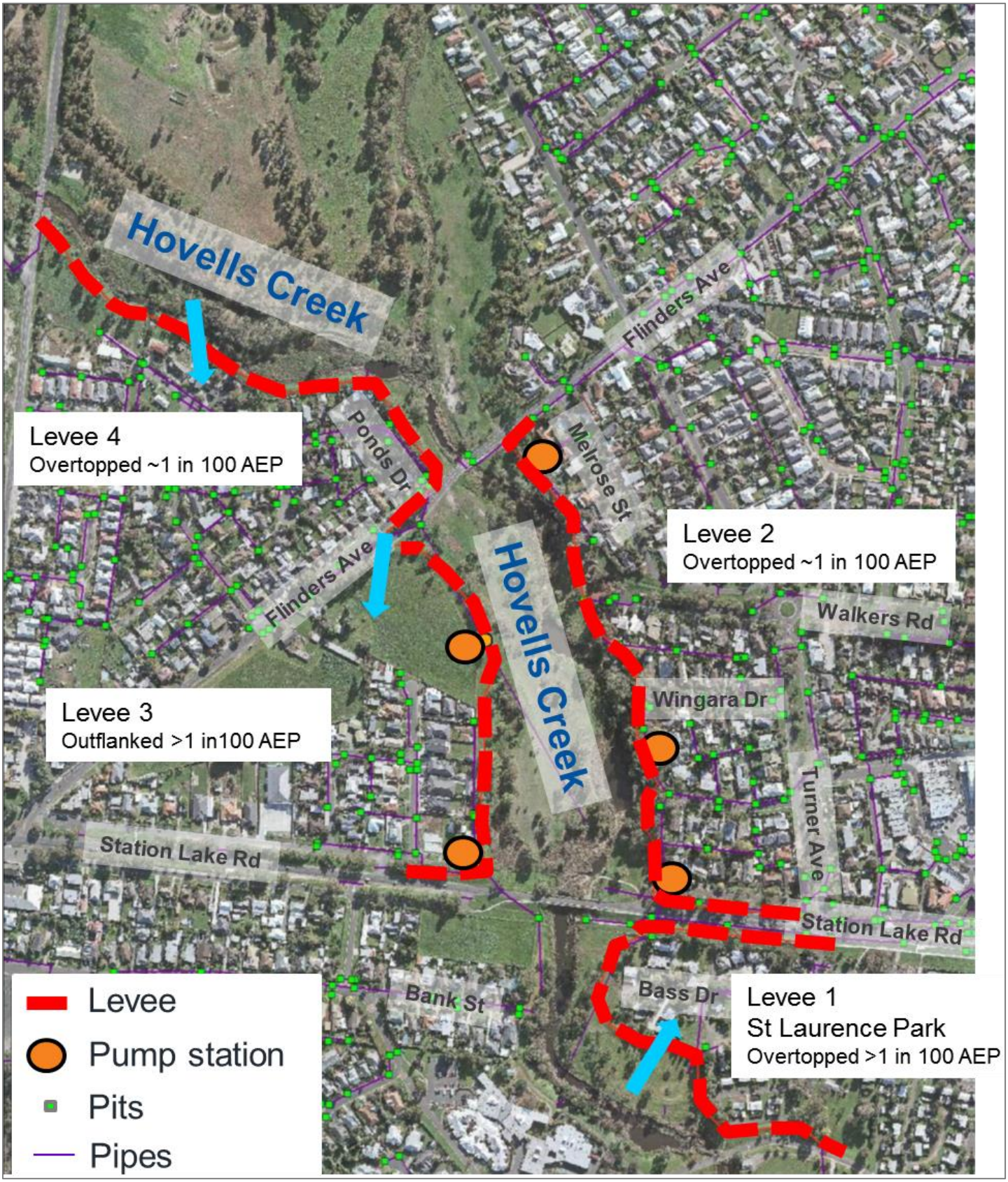


Figure 34. Lara levees and pump locations along Hovells Creek (Water Technology 2020).

Lara Pumping Stations

A set of vertical lift gates are located along Hovells Creek between Station Lake Road and Flinders Avenue to restrict high water levels from Hovells Creek backing up into the stormwater network. These are manually closed during a flood event and pumps are fitted within the pits to pump stormwater into Hovells Creek in five locations shown in the map above.

Flood Gates at Floodways

There are four floodways that are regularly impacted when flooding occurs along Hovells Creek, refer to the map below. Two monitored flood gates have been installed along Hovells Creek at Flinders Avenue and Rennie Street. Rennie Street has a recently installed Electronic Closed Warning Sign. These gates are manually operated by council staff at trigger levels identified in the table below. Additional flood gates are located at Windermere Road and Investigation Avenue, these gates are privately owned and operated. It is noted that temporary closure signs are often needed in Peak School Road at the waterway crossing. Refer to the flood triggers for each floodway below.

Table 6. Flood gates within the Hovells Creek catchment.

No	Floodway location	Flinders Ave stream gauge height (m) Flood Trigger (1 in year AEP)	Comments
1	Rennie Street	Less than a 2 year flood 5.8 m gauge height Flood depth 0.1 m	Road closure gate manually operated by Council. Flooding starts to overtop the floodway.
2	Flinders Avenue	Less than 2 year flood 6.6 m gauge height Flood level is 0.10m below road.	Road closure gate manually operated by Council.
3	Windermere Road	2 year flood, deep flooding cuts access to road 7.06 m gauge height	Privately owned and operated
4	Investigator Avenue	2 year flood 7.06 m gauge height	Privately owned and operated
5	Peak School Road	2 year flood, deep flooding cuts access to road 7.06 m gauge height	No gate, temporary road closure signs are needed.
6	Princes Freeway	10 year flood 8.49 m gauge height	Vic Roads trigger for flooding touching the underside of the support beam of the Princes Freeway creek crossing
7	Princes Freeway northbound	20 year flood 8.83 m gauge height	Vic Roads trigger for flooding overtopping the Princes Freeway northbound road.
8	Princes Freeway southbound	50 year flood 9.19 m gauge height	Vic Roads trigger for flooding overtopping the Princes Freeway southbound road.
9	Station Lake Road	50 year flood, shallow flooding overtops road 9.19m gauge height	Deploy road closure signs are needed.

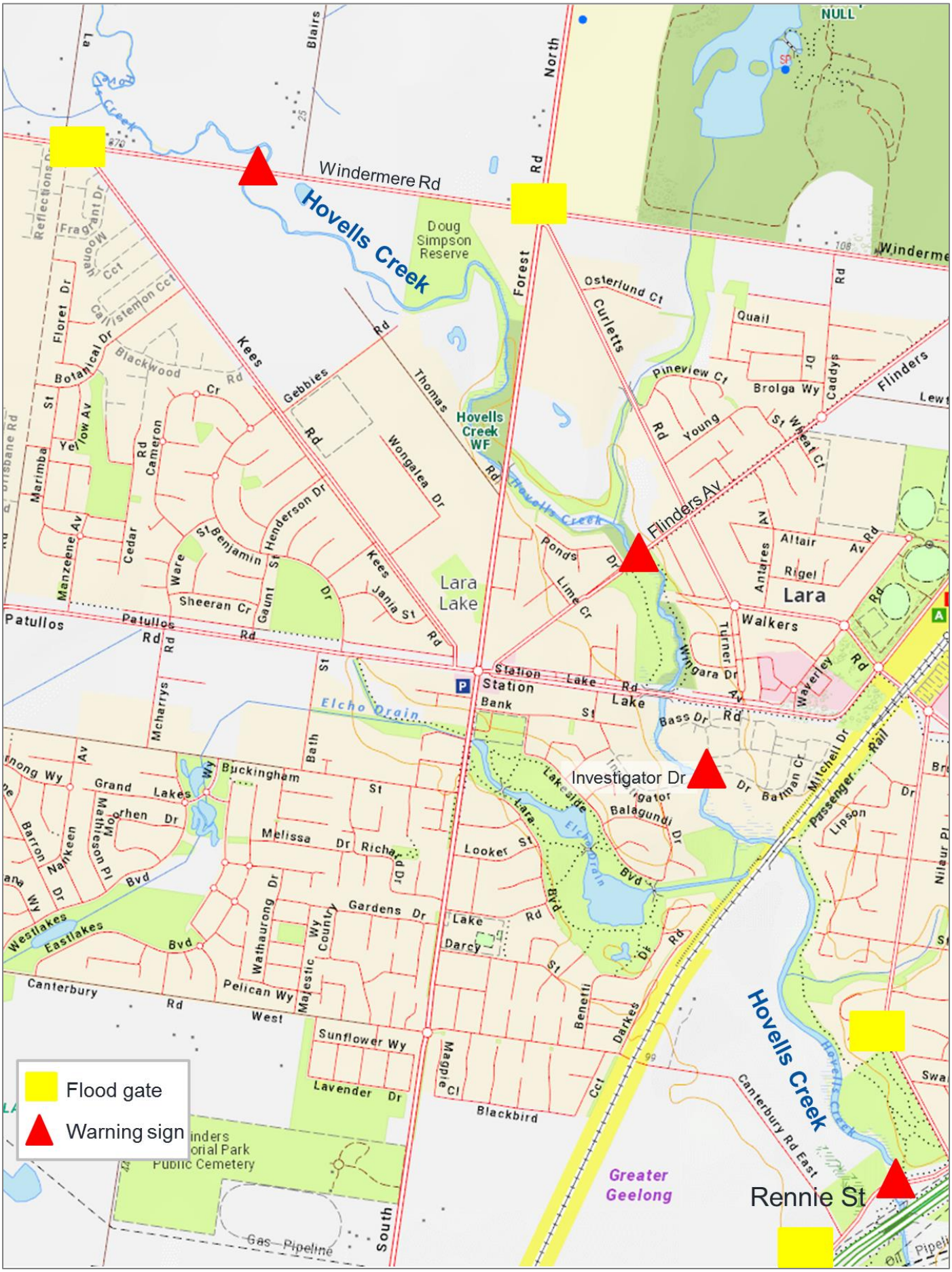


Figure 35. Lara flood gate and warning sign locations (Water Technology 2020).

St Laurence Park Retirement Village

Two stormwater drains outfall into Hovells Creek (downstream of Station Lake Road) from St Laurence Park Retirement Village (Figure 7-2). Both stormwater drains sit lower than the 1 in 100 AEP flood level and are required to be sandbagged during a flood event to prevent backflow from Hovells Creek entering the retirement village. Backflow is expected to begin at flood events in Hovells Creek greater than a 1 in 50 AEP flood level (when the water level reaches 9.00 m AHD on the Flinders Avenue gauge). If sandbagging occurs, local stormwater from the site cannot exit the village and may need to be pumped over the levee. A Council officer needs to monitor these outlets.

Figure 36. St Laurence Park Retirement Village stormwater drain outfall (Water Technology 2019).

Influence of Lara Lakes

There are several lakes within Lara that act as retarding basins, including Lara Lake and the Grand Lakes. Retarding basins are designed to minimise urban flood risk.

The Lara Lake acts as an informal retarding basin for flows from the residential area immediately surrounding the Lake as well as the upstream catchment that drains the majority of Lara to the west of Hovells Creek, including the Elcho Drain catchment. The Lake has a spill level of 6.6m AHD at the eastern side of the Lake, flowing to Hovells Creek via an open drain. Estimates of the storage in the Lake are between 2 to 2.2 ML.

The Grand Lakes residential estate is developed around a man-made lake which acts as an informal retarding basin along the Elcho Drain. Water enters the lake via Elcho Drain via 3x1350mm diameter culverts at Canterbury Road West. The outlet at the northern end of Grand Lakes at Buckingham Street is controlled by 4x1800x900 mm box culverts to convey the existing flows from Elcho Drain through the site while retarding stormwater flows from the estate back to pre-development conditions. This results in the water level within the lakes rising and inundating the roadways potentially limiting access during a flood event. Residential properties have been filled to above the 1 in 100 year AEP flood level based on previous modelling. Works within the estate are controlled by a Special Building Overlay (SBO) to ensure finished floor levels and any works do not increase flood risk to private property. Estimates of the lake storage are between 2 and 2.5 ML.

Warning time

Currently there are two stream gauges along Hovells Creek, these include Flinders Avenue and Rennie Street. There are three rainfall gauges that provide warning for Lara, these are located at Flinders Avenue (587035), Wooloomanata Sheep Station (587038), and at Granite Road Staughton Vale (587040). Refer to a map below of the location of these gauges. Refer to the maps in figures 17 and 18 above for the gauge locations.

A combination of flood modelling and anecdotal information from historic flood events was used to determine flood warning time for Lara from flooding in Hovells Creek. During historic flood events, flooding from Hovells Creek has peaked anywhere from 6 hours following the start of severe rainfall, through to 18-24 hours following prolonged rainfall.

In 1988 the catchment response time was 7 to 8 hours for a 6 hour storm. Rainfall commenced at 23:00 hours and overtopping of the levees occurred at 5:30 hours. The 1988 flood is considered to be a 1 in 100 flood event.

During the April 2017 flood event, minor flooding was observed in Lara. The figure below shows the timing of the April 2017 event where a significant spike in the two streamflow gauges occurred around 10 hours following the start of an intense rainfall event (Water Technology 2020). 62 mm of rainfall was recorded at the Avalon Airport in 42 hours up to 3:00 am on the 11th April including 22 mm in one hour. The rainfall produced a maximum stream level of 6.84 m AHD at Flinders Avenue gauge and 2.63 m AHD at the Rennie Street gauge. The travel time between the Flinders Avenue and the Rennie Street was approximately 1 hour. The table below provides a summary of the travel times for the calibration events modelled (Water Technology 2020).

The estimated travel time between heavy rainfall in the upper Hovells Creek catchment to steep rise in streamflow at Lara for a minor flood can vary between 6 to 12 hours. The flood peak travel time between heavy rainfall in the upper catchment and the flood peak arriving for a minor flood in Lara can vary between 10 to 24 hours.

During the April 2017 flood event the flood peak was maintained at Lara for one day, refer to the table and hydrograph below.

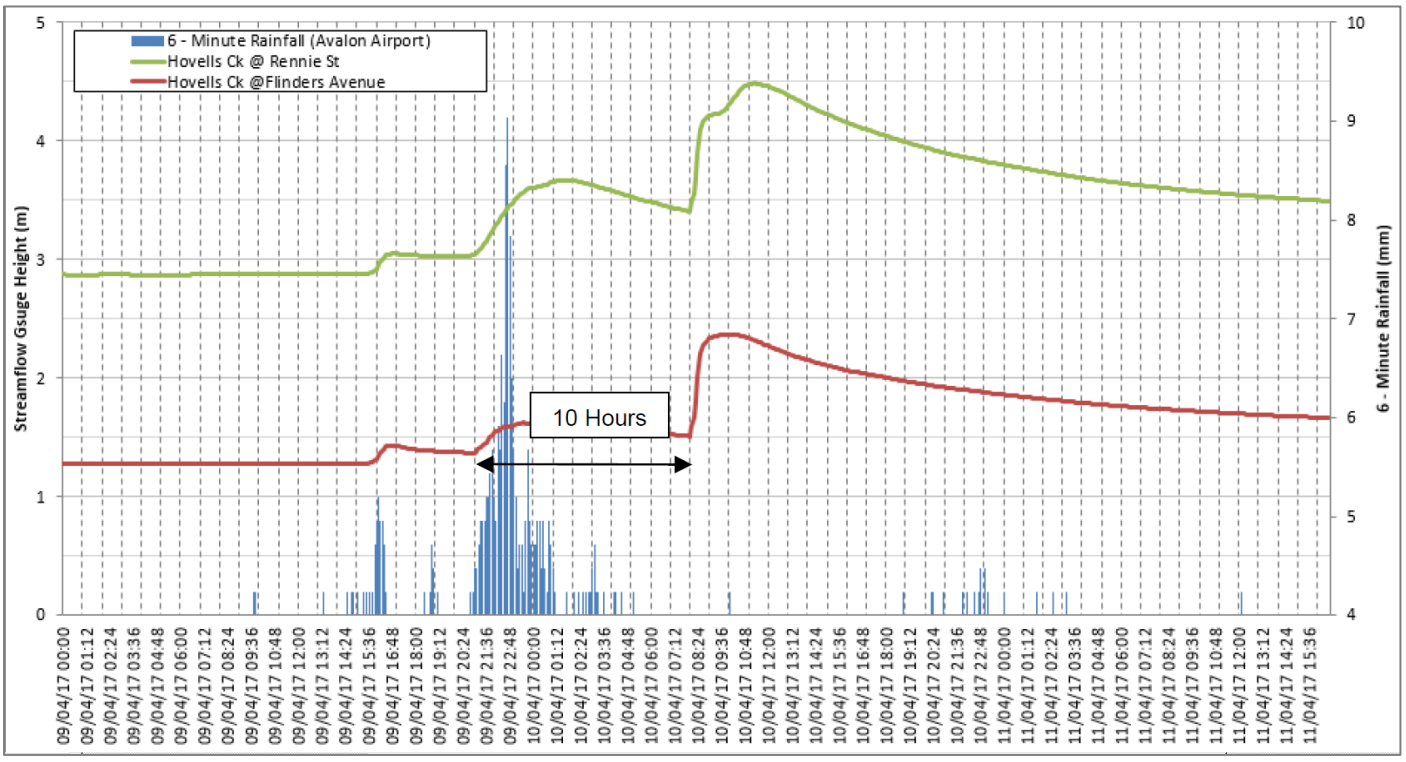


Figure 37. Flood peak travel time of the Hovells Creek stream gauges during the April 2017 flood event (Water Technology 2019).

Table 7. Travel time of flood peaks within the Hovells Creek catchment (Water Technology 2020).

Flood Event	Burst Rainfall	Rainfall Duration	Time from start of burst to rise of Hovells Creek at Lara	Time from start of burst to peak flooding of Hovells Creek at Lara
1973	80 mm*	5 hours	2 hours	3-4 hours
1988	120 mm*	6 hours	2-4 hours	4-6 hours
2005	120 mm^	48 hours	24 hours	48 hours
2017	50 mm*	4 hours	8 hours	10 hours

Stormwater Flood Behaviour

Flood modelling (Water Technology 2020) shows in a 1 in 100 year AEP event, there are 46 buildings identified to have above floor flooding from the stormwater flooding. These buildings are scattered across Lara.

A significant number of properties are at risk of frequent and nuisance flooding are located in the eastern side of Lara, spreading from Kyema Drive south across McClelland Avenue, to Brunel Close and through to Archimedes Avenue.

A large portion of buildings in Kyema Drive and McClelland Avenue that are flooded above floor are located behind the existing levees, within Lara East and along Elcho Drain. These impacted buildings reliant upon the water level in Hovells Creek being low and or the pumps being operational.

Model results for the 1 in 100 year AEP flood event in this area show McClelland Avenue acting as a hydraulic control, resulting in a 200 mm water level drop across the road. This combined with the flat terrain of the area and limited drainage network causes flood water to extend back up from McClelland Avenue into Brownlow Court. Refer to the flood map below. The depth of flooding within Kyema Drive is generally less than 300 mm in a 1 in 100 year AEP flood event, as event magnitude increases, the depth of flooding in Kyema Drive is not likely to get significantly higher due to the weiring of floodwaters over McClelland Avenue. For further details refer to the Lara Flood Intelligence Card (stormwater), tables and maps below.

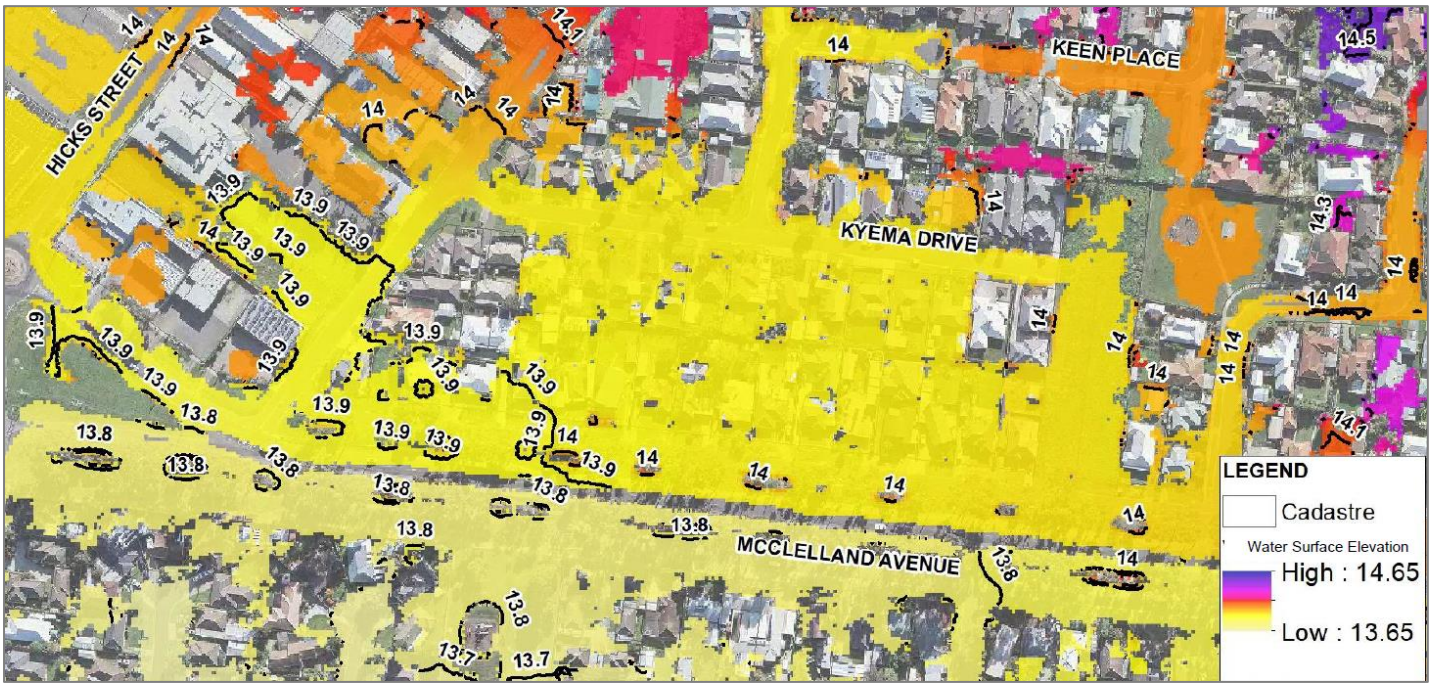


Figure 38. Significant flooding in the McClelland Avenue area during a 1 in 100 year AEP flood event (Water Technology 2020).

Stormwater Warning Time

Stormwater flooding can develop quickly as a result of local heavy rainfall. Heavy rainfall events can cause rapid rise of floodwater. Rapid rises of stormwater flooding in Lara can occur within 0.5 – 6 hours depending on rainfall intensity.

It's important to note that the time it takes rainfall associated with severe thunderstorm activity to develop into runoff is highly dependant on antecedent conditions, that saturation of the catchment. A flood on a 'dry' waterway travels more slowly that a flood on a 'wet' waterway. Hence the rainfall intensity, recent flood history, soil moisture and forecast weather conditions all need to be considered then using the following information to direct flood response activities.

Tide Influence

During flood events high tides may reduce the rate that floodwater flows from Hovells Creek and discharges to the ocean. High tides may extend the duration of flooding in Lara. However, low tides increase the rate of floodwater flow into the ocean. It's important to monitor the tides during flood events to assess the likely influence on the duration of flooding in Lara.

Tidal influences are not likely extend upstream of Station Lake Road (Water Technology 2020).

Table 8. Tide characteristics at Hovells Creek (Water Technology 2020).

Tide Details	Level (AHD)
Highest Astronomical Tide (no wind effect)	0.559
Mean Highest High Water	0.359
Mean High water Spring Tide	0.429
Highest High Water	1.058
Mean Sea Level	-0.041

Coastal Inundation

Approximately 30 dwellings located on the Avalon Foreshore Road have been identified to be at risk of becoming isolated during minor storm tide events. The highest astronomical tide level of 1.13 m AHD for Corio Bay indicates a potential flooding risk to these properties. The impact of coastal storm surge combined with a relatively minor catchment storm event is likely to result in a more significant flood impact to these properties.

A 1 in 10 and 1 in 100 AEP 12-hour duration with sea level rise for year 2090, estimated to result in a +0.80m in the tail water level. Flood modelling results showed the increases in flood levels were significant within the lower end of the Avalon Road catchment (and likely to cause significant flooding along the Avalon Foreshore Road, refer to the flood modelling map below. It is likely that minimal sea level rise will result in increased frequency and severity of flooding along the foreshore. An increase of 0.80 m along the lower end of Hovells Creek is likely to result in the capacity of the Rennie Street Ford crossing being reduced due to the higher tail water level. This may reduce the flow rate at which the road is overtopped, increase the frequency at which the road is closed. No significant increase is expected upstream of Rennie Street. The Princes Freeway bridge may experience flooding at a higher frequency at which the underside of the bridge is inundated. However, it is not likely that the frequency of overtopping would increase as a result of the modelled sea level rise.

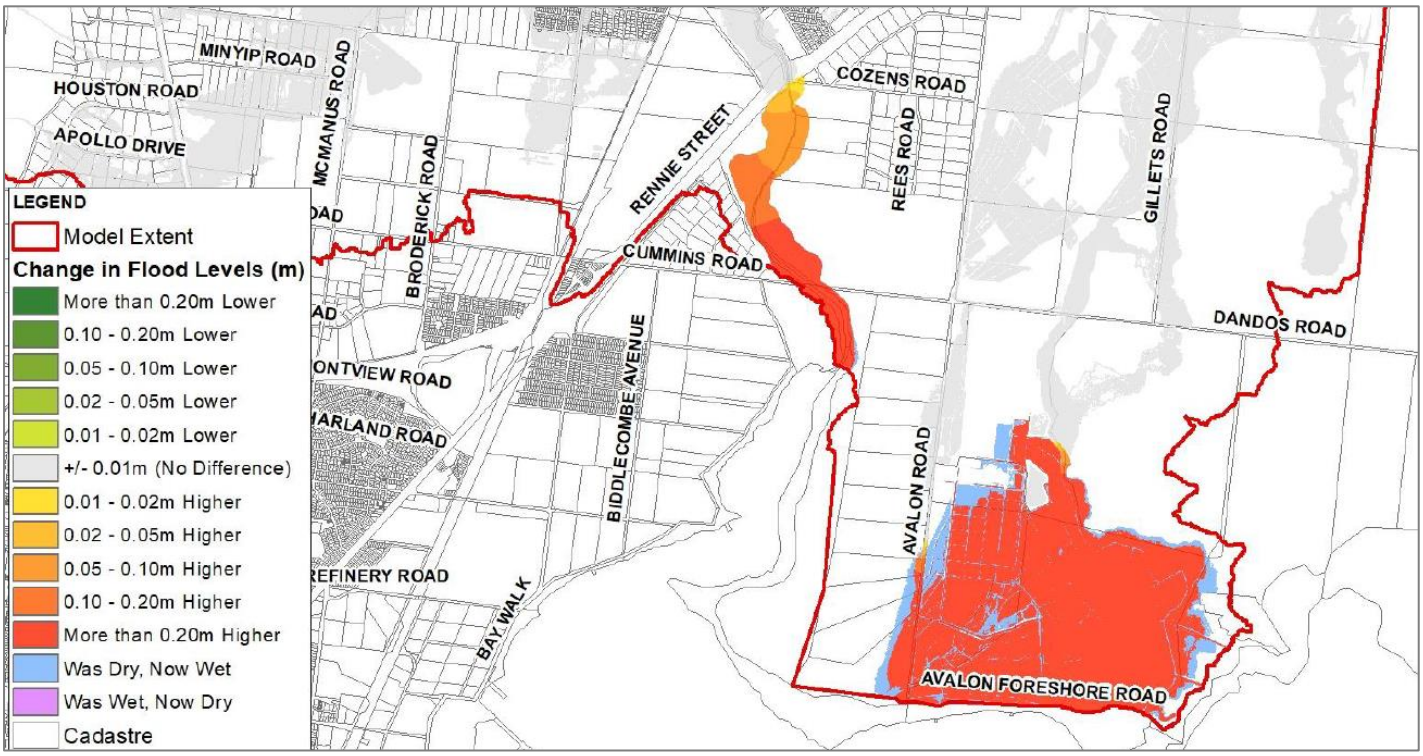


Figure 39. Sea level rise of 0.8m impacting the Avalon Foreshore Road (Water Technology 2020).

Flood Impacts and Required Actions

Flood mapping from the Lara Flood Study (Water Technology 2020) was used to estimate assets, buildings and roads impacted by flooding.

It's important to note that all flood events have different rainfall patterns. Where local rain falls across Lara is highly variable spatially. This creates uncertainty regarding what section of Lara will be impacted by stormwater flooding during each stormwater flood event. Therefore, the stormwater flood mapping and building damages should be used as a guide only for areas that may be at risk of stormwater flooding.

Key assets at risk of flooding in Lara are listed below.

Table 9. Key assets at risk of flooding.

Asset register				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
Rennie Street floodway, at Hovells Creek, south of Lara.	<2 year flood 5.8 m Flinders gauge	Shallow flooding starts to impact Rennie Street at 5.8 m at the Flinders Avenue gauge, to a depth of 0.10m.	Close the road gates and turn on the flood warning signs either side of the floodway as needed.	Council
Flinders Avenue floodway, at Hovells Creek, south of Lara.	<2 year flood 6.6 m Flinders gauge	Flooding is close to impacting Flinders Avenue at 6.6 m at the Flinders Avenue gauge, to a depth of 0.10m below the road level.	Close the road gates and turn on the flood warning signs either side of the floodway as needed.	Council
Elcho Golf Course, 125 Elcho Road, Lara.	2 year flood	Shallow flooding starts to impact the grounds of the Elcho Golf Course during a 1 in 2 year flood.	Evacuate the Golf Course and adjacent ovals as needed.	Victoria Police
A house at 13 Melrose Street, Lara.	2 year flood	A house at Melrose Street may be flooded above floor during a 1 in 2 year flood event.	Sandbag the building and undertake evacuations and asset protection works as needed.	Victoria Police VICSES
Flinders Avenue, Windermere Road, Peak School Road and Ohallorans Road, Lara.	2 year flood	Deep flooding may cut access to Flinders Avenue, Windermere Road, Peak School Road and Ohallorans Road during a 1 in 2 year flood, depth greater than 0.3m.	Deploy road signs to close the roads and undertake traffic management as needed.	Council Vic Roads
Drainage outfalls at St Laurence Park, Lara.	20 year flood	Two drainage outfalls are likely to cause flooding via backwater into St Laurence Park during a 1 in 20 year flood.	Block backflow and use pumps to remove stormwater build up against the levee.	Council
Princes Freeway (northbound), at intersection of Hovells Creek, south of Lara.	20 year flood	Flooding may impact the Princes Freeway (northbound), during a 1 in 20 year flood, depth 0.11 m.	Deploy road signs to close the Freeway and undertake traffic management as needed.	Vic Roads
Princes Freeway (southbound), at intersection of Hovells Creek, south of Lara.	50 year flood	Flooding may impact the Princes Freeway (southbound), during a 1 in 20 year flood, depth 0.13 m.	Deploy road signs to close the Freeway and undertake traffic management as needed.	Vic Roads
Lara levees (refer to the levee map above), east and west of Hovells Creek, Lara	100 year flood	Some of the Lara Levees are likely to be overtopped in a less than a 1 in 100 year flood.	Evacuate buildings at risk of flooding as needed.	Victoria Police

For more detailed information regarding buildings and roads impacted refer to the Lara Flood Intelligence Card and flood impact maps below. Also refer to the Lara flood depth maps in **Appendix E** and community sandbag collection points in **Appendix H**.

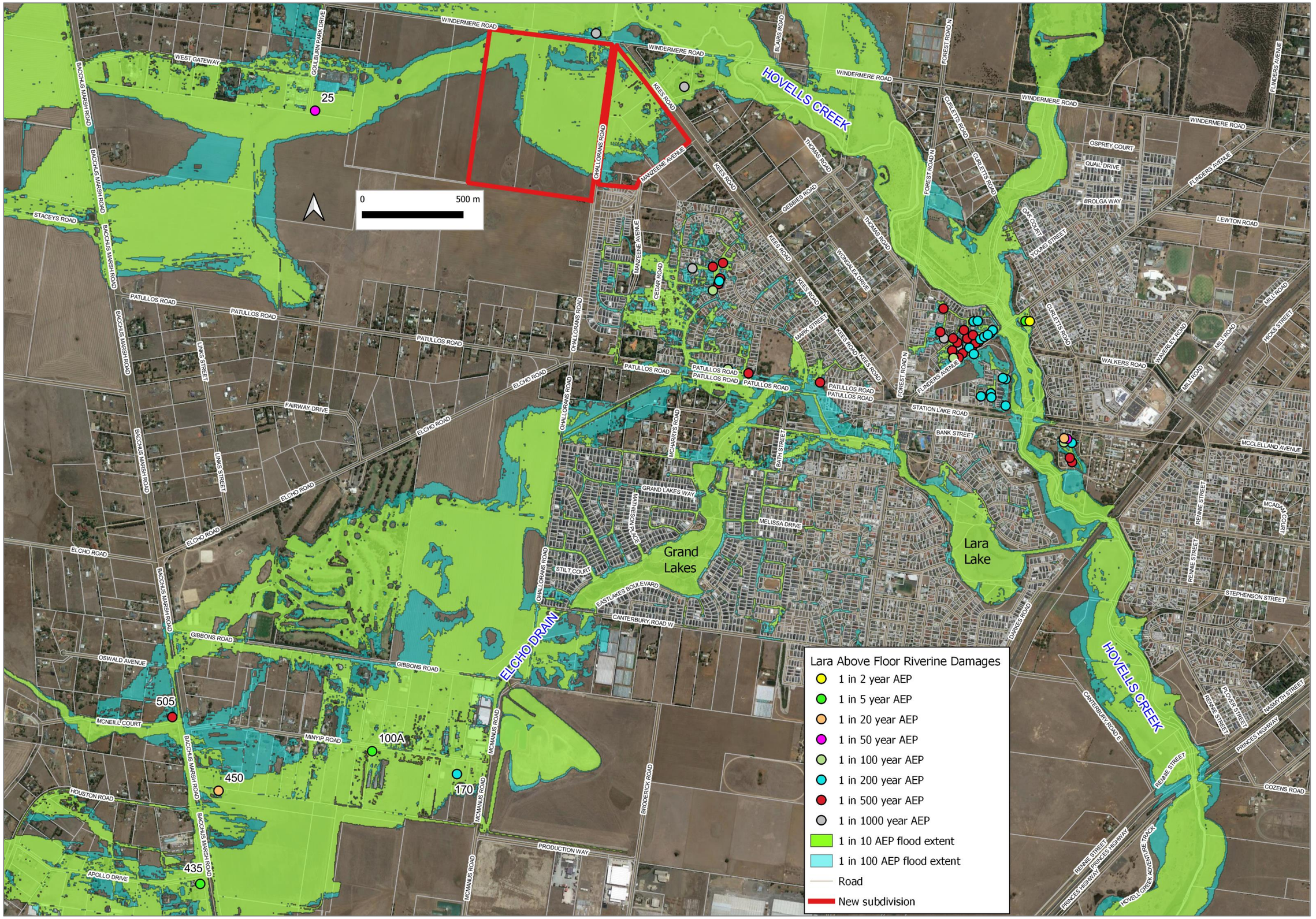


Figure 40. Lara buildings impacted by over flood flooding for a range of design flood events (Water Technology 2020).

Figure 41. Lara buildings impacted by riverine flooding for a range of design flood events (Water Technology 2020).

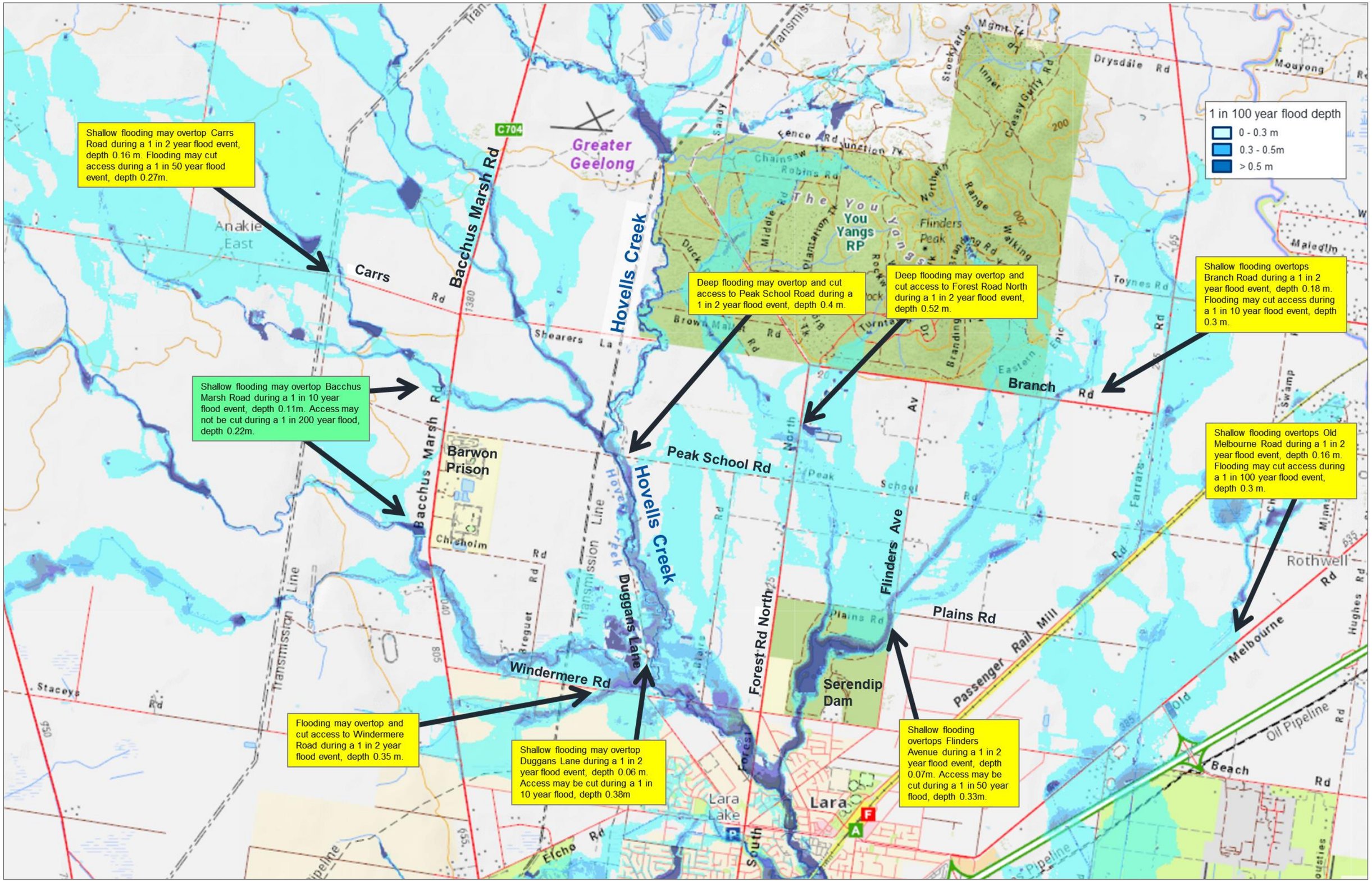


Figure 42. Lara roads impacted by riverine flooding for a range of design flood events (Water Technology 2020).

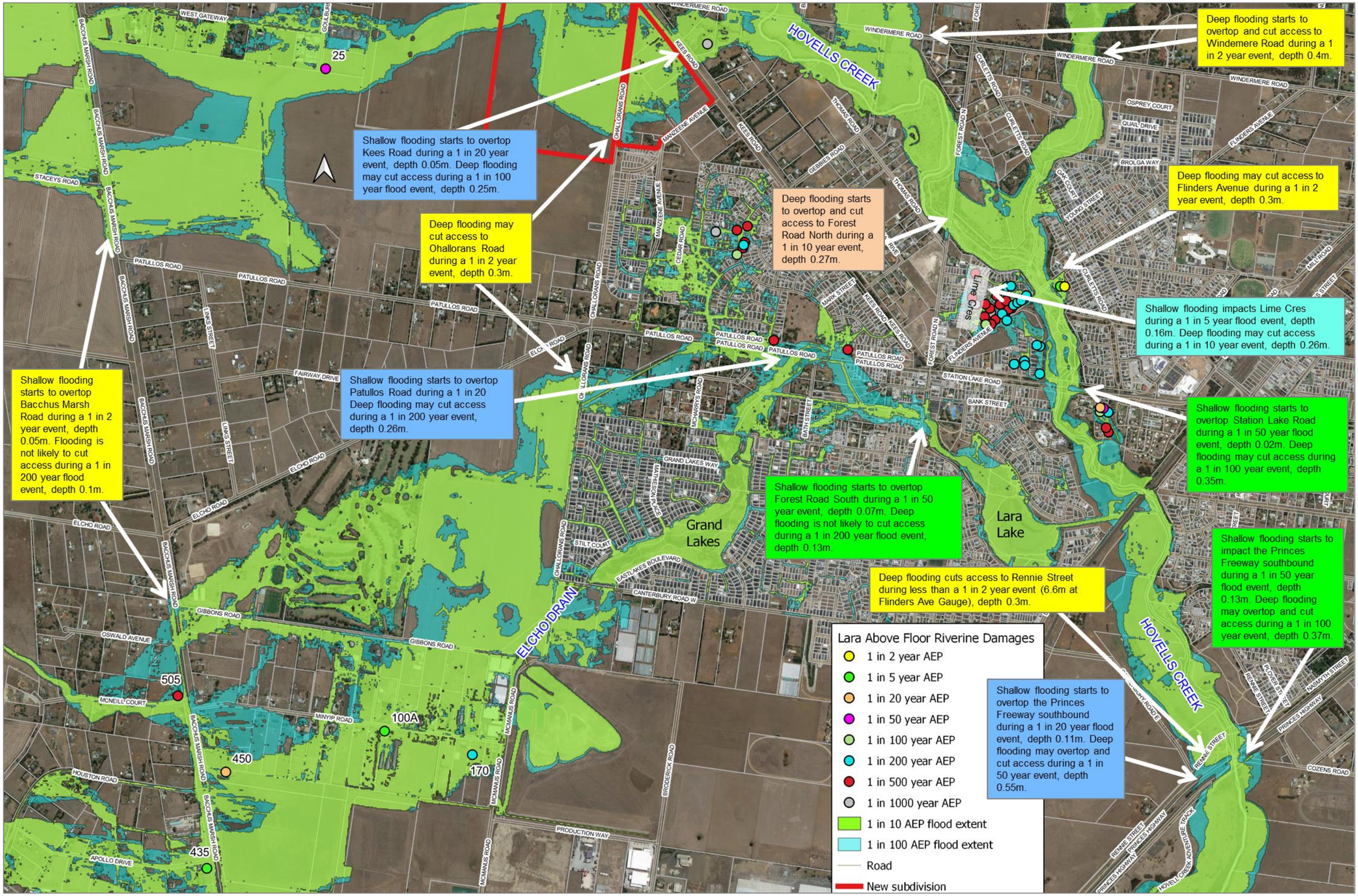


Figure 43. Lara roads impacted by riverine flooding for a range of design flood events (Water Technology 2020).

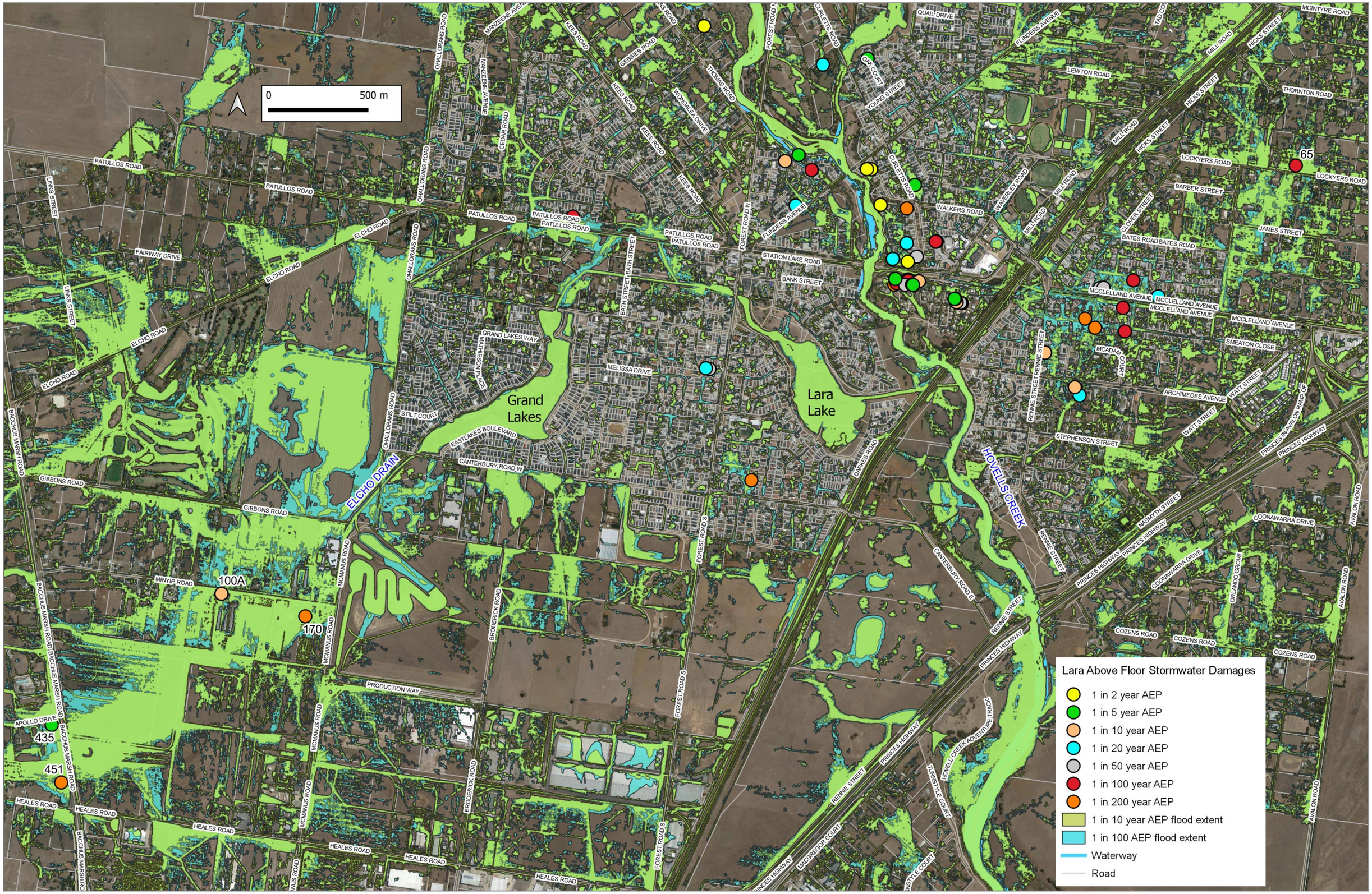


Figure 44. Lara buildings impacted by over floor stormwater flooding for a range of design flood events (Water Technology 2020).

Figure 45. Lara buildings impacted by over floor stormwater flooding for a range of design flood events (Water Technology 2020).

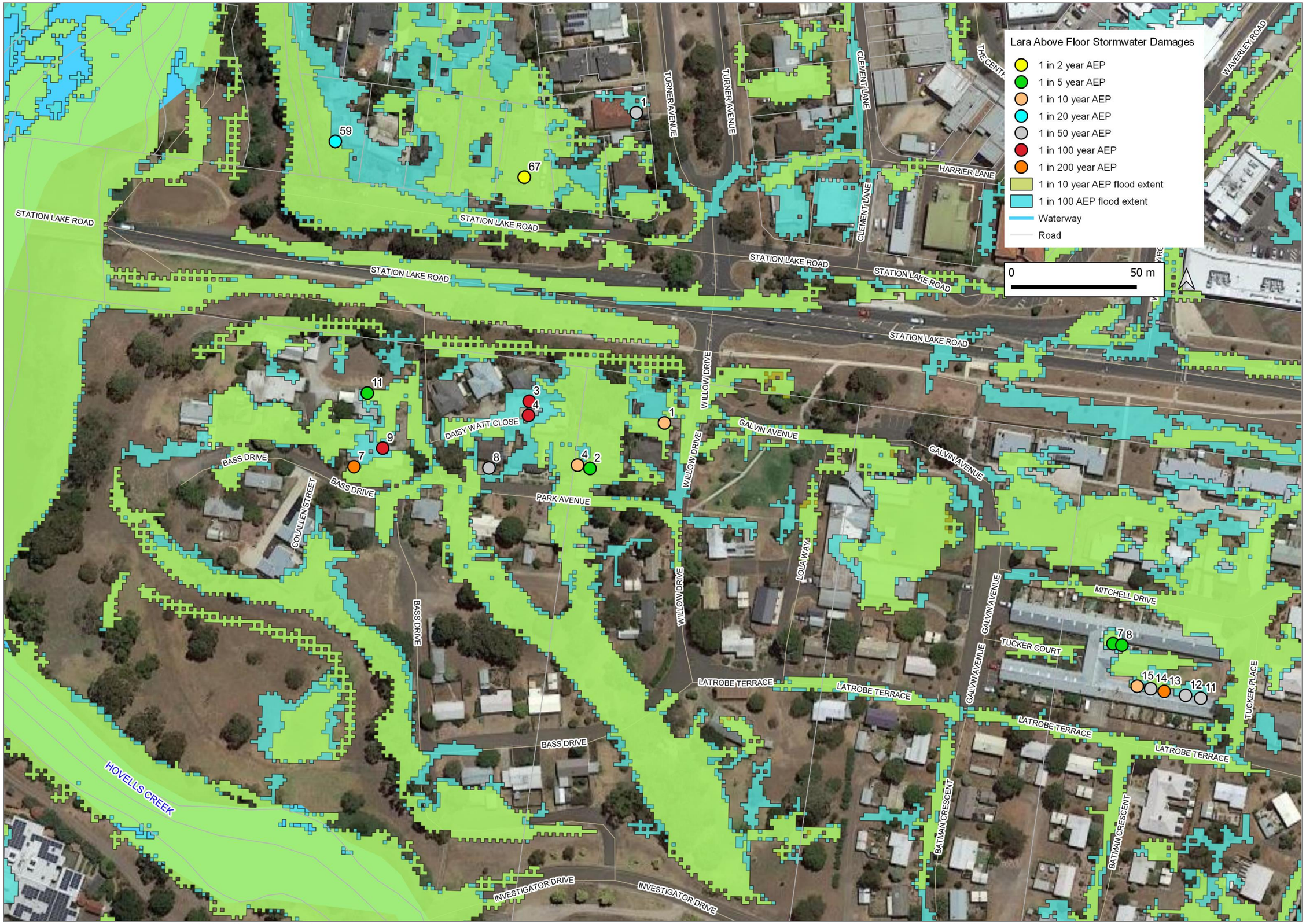


Figure 46. Lara buildings, adjacent to the St Lawrence Retirement Village impacted by over floor stormwater flooding for a range of design flood events (Water Technology 2020).

Table 10. Lara Flood Intelligence Card (Riverine Flooding)

Flood travel time	Time from start of rain to steep rise in floodwater in Lara 6 to 12 hours Time from start of rain to peak at Flinders gauge 10 to 24 hours Travel between the Flinders gauge to the Rennie Street gauge 1 hour Riverine flooding duration: 1 to 2 days

Hovells Creek at Flinders Ave gauge height 232802 (m AHD)	Hovells Creek at Rennie Street gauge board height (m AHD)	Annual Exceedance Probability (1 in year)	Hovells Creek at Flinders Design Flows (ML/d)	Lara damages total number properties flooded (above floor)	Consequences/ Impacts	Houses /buildings flooded / isolated	Roads impacted	Actions
5.8 (0.8 m)	2.1				Trigger for council to close the Rennie Street floodway road gates. After peak has passed, and once creek height has dropped to 0.7m, Rennie Street floodway needs to be inspected for possible opening. It has been estimate that time of travel for the flood peak to travel from Flinders Avenue to Rennie Street is approximately 1 hour.		Flinders Avenue depth 0m Rennie Street depth 0.1m	**Council** will close the Rennie Street floodway road gates. **Council** will notify VICSES via South West Duty Officer as soon as they are aware of any flood risk in Lara. **Council** clear debris from waterway crossings, drains and culverts as needed. **VICSES** RDO will activate ground observers to take photos and record flood levels at key crossings via Snap Send Solve.
6.6 (1.6 m)	2.4				Alarm level for the stream gauge, deep flooding cuts access to Rennie Street. Flood level is 0.10m below Flinders Avenue road level		Flinders Avenue depth -0.1m Rennie Street depth 0.3m	In addition to actions listed above; **Council** will close the Flinders Avenue floodway road gates.
6.84 (1.84 m)	2.6	April 2017	1,209		The 2017 flood event did not cause significant flood damage to private property. 57mm over 24 hours was recorded. Flood depth at Flinders Avenue is at the road level. Flood depth at Rennie Street is 0.5m above road level on floodway.			
7.06 (2.06m)	2.58	2	1,400	2,498 (1)	A building at 13 Melrose Street is flooded above floor. Flooding of the Elcho Drain beings to inundate private property. Shallow flooding overtops Duggans Lane and Kees Road. Flooding cuts access to Flinders Avenue, Windermere Road, Ohallorans Road and Peak School Road. Shallow flooding starts to impact the Elcho Park Golf Course grounds and the North Geelong Soccer Club oval. Flooding cuts access to the bike trails adjacent to Hovells Creek.	1 building is flooded above floor: 13 MELROSE STREET. The Elcho Park Golf Course (125 Elcho Road) and the North Geelong Soccer Club oval are impacted by flooding.	Flinders Avenue depth 0.3m Rennie Street depth 0.40m Windermere Road depth 0.4m Duggans Lane depth 0.06m Kees Road depth 0.05m Peak School Road depth 0.40m Ohallorans Road depth 0.3m	In addition to actions listed above; **VICSES** publish a community flood advice warning via EMCOP. **Victoria Police** evacuate the Elcho Park Golf Course the North Geelong Soccer Club oval as needed. **VICSES** sandbag a house and assist to protect assets as needed at 13 Melrose Street. **Council** will close the Flinders Avenue floodway road gates, Windermere Road, Peak School Road and Ohallorans Road. Deploy road signs to close roads and undertake traffic management as needed. **Barwon Water** staff check assets to ensure they are operational, request VICSES to assist with asset protection as needed, provide updates to the ICC.
7.90 (2.90 m)	3.00	5	3,922	2,857 (4)	Three additional buildings are flooded above floor. Flooding impacts properties at West Gateway. Overland flows impact farmlands west of the HM Barwon Prison, north of Windermere Road and west of Blairs Road. Widespread flooding north of Lara impacting farmland. Land between Lochyers Road and McClelland Avenue is partially overtopped. The floodwater flows across the farmland from upstream until Old Melbourne Road. Floodwater breaks out of waterways and spread across farmlands south of Princes Highway. Shallow flooding starts to impact a large number of minor roads within Lara, such as Lime Cres, flood depth may be greater than to 0.15m.	3 additional buildings are flooded above floor: 64-68 FLINDERS AVE, 100A MINYIP ROAD, 435 BACCHUS MARSH ROAD.	Flinders Avenue depth 0.94m Rennie Street depth 0.82m Windermere Road depth 0.9m Duggans Lane depth 0.24m Kees Road depth 0.08m Peak School Road depth 1.20m Ohallorans Road depth 0.33m Lime Cres depth 0.16m	In addition to actions listed above; **VICSES** sandbag buildings and assist to protect assets as needed. **Council** deploy road signs to close roads at Duggans Lane and others, and undertake traffic management as needed. **Parks Victoria** staff check the Serendip Dam levels and the integrity of the Dam wall, provide updates to the ICC.
8.33 (3.33 m)		February 2005	7,819		131mm over 36 hours was recorded at the Granite Road gauge. Hovells Creek levels rose and lapped the underside of the Station Lake Road bridge. Flood levels remained at this level for 2 hours. Levees were not overtopped and floodwaters got within 800mm of the levee crests. Pumping was undertaken intermittently from the west pump pits. Flooding overtopped Forest Road Bridge and Flinders Avenue.			
	3.10				Flood depth at Rennie Street is 1.0m above road level on floodway.			
	3.34				Flood level is touching the underside of the support beam (Princes Freeway creek crossing).			
8.49 (3.49 m)	3.54	10	8,043	3,122 (4)	Flooding may reach the Station Lake road bridge deck level (in the south west corner). There is a large flood extent upstream of Hovells Creek, north of the town and in Lara East, there is also a large flood extent upstream of Hovells Creek, north of the town. Water overtops Old Melbourne Road and spreads across farmland west of Gillets Road. Deep flooding cuts access to Duggans Lane and Forest Road. Deep flooding may cut access to a large number of minor roads within Lara, such as Lime Cres, flood depth may be greater than to 0.26m.	0 additional buildings are flooded above floor.	Flinders Avenue depth 1.46m Rennie Street depth 1.43m Forest Road North depth 0.27m Windermere Road depth 1.15m Duggans Lane depth 0.38m Kees Road depth 0.11m Peak School Road depth 1.71m Ohallorans Road depth 0.35m Lime Cres depth 0.26m	In addition to actions listed above; **Council** deploy road signs to close roads at Forest Road North, Lime Cres and others, and undertake traffic management as needed.
8.83 (3.83 m)	4.08	20	11,456	3,339 (6)	Two additional buildings are flooded above floor. Shallow flooding may start to overtop the Princes Freeway (northbound), may need to close the Free. More flooding occurs along two sides of Mill Road, north east of the area of Lara East and in Avalon Road catchment, flood breaks out north east of the area and observed extents largely	2 additional buildings are flooded above floor: 8 PARK AVENUE, 450-490 BACCHUS MARSH ROAD.	Flinders Avenue depth 1.77m Rennie Street depth 1.99m Forest Road North depth 0.40m Windermere Road depth 1.28m Duggans Lane depth 0.49m Kees Road depth 0.13m	In addition to actions listed above; **Vic Roads** deploy road signs to close the Princes Freeway northbound and undertake traffic management as needed.

					increase between Old Melbourne Road and Princes Highway. Two drainage outfalls are likely to cause flooding via backwater into St Laurence Park.		Princes Freeway northbound depth 0.11m Peak School Road depth 2.10m Ohallorans Road depth 0.37m Lime Cres depth 0.29m	**VICSES** sandbag buildings and assist to protect assets as needed. **Council** use stormwater pumps along the Lara levees to remove stormwater build up against the levees.
9.05 (4.05 m)		February 1973	15,210		The 1973 flood event was the second largest flood in living memory which directly affected 73 residences. Flood level is approx. 0.50m below the levee's crest at Flinders Avenue end.			
9.10 (4.10 m)								In addition to actions listed above; **Council** will close the Station Lake road floodway.
9.19 (4.19 m)	4.60	50	15,992	3,691 (8)	Two additional buildings are flooded above floor. Shallow flooding may overtop Station Lake Road and the Princes Freeway (southbound). Deep flooding may cut access to the Princes Freeway (northbound).	2 additional buildings are flooded above floor: 25 GOULBURN PARK DRIVE, 6 PARK AVENUE.	Windermere Road depth 1.43m Station Lake Road depth 0.08m Flinders Avenue depth 2.11m Rennie Street depth 2.52m Duggans Lane depth 0.62m Peak School Road depth 2.41m Kees Road depth 0.18m Forest Road North depth 0.62m Ohallorans Road depth 0.41m Princes Freeway northbound depth 0.55m Princes Freeway southbound depth 0.13m Lime Cres depth 0.32m	In addition to actions listed above; **Vic Roads** deploy road signs to close the Princes Freeway southbound and undertake traffic management as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Council** engineer staff checks the integrity of the Lara levees. Undertake projection works to fill low points in the levees as needed.
9.40 (4.40 m)		December 1988	19,526		The 1988 flood event was the largest flood in living memory which directly affected a significant number of buildings. The Serendip Dam failed, contributing to flooding in Lara. 125mm over 6 hours was recorded close to Lara. Station Lake Road bridge overtopped by 300-400mm. Flinders Avenue at Hovells Creek was well under water. Forest Road North bridge wasn't overtopped. Forest Road Bridge came very close to being overtopped. Station Lake Road Bridge was overtopped by approx 300-400mm. Flinders Avenue and Rennie Street monitoring sites were overtopped almost immediately. Bacchus Marsh Road was flooded in numerous locations between Heals Road and Granite Road. In some locations the road may become impassable particularly to smaller vehicles.		Rennie Street depth 2.75m Windermere Road depth 1.53m	
9.42 (4.42 m)	4.85	100	19,716	3,923 (12)	Four additional buildings are flooded above floor. Levee at Flinders Ave (western flood gate end) may be overtopped. Levee may be overtopped into Wingara Drive. Deep flooding cuts access to Station Lake Road and Kees Road.	4 additional buildings are flooded above floor: 5 PARK AVENUE, 17 FLINDERS AVENUE, 77 PATULLOS ROAD, 59 BENJAMIN DRIVE.	Windermere Road depth 1.57m Station Lake Road depth 0.41m Flinders Avenue depth 2.39m Rennie Street depth 2.76m Duggans Lane depth 0.73m Peak School Road depth 2.56m Kees Road depth 0.25m Forest Road North depth 0.81m Ohallorans Road depth 0.44m Princes Freeway northbound depth 0.86m Princes Freeway southbound depth 0.37m Lime Cres depth 0.33m	In addition to actions listed above; **VICSES** sandbag buildings and assist to protect assets as needed. **Council** engineering staff check the integrity of the Lara levees. **Victoria Police** consider evacuating an additional 18 buildings at risk of flooding during a 200 year flood in case the Lara Levees are overtopped.
9.63 (4.63 m)	5.02	200	22,127	4,100 (30)	18 additional buildings are flooded above floor. The Levee between Forest Road North and Flinders Ave may be overtopped. Flooding in Martain Avenue may still be behind the levee. The St Laurence Levee may be overtopped.	18 additional buildings are flooded above floor: X7 FLINDERS AVENUE (24, 25, 33, 35, 37, 39, 41), x4 MARTAIN AVE (1, 3, 2/16, 3/16), x2 PONDS DRIVE (13, 15), 52 BENJAMIN DRIVE, 170 MINYIP ROAD, 49B STATION LAKE ROAD, 10 BEVERLEY CRESCENT, 1 PARK AVENUE.	Windermere Road depth 1.65m Station Lake Road depth 0.48m Flinders Avenue depth 2.57m Rennie Street depth 2.91m Duggans Lane depth 0.76m Peak School Road depth 2.76m Kees Road depth 0.36m Forest Road North depth 0.98m Ohallorans Road depth 0.51m Princes Freeway northbound depth 1.04m Princes Freeway southbound depth 0.47m Lime Cres depth 0.38m	In addition to actions listed above; **VICSES** sandbag buildings and assist to protect assets as needed.
9.82 (4.82 m)	5.24	500	29,358	4,339 (52)	22 additional buildings are flooded above floor. Overland flow reaches and overtops Manzeene Avenue and floodwater flows to further south at Canterbury Road, but only a minor overall increase in flood extent.	22 additional buildings are flooded above floor: x5 LIME CRESCENT (1, 4-6, 8, 11, 23), x5 FLINDERS AVENUE (19, 21, 27, 29, 31), x4 BENJAMIN DRIVE (50, 54, 62, 71), x3 JAN COURT (2, 3, 5), x2 BASS DRIVE (92, 93), x2 PATULLOS ROAD (33, 69), 505 BACCHUS MARSH ROAD,	Windermere Road depth 1.82m Station Lake Road depth 0.9m Flinders Avenue depth 2.75m Rennie Street depth 3.13m Duggans Lane depth 0.84m Peak School Road depth 3.05m Kees Road depth 0.54m Forest Road North depth 1.18m Ohallorans Road depth 0.67m Princes Freeway northbound depth 1.27m Princes Freeway southbound depth 0.66m Lime Cres depth 0.98m	Refer to actions listed above.

9.95 (4.95 m)	5.38	1000	35,078	4,490 (57)	5 additional buildings are flooded above floor in Kees Road, Lime Crescent and Foot Court. Flood water flowing along the Kees Road and impacting adjacent properties, private properties in SW of Grand Lakes estate are flooded and there is major flooding across private property between Plains Road, Old Melbourne Road and Princess Highway.	5 additional buildings are flooded above floor: x2 LIME CRESCENT (2, 7), 180 KEES ROAD, 6 FOOT COURT, 390 WINDERMERE ROAD.		Refer to actions listed above.

Table 11. Lara Flood Intelligence Card (Stormwater Flooding)

Flood travel time	Time from start of rain to steep rise in stormwater flooding in Lara 0.5 to 6 hours Riverine flooding duration: 0.5 to 1 day					
Observed Design Rainfall (BOM) (mm/hour)	**Annual Exceedance Probability (1 in year)**	**Hovells Creek at Flinders Design Flows (ML/d)**	**Lara Stormwater damages total number properties flooded (above floor)**	**Consequences/ Impacts**	**Houses /buildings flooded / isolated**	**Actions**
~ 22 mm in 6 hours to 32 mm in 24 hours	2	1,399	2498 (5)	Five houses may be flooded above floor in Walkers Road, Flinders Avenue, Melrose Street, Thomas Road and Station Lake Road. Shallow widespread flooding across Lara impacts most roads up to 0.25m depth. When stormwater builds up against the Lara levees, trigger for council to use stormwater pumps to pump floodwater over the levee. Stormwater drains at the St Laurence Retirement Village drain to Hovells Creek and sit lower that the Hovells Creek flood level. During flood events floodwater is likely to backflow along these drains from Hovells Creek and enter the Retirement Village. If riverine flooding occurs within Hovells Creek up to a 1 in 50 year AEP flood (Flinders Ave gauge 4.19m, 9.19 m AHD) stormwater pits at the St Laurence Retirement Village may need to be sandbagged and excess stormwater pumped over the levee.	5 buildings are flooded above floor: 63 WALKERS ROAD, 64-68 FLINDERS AVENUE, 13 MELROSE STREET, 78 THOMAS ROAD, 67 STATION LAKE ROAD.	**VICSES** sandbag stormwater pits at the St Lawrence Retirement Village and others as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Council and DEPARTMENT OF TRANSPORT** deploy road signs to close roads and undertake traffic management as needed. **Council** pump stormwater building up against the Lara Levees over the levee.
~ 29 mm in 6 hours to 42 mm in 24 hours	5	3,922	2857 (15)	Ten additional buildings may be flooded above floor.	10 additional buildings are flooded above floor: X2 PARK AVENUE (2, 11), x2TUCKER COURT (7, 8), 2/6 CURLETTS ROAD, 435 BACCHUS MARSH ROAD, 1-2 OAK COURT, 2/28 PONDS DRIVE.	Refer to actions listed above.
~ 34 mm in 6 hours to 48.5 mm in 24 hours	10	8,043	3122 (20)	Five additional buildings may be flooded above floor. Many roads in Lara may be impacted by shallow flooding, depth up to 0.15m. Depth of floodwater along Kyema Drive and McClelland Ave may be up to 0.20m.	5 additional buildings are flooded above floor: 1 WILLOW DRIVE, 15 TUCKER COURT, 4 PARK AVENUE, 100A MINYIP ROAD, 29 RENNIE STREET, 21 LIME CRESCENT, 60 ARCHIMEDES AVENUE.	Refer to actions listed above.
~ 40.4 mm in 6 hours to 57.2 mm in 24 hours	20	11,456	3339 (27)	Seven additional buildings may be flooded above floor.	7 additional buildings are flooded above floor: 17 FLINDERS AVENUE, 59 STATION LAKE ROAD, 79 MCCLELLAND AVENUE 2 WINGARA DRIVE, 4/66 FOREST ROAD S 75 CURLETTS ROAD, 64 ARCHIMEDES AVENUE.	Refer to actions listed above.
~ 49.6 mm in 6 hours to 69.6 mm in 24 hours	50	15,992	3691 (35)	Eight additional buildings may be flooded above floor.	8 additional buildings are flooded above floor: x3 TUCKER COURT (11, 12, 14), X2 MCCLELLAND AVENUE (45, 47), 1 TURNER AVENUE, 8 PARK AVENUE, 3/66 FOREST ROAD S.	Refer to actions listed above.
~ 57 mm in 6 hours to 79.8 mm in 24 hours	100	19,716	3924 (46)	Five additional buildings may be flooded above floor. Deeper flooding along many roads in Lara, flood depth is up to 0.25 along Kyema Drive and McClelland Ave.	11 additional buildings are flooded above floor: 17 PONDS DRIVE, 42 MCCLELLAND AVENUE, 77 PATULLOS ROAD, 85 SMEATON CLOSE, 3 DAISY WATT CLOSE, 9 PARK AVENUE, 15-16 THE CENTREWAY, 26 KYEME DRIVE, 15-16 THE CENTREWAY, 65 LOCKYERS ROAD, 4 DAISY WATT CLOSE.	Refer to actions listed above.
	200	22,127	4101 (53)	Seven additional buildings may be flooded above floor.	7 additional buildings are flooded above floor; X2 BRUNEL (19, 26), 13 TUCKER COURT, 415 BACCHUS MARSH ROAD, 18 NEWELL STREET, 170 MINYIP ROAD, 7 BASS DRIVE.	Refer to actions listed above.
	500	29,358	4341 (68)	Fifteen additional buildings may be flooded above floor.	15 additional buildings are flooded above floor; X4 KYEMA DRIVE (10, 20, 24), x2 STATION LAKE ROAD (49A, 49B), 3 SAINTFIELD STREET, 13 WALKERS ROAD, 110 GIBBONS ROAD L, 60 MCCLELLAND AVENUE, 5 MARTAIN AVENUE, 10 BANK STREET, 15-16 THE CENTREWAY, 25 OLD MELBOURNE ROAD and 140 AVALON ROAD, AVALON	Refer to actions listed above.
	1000	35,078	4494 (83)	Fifteen additional buildings may be flooded above floor.	15 additional buildings are flooded above floor; 46 PATULLOS ROAD (46, 69), 49 WALKERS ROAD, 6 PARK AVENUE, 20 NEWELL STREET, 18 FOREST ROAD SOUTH (18, 2/66), 2/28 CURLETTS ROAD, 59 BENJAMIN DRIVE, MCCLELLAND AVENUE (43, 58), 9 BRUNEL CLOSE, 22 KYEMA DRIVE, 1 SAINTFIELD STREET, 86 SMEATON CLOSE.	Refer to actions listed above.

Table 12. Lara Riverine Flood Property Inundation Table

Colours used in the table below are the same used in the Lara riverine flood risk maps above. Yellow, buildings flooded above floor in a 1 in 2 year AEP. Green, buildings flooded above floor in a 1 in 5 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)								
		2	5	10	20	50	100	200	500	1000
1	13 MELROSE STREET, LARA	0.016	0.209	0.509	0.518	0.53	0.799	0.96	1.113	1.284
2	64-68 FLINDERS AVENUE, LARA		0.148	0.447	0.457	0.468	0.745	0.919	1.078	1.249
3	100A MINYIP ROAD, LARA		0.062	0.086	0.099	0.125	0.136	0.147	0.159	0.17
4	435 BACCHUS MARSH ROAD, Challeen Park, LARA		0.032	0.062	0.071	0.08	0.088	0.115	0.151	0.17
5	8 PARK AVENUE, LARA				0.044	0.05	0.056	0.467	1.293	1.928
6	450-490 BACCHUS MARSH ROAD, LARA				0.002	0.011	0.035	0.067	0.089	0.115
7	25 GOULBURN PARK DRIVE, LARA					0.042	0.094	0.093	0.127	0.183
8	6 PARK AVENUE, LARA					0.01	0.028	0.325	1.15	1.787
9	5 PARK AVENUE, LARA						0.098	0.548	1.37	1.994
10	17 FLINDERS AVENUE, Soma-Kia Martial Arts Office, LARA						0.084	0.09	0.564	0.854
11	77 PATULLOS ROAD, LARA						0.04	0.094	0.148	0.192
12	59 BENJAMIN DRIVE LARA						0.004	0.019	0.064	0.082
13	49B STATION LAKE ROAD, LARA							1.048	1.437	1.555
14	1 MARTAIN AVENUE, LARA							0.607	1.037	1.198
15	24 FLINDERS AVENUE, LARA							0.439	0.969	1.241
16	UNIT 2/16 MARTAIN AVENUE, LARA							0.394	0.868	1.073
17	15 PONDS DRIVE, LARA							0.347	0.928	1.302
18	10 BEVERLEY CRESCENT, LARA							0.303	0.751	0.937
19	37 FLINDERS AVENUE, LARA							0.295	0.843	1.166
20	1 PARK AVENUE, LARA							0.178	0.999	1.625
21	3 MARTAIN AVENUE, LARA							0.171	0.611	0.786
22	41 FLINDERS AVENUE, LARA							0.119	0.673	1.008
23	UNIT 3/16 MARTAIN AVENUE, LARA							0.106	0.576	0.773
24	13 PONDS DRIVE, LARA							0.085	0.666	1.038
25	35 FLINDERS AVENUE, LARA							0.075	0.612	0.926
26	39 FLINDERS AVENUE, LARA							0.07	0.622	0.953
27	33 FLINDERS AVENUE, LARA							0.063	0.582	0.888
28	25 FLINDERS AVENUE, LARA							0.004	0.555	0.842
29	52 BENJAMIN DRIVE LARA							0.003	0.048	0.066
30	170 MINYIP ROAD, LARA							0.003	0.012	0.018

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)								
		2	5	10	20	50	100	200	500	1000
31	93 BASS DRIVE, LARA								0.778	1.373
32	92 BASS DRIVE, LARA								0.669	1.267
33	27 FLINDERS AVENUE, LARA								0.507	0.791
34	2 JAN COURT, LARA								0.475	0.817
35	4-6 LIME CRESCENT, LARA								0.424	0.767
36	29 FLINDERS AVENUE, LARA								0.379	0.672
37	31 FLINDERS AVENUE, LARA								0.369	0.655
38	3 JAN COURT, LARA								0.348	0.692
39	21 FLINDERS AVENUE, LARA								0.347	0.631
40	8 LIME CRESCENT, LARA								0.289	0.645
41	23 LIME CRESCENT, LARA								0.257	0.699
42	5 JAN COURT, LARA								0.232	0.587
43	1 LIME CRESCENT, LARA								0.127	0.453
44	11 LIME CRESCENT, LARA								0.114	0.506
45	50 BENJAMIN DRIVE LARA								0.036	0.054
46	62 BENJAMIN DRIVE LARA								0.031	0.049
47	71 BENJAMIN DRIVE LARA								0.03	0.048
48	33 PATULLOS ROAD, LARA								0.024	0.077
49	69 PATULLOS ROAD, LARA								0.015	0.057
50	19 FLINDERS AVENUE, LARA								0.004	0.281
51	54 BENJAMIN DRIVE LARA								0.003	0.021
52	505 BACCHUS MARSH ROAD, LARA								0.001	0.002
53	2 LIME CRESCENT, LARA VIC									0.226
54	7 LIME CRESCENT, LARA VIC									0.206
55	180 KEES ROAD, LARA									0.118
56	6 FOOT COURT LARA									0.005
57	390 WINDERMERE ROAD, LARA									0.004

Table 13. Lara Stormwater Flood Property Inundation Table

Colours used in the table below are the same used in the Lara stormwater flood risk maps above. Yellow, buildings flooded above floor in a 1 in 2 year AEP. Green, buildings flooded above floor in a 1 in 5 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)						
		2	5	10	20	50	100	200
1	63 WALKERS ROAD, LARA	0.4	0.408	0.415	0.418	0.416	0.42	0.424
2	64-68 FLINDERS AVENUE, LARA	0.121	0.165	0.201	0.233	0.273	0.309	0.345
3	13 MELROSE STREET, LARA	0.104	0.133	0.186	0.232	0.289	0.342	0.393
4	78 THOMAS ROAD, LARA	0.043	0.049	0.053	0.056	0.061	0.065	0.068
5	67 STATION LAKE ROAD, LARA	0.022	0.059	0.069	0.082	0.13	0.14	0.143
6	1-2 OAK COURT, LARA		0.138	0.139	0.143	0.147	0.151	0.156
7	2/28 PONDS DRIVE, LARA		0.125	0.127	0.128	0.128	0.13	0.132
8	11 PARK AVENUE, LARA		0.087	0.092	0.095	0.096	0.1	0.104
9	2 PARK AVENUE, LARA		0.043	0.057	0.065	0.068	0.08	0.092
10	7 TUCKER COURT, LARA		0.042	0.044	0.047	0.052	0.054	0.056
11	8 TUCKER COURT, LARA		0.025	0.028	0.031	0.035	0.037	0.039
12	2/6 CURLETTS ROAD LARA		0.02	0.047	0.07	0.098	0.121	0.132
13	435 BACCHUS MARSH ROAD, LARA		0.008	0.041	0.061	0.065	0.08	0.127
14	1 WILLOW DRIVE, LARA			0.136	0.143	0.15	0.171	0.182
15	15 TUCKER COURT, LARA			0.042	0.044	0.046	0.049	0.051
16	4 PARK AVENUE, LARA			0.027	0.037	0.041	0.054	0.066
17	100A MINYIP ROAD, LARA			0.015	0.043	0.09	0.103	0.115
18	29 RENNIE STREET LARA			0.009	0.015	0.034	0.075	0.097
19	21 LIME CRESCENT, LARA			0.005	0.008	0.011	0.013	0.015
20	60 ARCHIMEDES AVENUE LARA			0.001	0.013	0.019	0.047	0.083
21	17 FLINDERS AVENUE, LARA				0.086	0.092	0.097	0.102
22	59 STATION LAKE ROAD, LARA				0.024	0.128	0.138	0.141
23	79 MCCLELLAND AVENUE LARA				0.013	0.084	0.107	0.121
24	2 WINGARA DRIVE, LARA				0.012	0.018	0.022	0.026
25	4/66 FOREST ROAD S LARA				0.011	0.024	0.031	0.036
26	75 CURLETTS ROAD, LARA				0.008	0.01	0.024	0.035
27	64 ARCHIMEDES AVENUE LARA				0.001	0.008	0.025	0.049
28	1 TURNER AVENUE, LARA					0.19	0.191	0.192
29	8 PARK AVENUE, LARA					0.078	0.082	0.09
30	45 MCCLELLAND AVENUE LARA					0.046	0.06	0.067
31	47 MCCLELLAND AVENUE LARA					0.016	0.032	0.039
32	14 TUCKER COURT, LARA					0.011	0.014	0.016
33	11 TUCKER COURT, LARA					0.011	0.013	0.014
34	12 TUCKER COURT, LARA					0.007	0.01	0.012
35	3/66 FOREST ROAD S LARA					0.005	0.012	0.017
36	17 PONDS DRIVE, LARA						0.088	0.089
37	42 MCCLELLAND AVENUE LARA						0.057	0.096
38	77 PATULLOS ROAD, LARA						0.05	0.097
39	85 SMEATON CLOSE LARA						0.024	0.053
40	3 DAISY WATT CLOSE, LARA						0.019	0.031
41	9 PARK AVENUE, LARA						0.018	0.025
42	15-16 THE CENTREWAY LARA						0.015	0.029
43	26 KYEME DRIVE LARA						0.008	0.019
44	15-16 THE CENTREWAY LARA						0.007	0.021

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)						
		2	5	10	20	50	100	200
45	65 LOCKYERS ROAD LARA						0.007	0.008
46	4 DAISY WATT CLOSE, LARA						0.001	0.013
47	13 TUCKER COURT, LARA							0.041
48	415 BACCHUS MARSH ROAD LARA							0.027
49	18 NEWELL STREET LARA							0.019
50	26 BRUNEL CLOSE LARA							0.015
51	19 BRUNEL CLOSE LARA							0.015
52	170 MINYIP ROAD, LARA							0.008
53	7 BASS DRIVE, LARA							0.002

Appendix C2: Batesford Flood Emergency Plan

The eastern section of Batesford, east of the Moorabool River lies within the floodplain. Batesford is frequently impacted by flooding from the Moorabool River. The upper reaches of Moorabool River East and West Branch's drain the southern ranges of the Wombat State Forest, and join to form the Moorabool River 2 km south of the Morrisons stream gauge. Refer to the map below. There are several tributaries of Moorabool River that provides inflow, these include Southerland Creek, Eclipse Creek and Coolebarghurk Creek. The catchment area of Moorabool River is approximately 1,025 km^2. The Moorabool River is a tributary of the Barwon River, provides inflow into the Barwon River 6 km south of Batesford, adjacent to Fyansford.

There are several storages within the upper Moorabool River catchment, these include Lal Lal Reservoir, Moorabool Reservoir and Bostock Reservoir. During large floods events, when the Lal Lal Reservoir is not full at the beginning of a flood event it can provide flood mitigation, can reduce the peak flood flow at Batesford by approximately 20% (Corangamite CMA 2018).

The November 1995 flood event caused significant damage to buildings, roads and infrastructure in Batesford. More than 35 buildings were flooded above floor including Batesford Hotel. Flooding cut access to most minor and major roads including the Midland Highway (Ballarat Road), Cross Street, River Street, Bridge Street and Old Ballarat Road.

There are two stream gauges along the Moorabool River that provide flood warning for Batesford, these include Morrisons and Batesford, refer to the map below. The estimated travel time between heavy rainfall in the upper Moorabool River catchment to steep rise in streamflow at Batesford may be greater than 24hours. The flood peak travel time between heavy rainfall and flood peak at Batesford varies between 24 to 30 hours.

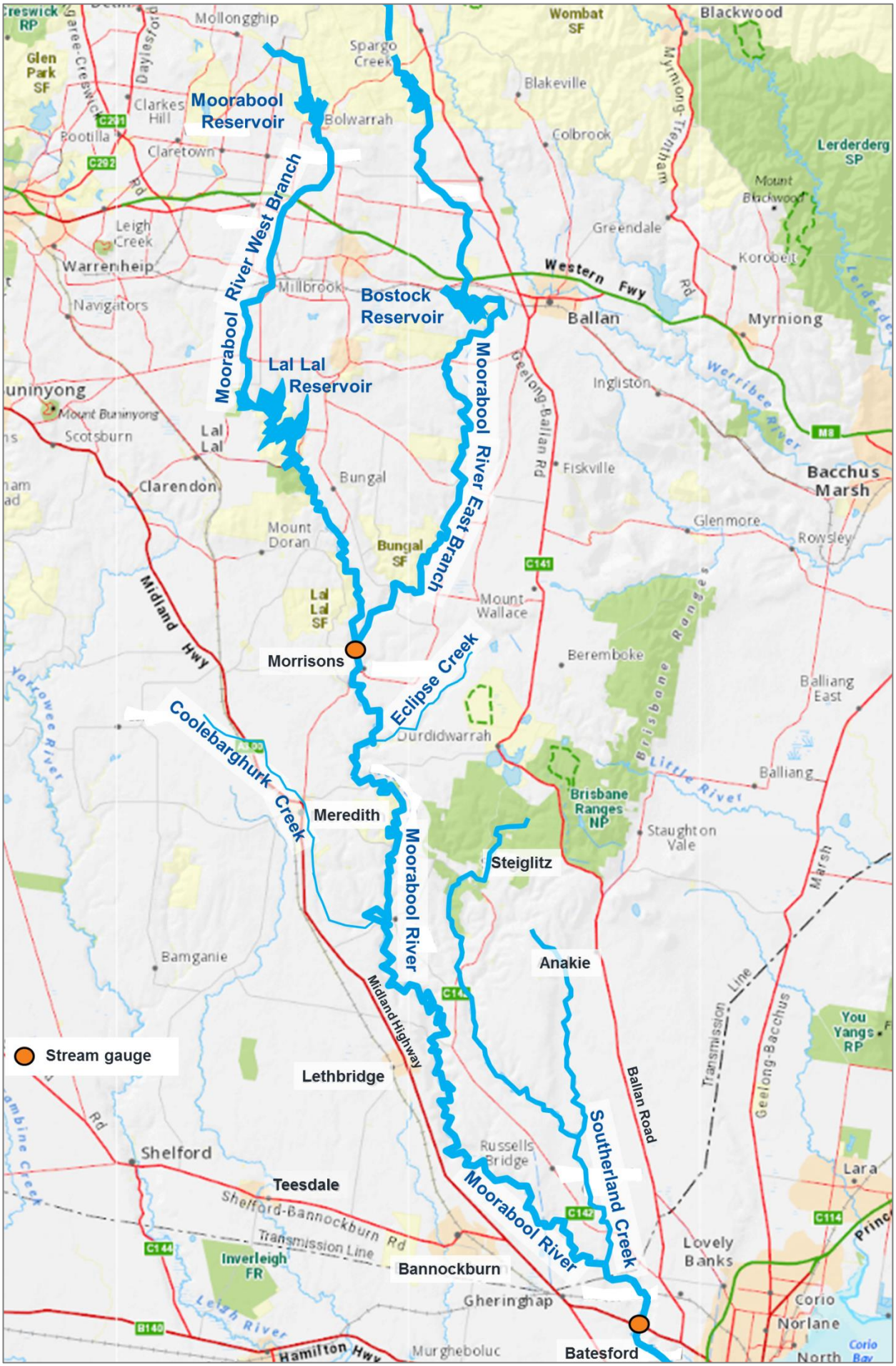


Figure 47. Batesford waterways and stream gauges.

Historic flood events

Stream records show that Batesford has experienced frequent flood events since the early 1950's, refer to the graphs below. Significant flood events have occurred in 1880, 1909, 1933, 1952, 1960, 1963, 1965, 1970, 1971, 1973, 1974, 1975, 1976, 1977, 1978, 1983, 1985, 1987, 1988, 1990, 1991, 1992, 1993, 1995, 1996, 2000, 2001, 2005, 2011 and 2016. The 1952 flood event was the largest flood event on record. The most recent flood event was in 2016.

The Moorabool River stream gauge at Batesford (232202) was used to indicated historic flood events that have occurred in Batesford.

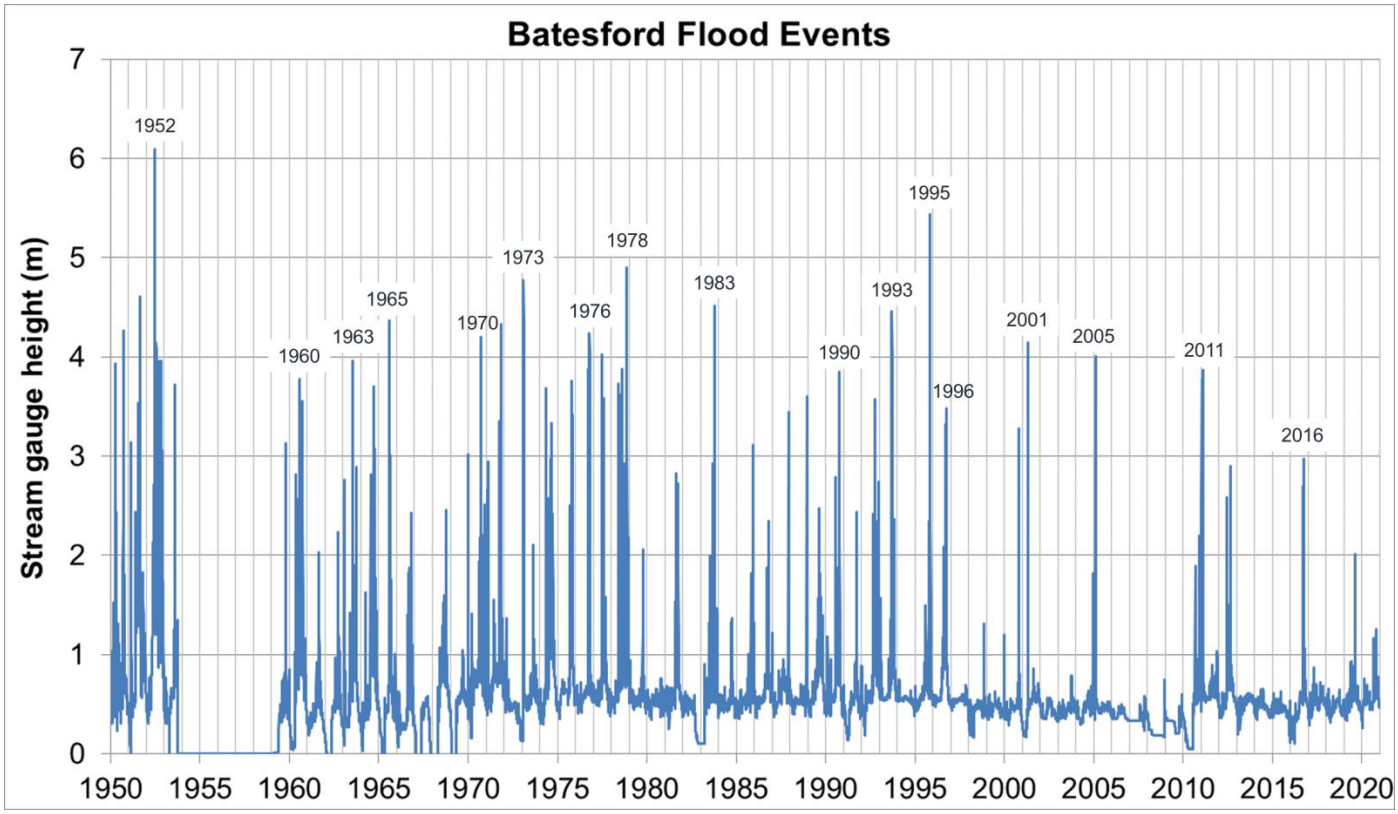


Figure 48. Batesford historic flood events.

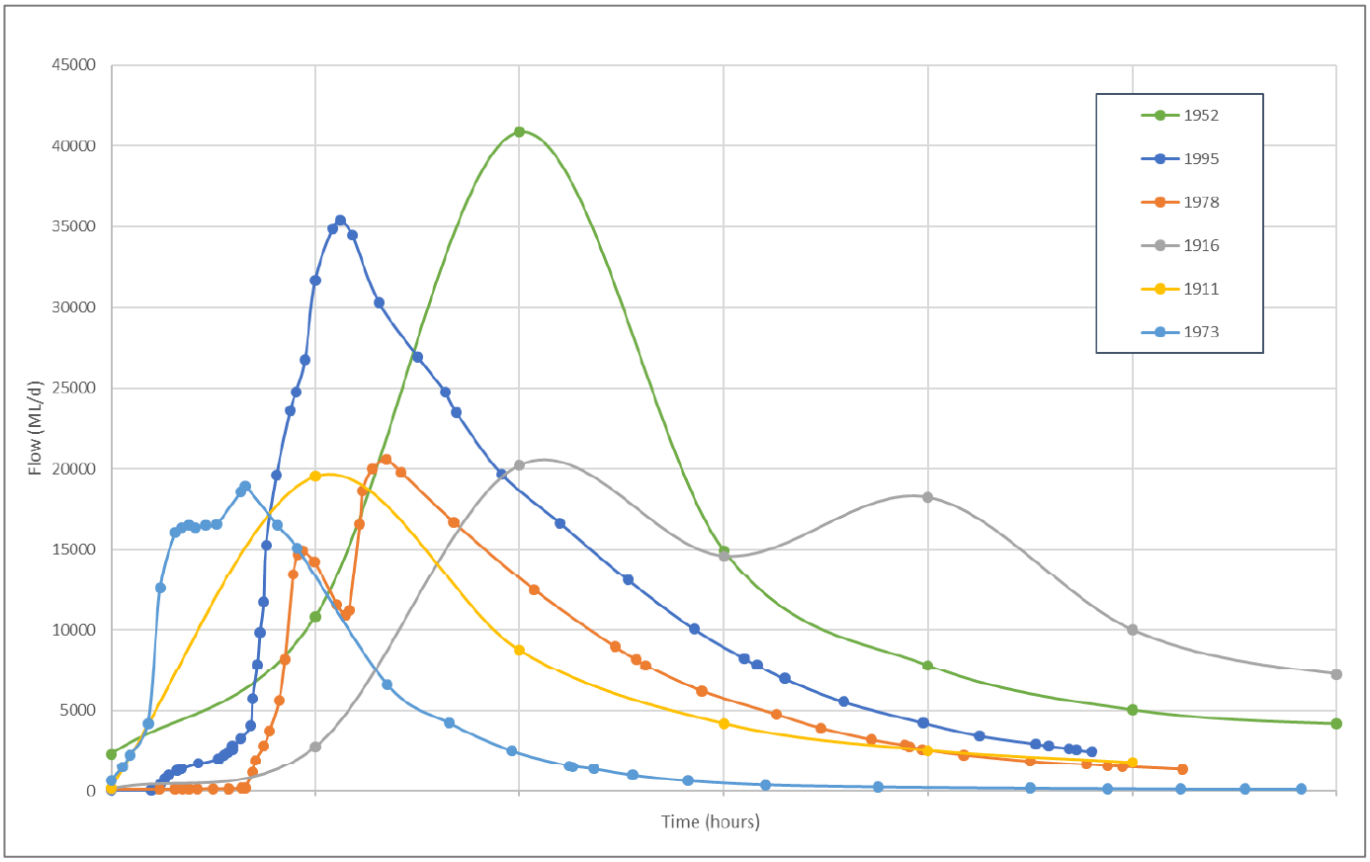


Figure 49. Batesford historic flood peak flows (Water Technology 2019).

November 1995 flood event

The November 1995 flood event was Batesford's largest recent flood event on record, estimated to be approximately between a 1 in 200 and 500 year AEP event. The Meredith rainfall gauge recorded 220 mm of rainfall over 4 days, with 99.6 mm on the 6th of November. Significant flooding occurred in Batesford on the 7 of November 1995. The flood peak was maintained for more than 2 days.

This event caused considerable damages to buildings above floor, roads, bridges and other infrastructure, refer to flood photos below. Deep flooding impacted approximately more than 35 buildings above floor including the Batesford Hotel. Minor and major roads were impacted by flooding within and surrounding Batesford, these included the Midland Highway (Ballarat Road), Cross Street, River Street, Bridge Street and Old Ballarat Road. For more details regarding flood impacts refer to the Batesford Flood Intelligence Card below.

Figure 50. Flooding at the Batesford during the 1995 flood event.

Figure 51. Flooding at the Batesford Hotel during the 1995 flood event.

Figure 52. Flooding adjacent to the Midland Highway Bridge during the 1995 flood event.

Figure 53. Flooding adjacent to the Midland Highway Bridge during the 1995 flood event.

Influence of the Lal Lal Reservoir

The Lal Lal Reservoir is the largest storage in the upper Moorabool River catchment, with a capacity of 59,540 ML. When the Lal Lal Reservoir is not full at the beginning of a flood event, this storage space will provide attenuation of flood flows, flood mitigation downstream of the Lal Lal Reservoir. An analysis undertaken by the Corangamite CMA determined that in large flood events the upstream storages results in a reduction of approximately 20% of the peak flow at Batesford (Corangamite CMA 2018). Flows released or spilled from the storage cannot be diverted away from the West Moorabool River due to the steep terrain by which it is surrounded.

A summary of the storage levels in the graph below shows that over the limited monitoring record available, the Lal Lal Reservoir hasn't spilled often. The graph also shows that from the 6th February 2010 to the 8th March 2011 the Lal Lal Reservoir received more than 51,462 ML of inflows, rapidly increased the storage level from 3,920 ML to 55,382 ML over 30 days. The graph also indicates that it's likely that spills occurred in 2011, 2012, 2016, 2019 and 2020. The spill volume is unknown given historical spillway flow data is not measured or captured by Central Highlands Water.

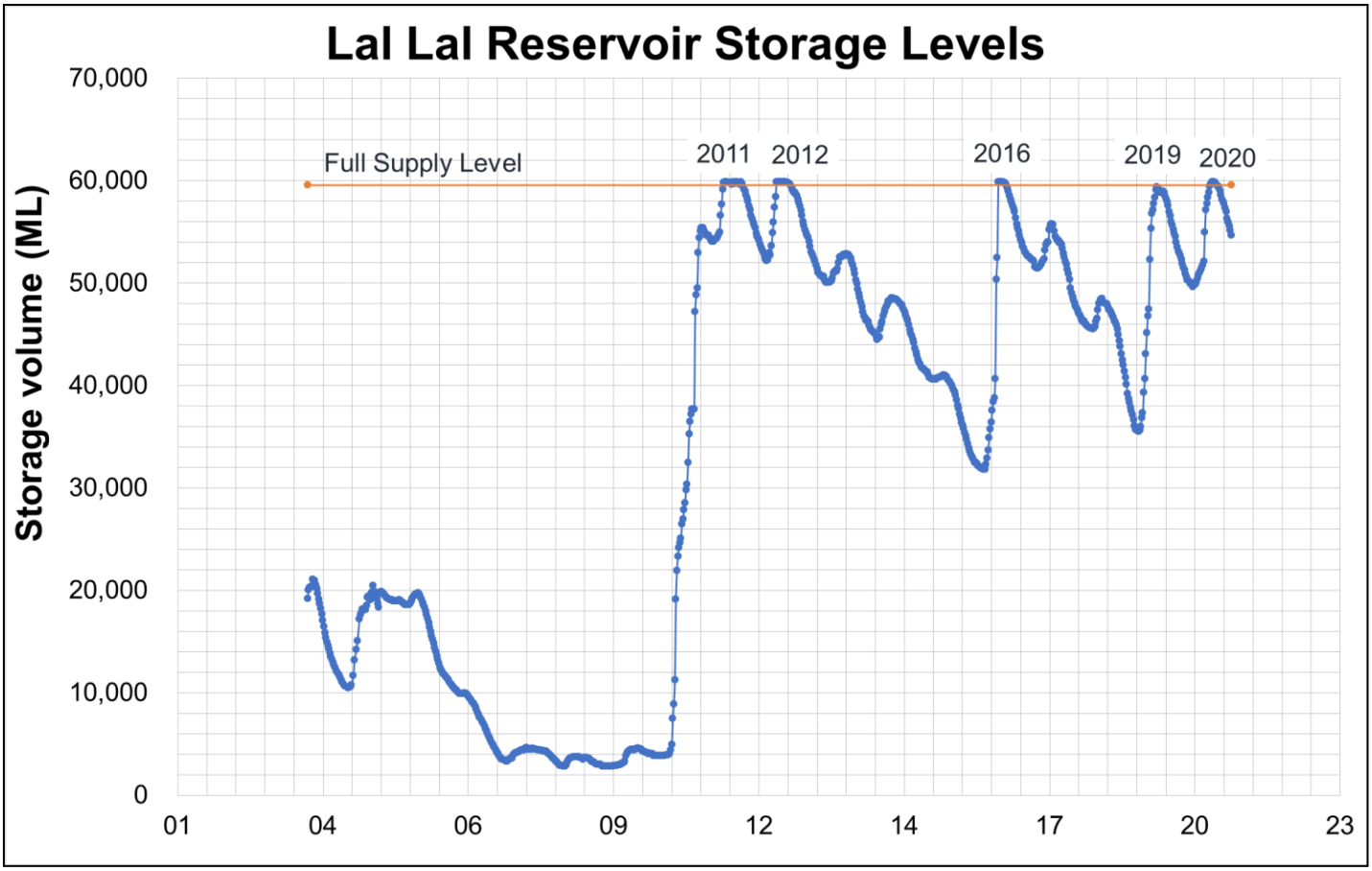


Figure 54. Historic Lal Lal Reservoir storage levels.

Given the Lal Lal Reservoir's potential to spill significant volumes it is critically important to check its storage volume before a flood event occurs. Checking the storage level will provided an indication of the storage space available for inflows and assess the risk of spills occurring, contribution to flooding in Batesford, Fyansford and Geelong. Refer to this website for Lal Lal Reservoir storage levels: https://www.chw.net.au/community/water-storage-levels/

For more details regarding the Lal Lal Reservoir, refer to the Dam Spill section in **Appendix A and C3**.

Warning Time and flood behaviour

There are two stream gauges along the Moorabool River that provide flood warning for Batesford, these include the Morrisons and Batesford gauges. Refer to the map above for the stream gauge locations.

The estimated travel time between heavy rainfall and steep rise in streamflow at Batesford may be greater than 24hours. The flood peak travel time between heavy rainfall and flood peak at Batesford varies between 24 to 30 hours.

During 2001 flood event, the Moorabool River stream gauge monitoring shows there was significantly more contribution of flood flows from the Moorabool River tributaries than from the upper Moorabool River. The peak flood height of the Morrisons gauge was only 0.41 m (234 ML), compared to the Batesford gauge peak height of 4.14 m (11,681 ML). Refer to the graph below.

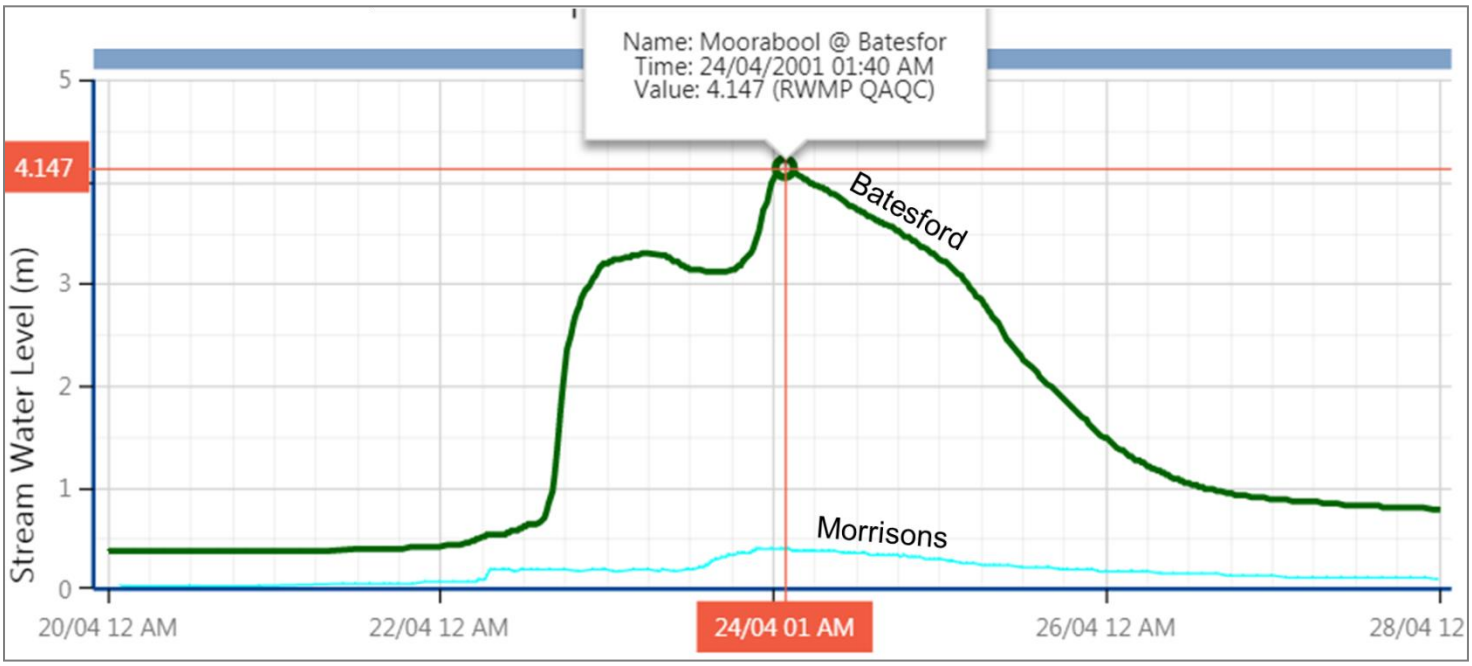


Figure 55. Moorabool River flows during the April 2001 flood event (Floodzoom).

This was also the case during the 1995 flood. The graph below clearly indicates that the Batesford gauge peaked at 5.44 m (> 38,000 ML) at 4:21am on the 7th of November, well before the upstream Morrisons gauge peak of 4.81 m (17,674 ML) at 11:48 am on the 7th of November. Again, this indicates there was significant contribution of flows from ungauged Moorabool River tributaries, such as from the Sutherland Creek catchment. It would be worth installing additional stream gauge monitoring within the Sutherland Creek catchment to provide critical flood warning for Batesford, Fyansford and Geelong.

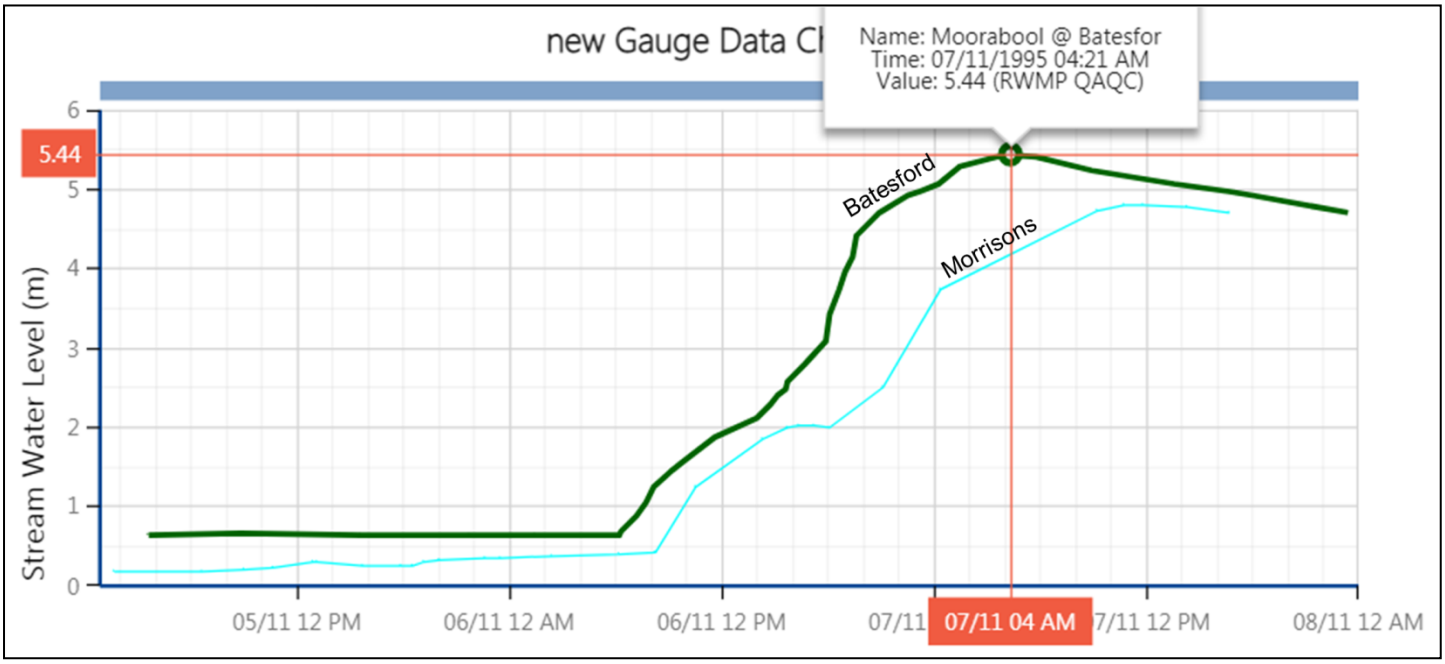


Figure 56. Moorabool River flows during the April 2001 flood event (Floodzoom).

Flood Impacts and Actions Required

Flood mapping undertaken as part of the Lower Moorabool Flood Study (Water Technology 2019) was used to estimate assets, buildings and roads impacted by flooding for a range of design flood events.

During a 1 in 5 year AEP event deep flooding cuts access to the western section of Bridge Street.

During a 1 in 10 year AEP event flooding cuts access to River Street to a depth of 0.31m.

During a 1 in 20 year AEP event four buildings are at risk of over floor flooding in Bridge Street. Flooding also cuts access to a number of additional roads, including Cross Street, Old Ballarat Road, eastern section of Bride Street.

During a 1 in 100 year AEP event flooding impacts the Midland Highway (Ballarat Road) east of the Highway Bridge to a depth of 0.21m for a length of over 300 m. This flooding may cut the east-west access to Batesford, cutting the town in half.

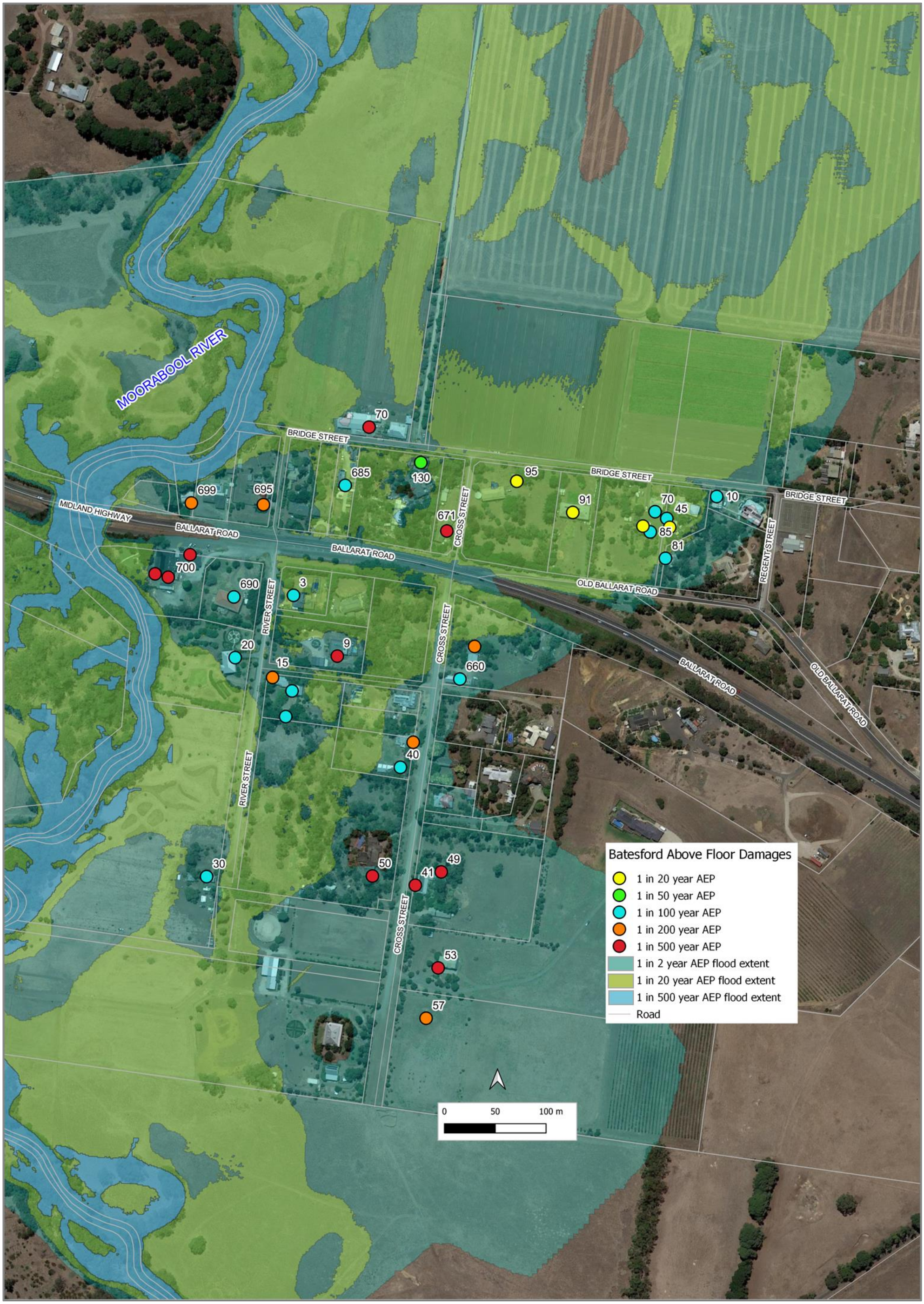
For additional flood risk information refer to the Batesford Flood Intelligence Cards, tables and maps below.

Key assets at risk of flooding in Batesford are listed below.

Table 14. Key Batesford assets at risk of flooding.

Asset register				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
Bridge Street, western section, Batesford.	5 year	Flooding may cut access to the western section of Bridge Street during a 5 year flood event, depth 0.35 m.	Deploy road closure signs as needed.	Council
River Street, Batesford.	10 year	Flooding may cut access to the western section of Bridge Street during a 10 year flood event, depth 0.31 m.	Deploy road closure signs as needed.	Council
Cross Street, Old Ballarat Road and the eastern section of Bridge Street, Batesford.	20 year	Flooding may cut access to Cross Street, Old Ballarat Road and the eastern section of Bridge Street during a 20 year flood event, greater than depth 0.35 m.	Deploy road closure signs as needed.	Council
Four buildings are flooded above floor in Bridge Street and Old Ballarat Road, Batesford. Refer to the maps and Flood Intelligence Card below for the location of these buildings.	20 year	Flooding impacts the Batesford car park and the boat ramp at the end of Dorey Street.	Sandbag and evacuate buildings as needed	VICSES Victoria Police
Batesford Hotel, 700 Ballarat Road, Batesford	100 year	Shallow flooding begins to surround the Batesford Hotel during a 100 year flood event. The Hotel is impacted by above floor flooding during a 500 year flood event.	Evacuate the buildings before access is cut.	Victoria Police
Midland Highway, Ballarat Road, Batesford.	100 year	Flooding to a depth of 0.21m and a length of over 300 m may impact the Midland Highway (Ballarat Road), east of the highway bridge during a 100 year flood event. This flooding cuts the east-west access to Batesford cutting the town in half.	Deploy road closure signs as needed.	Regional Roads Victoria

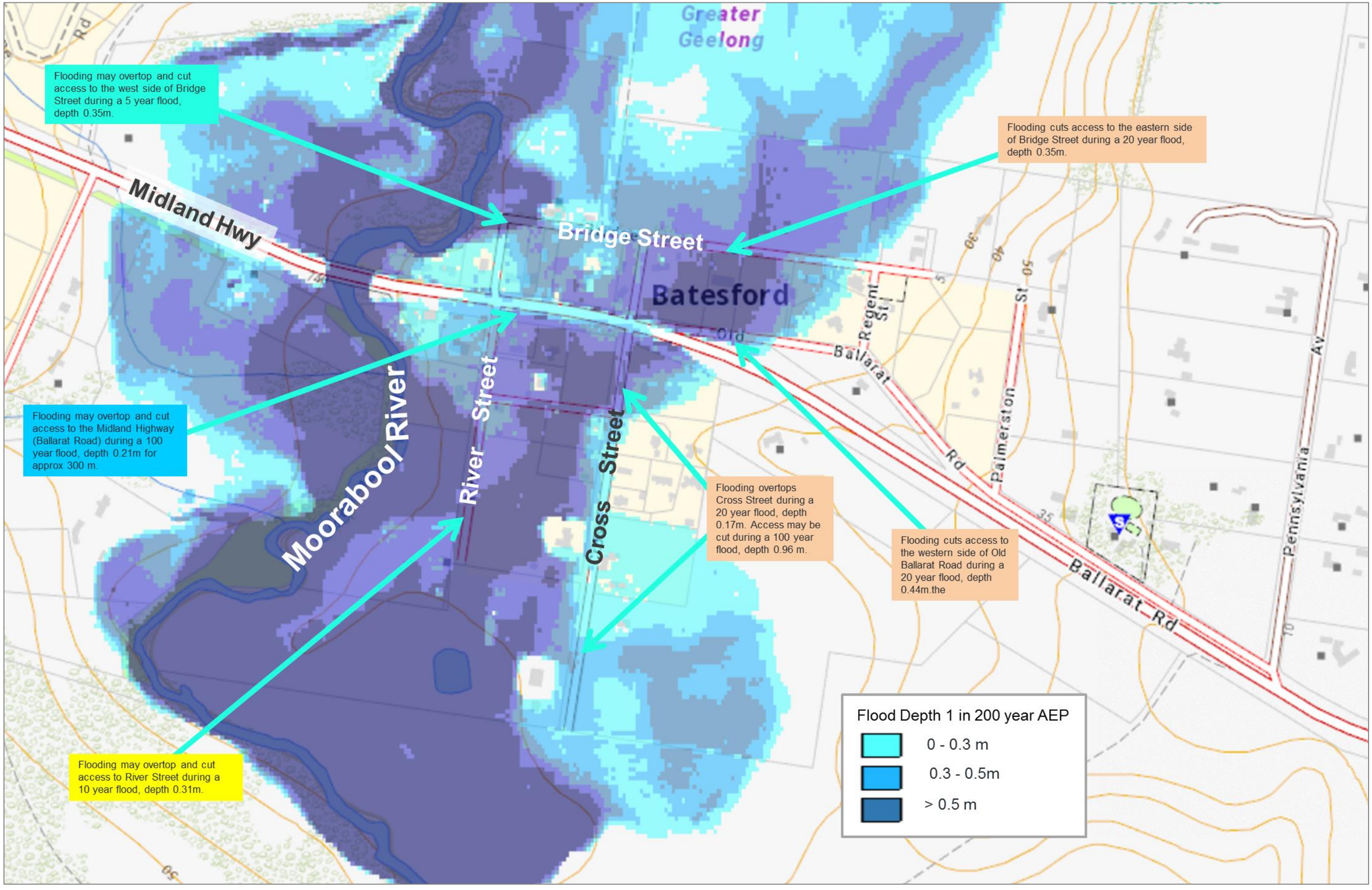
For more detailed information regarding buildings and roads impacted refer to the Batesford Flood Intelligence Card and flood impact maps below. Also refer to the Batesford flood depth maps in **Appendix E** and community sandbag collection points in **Appendix H**. Given that flooding in Hovells Creek can cut Lara in half, sandbag collection points have been nominated for the eastern and western sections of Lara.



4.37

Figure 57. Batesford buildings impacted by flooding for a range of design flood events (Water Technology 2019).

4.38



4.39

Figure 58. Batesford roads impacted by flooding for a range of design flood events, with the 1 in 200 year AEP flood depth map (Water Technology 2019).

Table 15. Batesford Flood Intelligence Card (Moorabool River)

Flood travel time						Time between rainfall and steep rise in flood levels at Batesford gauge may be greater than 24 hours. Time between rainfall and flood peak at Batesford gauge 24 -30 days Riverine flooding duration: 2 to 3 days		
Moorabool River at Morrisons gauge height 232204 (m)	**Moorabool River at Batesford gauge height 232202 (m)**	**Annual Exceedance Probability (1 in 100)**	**Moorabool River at Batesford Flows (ML/d)**	**Batesford damages total number properties flooded (above floor)**	**Consequences/ Impacts**	**Houses / buildings flooded / isolated**	**Roads Impacted**	**Action**
	2.70	Minor						
3.66	2.99	October 2016						
	3.19	2	3,197	0 (0)	Flooding has minor impacts to the low-lying farmland and crossings along the Moorabool River.		Cross Street depth 0m Bridge Street depth 0m Midland Highway depth 0m Old Ballarat Road depth 0m River Street depth 0m	**Council** clear debris from waterway crossings, drains and culverts as needed. **VICSES** activate ground observer to take photos and record flood levels at key crossings, share information via Snap Send Solve.
4.07	3.87	January 2011						
	3.8	5	8,726	0 (0)	Minor breakouts of floodwater occur along the Moorabool River. Flooding extends a maximum of 125m from the river banks. Deep flooding to the western end of Bridge Street cuts access.		Cross Street depth 0m Bridge Street depth 0.35m Midland Highway depth 0m Old Ballarat Road depth 0m River Street depth 0m	In addition to actions listed above; **VICSES** publish a community advice warning via EMCOP. **Council** deploy road close signs for Bridge Street and others as needed.
	4.00	Moderate						
	4.1	10	13,910	0 (0)	Floodwater breakouts occur to the north and south of Batesford. Flooding cuts access to River Street, depth 0.31m, south of the Midland Highway. Mostly farmland and parkland along the Moorabool River is impacted by flooding.		Cross Street depth 0m Bridge Street depth 0.75m Midland Highway depth 0m Old Ballarat Road depth 0m River Street depth 0.31m	In addition to actions listed above; **Council** deploy road close signs for River Street and others as needed. **Barwon Water** staff provide updates regarding the Lal Lal Reservoir storage level and potential spill risk.
0.41	4.15	2001						
	4.24	1976						
	4.35	20	19,699	8 (4)	Four buildings are flooded above floor in Bridge Street, Old Ballarat Road and River Street. Shallow flooding overtops Cross Street south of Midland Highway, to the north access is cut to Cross Street to a depth of 0.32m. Deep flooding to the east of Bridge Street cuts access along the length of the street. Deep flooding cuts access to the western section of the Old Ballarat Road, depth 0.44m	Four buildings are flooded above floor; x3 OLD BALLARAT ROAD (85, 91, 95), 45 BRIDGE STREET.	Cross Street depth 0.17m Bridge Street depth 1.12m Midland Highway depth 0m Old Ballarat Road depth 0.44m River Street depth 0.37m	In addition to actions listed above; **VICSES** sandbag houses and assist to protect assets as needed. **Victoria Police** evacuate houses impacted by flooding as needed.
	4.61	50	27,734	8 (5)	One additional building is flooded above floor in Old Ballarat Road. Widespread flooding occurs to the north of Batesford. Most of the floodplain is inundated, floodwaters spread over a width of 900m. Water levels are increased by approximately 0.2 m on the north side of Midland Highway.	One additional building is flooded above floor; 130 BRIDGE STREET.	Cross Street depth 0.18m Bridge Street depth 1.12m Midland Highway depth 0m Old Ballarat Road depth 0.77m River Street depth 0m	Refer to actions listed above.
	4.75	100	36,893	31 (18)	13 additional buildings are flooded above floor in River Street, Cross Street, Ballarat Road, Old Ballarat Road and Regent Street. Flooding overtops the Midland Highway (Ballarat Road) east of the bridge to a depth of 0.21m. The width of the area flooded along the Midland Highway is approximately 300m. Access along the Midland Highway is cut, isolating the eastern and western sections of Batesford. Most of the houses located between Cross Street and River Street are inundated in Batesford. Flood waters impacting on dwelling and access to 23 Cross St, Batesford. Flood depths are generally up to 0.36m. The Batesford Hotel (700 Ballarat Road) and 750 Midland Highway are partly impacted by floodwaters up to 0.2m deep.	13 additional buildings are flooded above floor; x5 RIVER STREET (1-5, 15,20, 30), x2 OLD BALLARAT ROAD (75, 85), 40 CROSS STREET, x4 BALLARAT ROAD (660, 675, 685, 690), 10-12 REGENT STREET.	Cross Street depth 0.96m Bridge Street depth 1.72m Midland Highway depth 0.21m Old Ballarat Road depth 1m River Street depth 1m	In addition to actions listed above; **Regional Roads Victoria** deploy road closure signs for the Midland Highway
	4.77	1973						
	4.90	Major						Refer to actions listed above.
	5.1	200	38,016	45 (25)	Seven additional buildings are flooded above floor in Cross Street, Ballarat Road and Old Ballarat Road. Flood levels increased by 0.14m. Floodwaters progress further east and dwelling at 51 Cross St is inundated. Depths up to 0.25m.	7 additional buildings are flooded above floor; x3 BALLARAT ROAD (687, 675, 697- 699),	Cross Street depth 1.37m Bridge Street depth 1.93m Midland Highway depth 0.4m Old Ballarat Road depth 1.2m River Street depth 0m	Refer to actions listed above.

						x2 OLD BALLARAT ROAD (75, 85), 57-65 CROSS STREET, 750 MIDLAND HIGHWAY.		
4.81	5.44	November 1995						
	5.64	500	40,262	54 (35)	Ten additional buildings are flooded above floor in Cross Street, Ballarat Road and Bridge Street. A marginal increase in flood extent. Depths on Midland Hwy increased by 0.4m. The Batesford Hotel (700 Ballarat Road) is flooded above floor.	10 additional buildings are flooded above floor; x5 CROSS STREET (50, 41-49), x3 BALLARAT ROAD (671, 687, 700), x2 BRIDGE STREET (68, 70).	Cross Street depth 1.9m Bridge Street depth 2.24m Midland Highway depth 0.7m Old Ballarat Road depth 1.47m River Street depth 0m	Refer to actions listed above.
	7.00	1880						

Table 16. Batesford Flood Property Inundation Table

Colours used in the table below are the same used in the Batesford flood risk maps above. Yellow, buildings flooded above floor in a 1 in 20 year AEP. Green, buildings flooded above floor in a 1 in 50 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)					Building Type
		20	50	100	200	500	
1	91 OLD BALLARAT ROAD BATESFORD	0.596	0.797	0.934	1.086	1.337	Weatherboard
2	95 OLD BALLARAT ROAD BATESFORD	0.544	0.743	0.876	1.025	1.272	Brick Veneer Standard
3	85 OLD BALLARAT ROAD BATESFORD	0.398	0.611	0.75	0.905	1.159	Fibro Cement Sheet
4	45 BRIDGE STREET BATESFORD	0.16	0.373	0.514	0.669	0.924	
5	130 BRIDGE STREET BATESFORD		0.073	0.171	0.323	0.572	
6	10 REGENT STREET BATESFORD			0.163	0.323	0.581	
7	685 BALLARAT ROAD BATESFORD			0.138	0.324	0.605	
8	40 CROSS STREET BATESFORD			0.225	0.635	1.175	
9	3 RIVER STREET BATESFORD			0.205	0.581	1.113	
10	15 RIVER STREET BATESFORD			0.202	0.604	1.143	
11	30 RIVER STREET BATESFORD			0.162	0.62	1.214	Brick Veneer Standard
12	15 RIVER STREET BATESFORD			0.128	0.53	1.067	
13	20 RIVER STREET BATESFORD			0.099	0.495	1.026	Weatherboard
14	70 BRIDGE STREET BATESFORD			0.095	0.248	0.503	
15	690 BALLARAT ROAD BATESFORD			0.085	0.447	0.973	
16	660 BALLARAT ROAD BATESFORD			0.07	0.47	1.006	
17	81 OLD BALLARAT ROAD BATESFORD			0.058	0.23	0.49	
18	15 RIVER STREET BATESFORD				0.341	0.876	Weatherboard
19	57-65 CROSS STREET BATESFORD				0.268	0.881	
20	660 BALLARAT ROAD BATESFORD				0.184	0.717	Weatherboard
21	695 BALLARAT ROAD BATESFORD				0.139	0.487	
22	40 CROSS STREET BATESFORD				0.037	0.576	Weatherboard
23	699 BALLARAT ROAD BATESFORD				0.019	0.403	
24	9 RIVER STREET BATESFORD					1.25	
25	50 CROSS STREET BATESFORD					0.534	
26	49 CROSS STREET BATESFORD					0.504	
27	53 CROSS STREET BATESFORD					0.464	
28	700 BALLARAT ROAD BATESFORD					0.38	BATESFOR HOTEL
29	41-49 CROSS STREET BATESFORD					0.38	Weatherboard
30	70 BRIDGE STREET BATESFORD					0.195	
31	700 BALLARAT ROAD BATESFORD					0.181	BATESFOR HOTEL
32	671 BALLARAT ROAD BATESFORD					0.171	Brick Veneer Standard
33	700 BALLARAT ROAD BATESFORD					0.137	

Appendix C3: Geelong Flood Emergency Plan

Geelong is significantly affected by riverine or stormwater flooding. Geelong has experienced extensive and frequent riverine flooding from the Barwon River, usually occurs as a result of prolonged heavy rainfall in the Otway Ranges.

The upper reaches of the Barwon River drains the eastern Otway Ranges surrounding Forrest, with an approximate catchment area of 2,800 km^2. Barwon River then flows through Birregurra and Winchelsea, Inverleigh, Fyansford, Geelong and Lake Connewarre Wetland Reserve before discharging to the sea at Barwon Heads and Ocean Grove. Flooding can occur in Geelong 1.5 to 2.3 days after rainfall in the upper Barwon River catchment.

In addition to the Barwon River receiving flows from the Otway Ranges, the Barwon River also receives flood flows from its tributaries, the Leigh River, Moorabool River, Waurn Ponds Creek and Armstrong Creek. Flooding can occur at different times due to the large size of the combined Barwon River catchment area, approximately 5,130 km^2. The Barwon River has the largest catchment area of approximately 2,800 km^2. Storms can impact different subcatchment areas in isolation. Flooding in the Barwon River at Geelong can be dominated by flood events in either the upper Barwon River, Moorabool River or the Leigh River.

The Leigh River joins the Barwon River east of Inverleigh. The upper reaches of the Leigh River is located to the north east of Ballarat, begins as the Yarrowee River and flows through Shelford and Inverleigh. The catchment area of the Leigh River upstream of Inverleigh is approximately 883 km^2. Flooding can occur in Shelford 14 to 24 hours after rainfall in the upper catchment, and in Inverleigh 4 to 8 hours after the flood peak in Shelford.

The Moorabool River joins the Barwon River at Fyansford. The Waurn Ponds Creek and Armstrong Creek inflows into the Barwon River downstream of Geelong. Refer to the map below.

During small floods, between a 1 in 2 to 10 year AEP event (similar to the 2016, 2001, 2011 and 1983 floods) there are significant damages to buildings, roads and infrastructure. More than 24 buildings were flooded above floor, including Barwon Valley Golf Course Clubrooms, Geelong Water Ski Clubrooms, Geelong Amateurs Football and Netball Club buildings, Belmont Council Ops Depot, several Rowing Clubroom buildings, Geelong Canoe Clubrooms, the Barwon River Holiday Caravan Park, in addition to many industrial business sheds and houses. Deep flooding, in parts is close to 3m surrounding Queens Park, Fyansford Common parkland, Barwon Valley Fun Park playground, Belmont Common parkland, King Lloyd Reserve, Balyang Sanctuary, Belmont Wildlife Reserve parkland, Landy Athletic Field, creating high risk to life to pedestrians and motorists. Flooding cuts access to minor and major ros including Gundog Road, Boundary Road, Barrabool Road, Marnock Road, Lower Paper Mills Road, Wilsons Road, Lake Road, The Promenade, Gravel Pits Road, Barwon Heads Road and Barwon Terrace.

In addition to riverine flooding, large sections of Geelong is also prone to stormwater. During the January 2016 flood event there were hundreds of buildings were impacted by stormwater flooding in Geelong (VICSES and City of Greater Geelong Council Request of Assistance Database). Geelong suburbs prone to stormwater flooding include Geelong CBD, Highton, Newtown, Belmont, Corio, Norlane, Bell Park, Waurn Ponds Grovedale, Newcomb and Moolap. Refer to **Appendix C7** for more stormwater flood risk information.

There are nine stream gauges along the Leigh River, Moorabool River and Barwon River that provide early flood warning for Geelong, these include Mt Mercer, Shelford, Morrisons, Ricketts Marsh, Kildean, Winchelsea, Inverleigh, Pollocksford and McIntyre Bridge. Refer to figure 9 above for the stream gauge location map.

The various catchment area sizes of the major rivers and various tributaries often result in the catchment responding to storm events at different time scales. The smaller urban catchments, such as Waurn Ponds Creek and Armstrong Creek respond quickly to intense storm events. Whereas the larger rural catchments of the Barwon River, Leigh River and Moorabool River respond later with the flood peak occurring long after the smaller catchments.

The Leigh River travel time between heavy rainfall in the upper catchment around Ballarat and rise in streamflow at Inverleigh (Leigh River and Barwon River confluence) is between 22 to 36 hours. The Moorabool River travel time between heavy rainfall in the upper catchment and rise in streamflow at Fyansford (Moorabool River and Barwon River confluence) is between 23 to 40 hours. Rises in streamflow at Geelong can occur 1.5 to 2.3 days after rainfall in the upper Barwon River catchment.

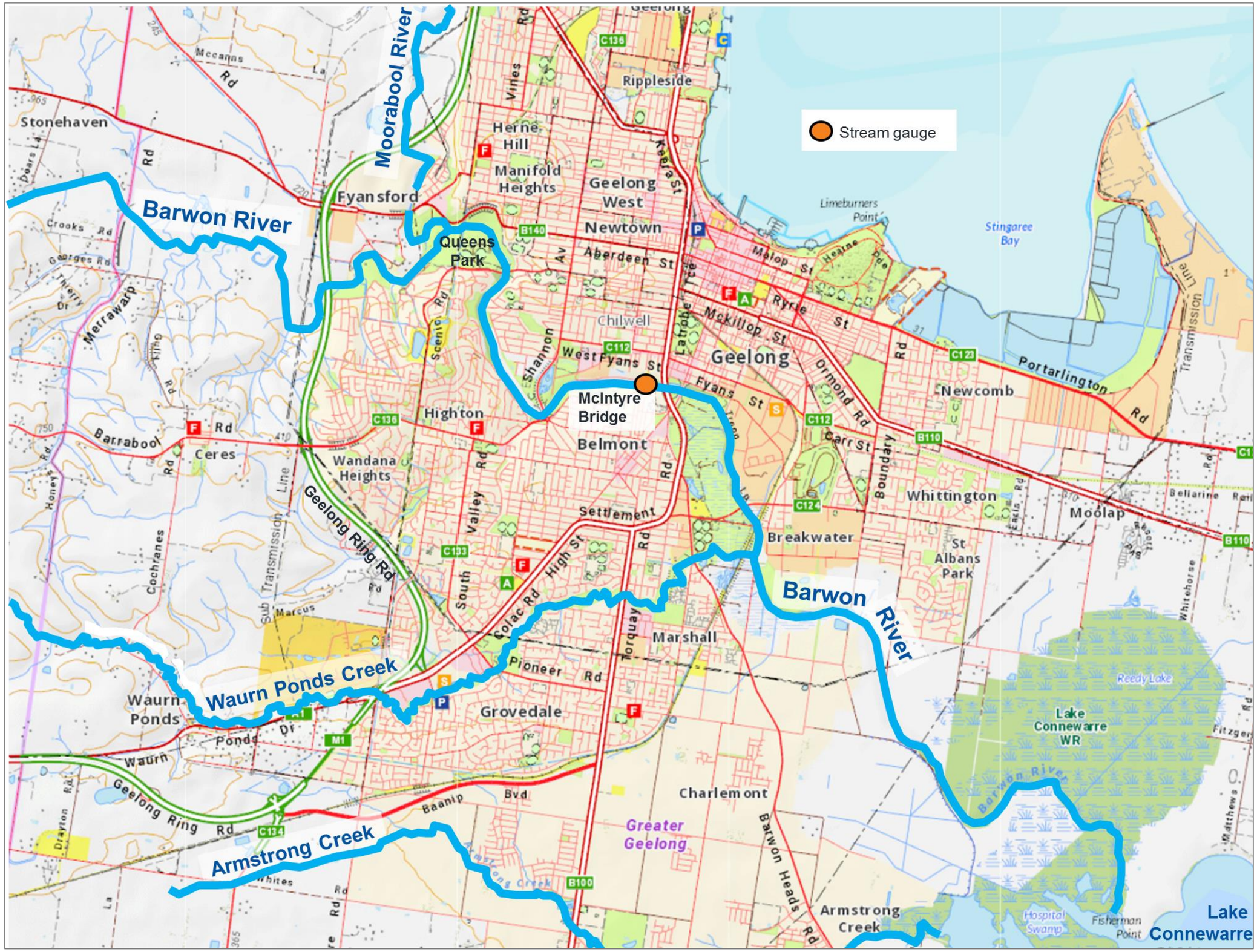


Figure 59. Geelong waterways and stream gauge.

Historic flood events

Stream records show that Geelong has experienced frequent flood events since the early 1970's, refer to graphs below. Significant flood events have occurred in 1909, 1952, 1970, 1971, 1973, 1974, 1975, 1976, 1977, 1978, 1983, 1984, 1996, 1992, 1995, 1996, 2001, 2007, 2011 and 2016. The 1909 flood event was the largest flood event on record. The most recent flood event was in 2016.

Due to gaps in the monitoring record of the Geelong gauge (McIntyre Bridge), the Pollocksford stream gauge, 17km upstream of Geelong was also used to indicate historic flood events that have occurred in Geelong. Refer to the graphs below show when historic Geelong flood events have occured.

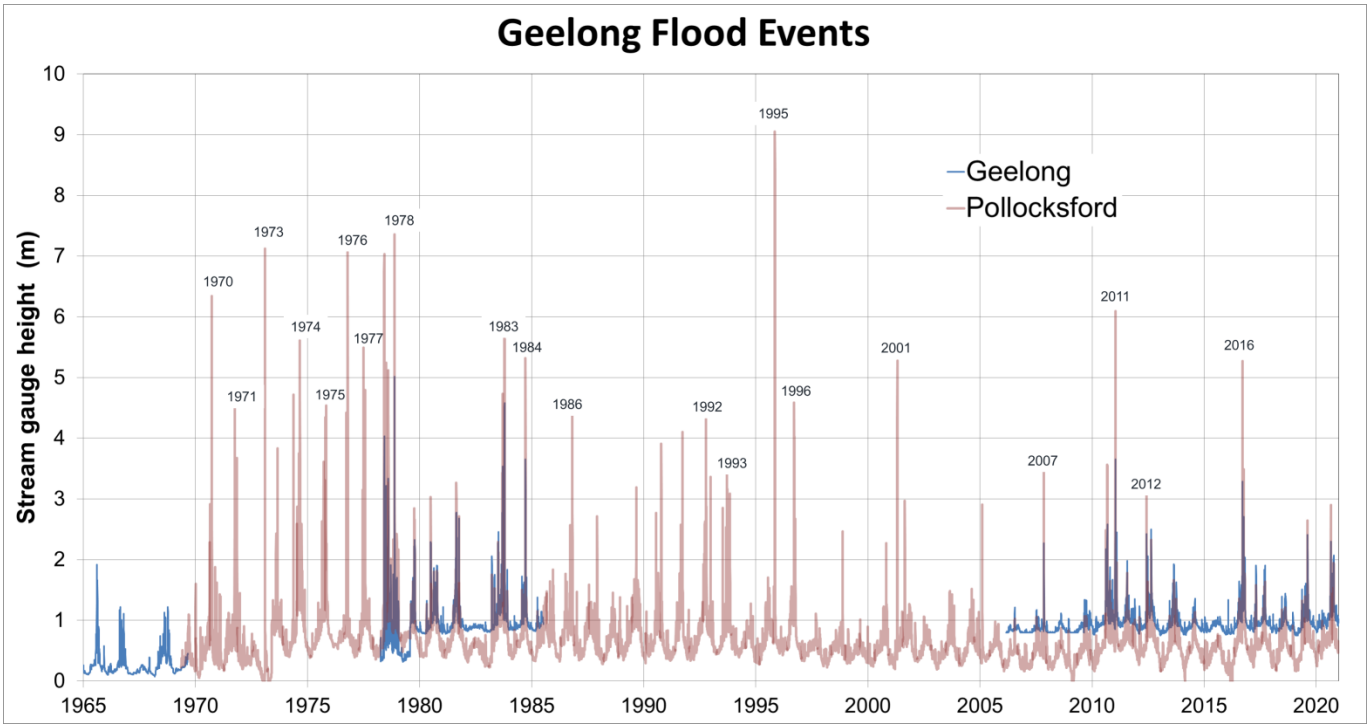


Figure 60. Geelong historic flood events.

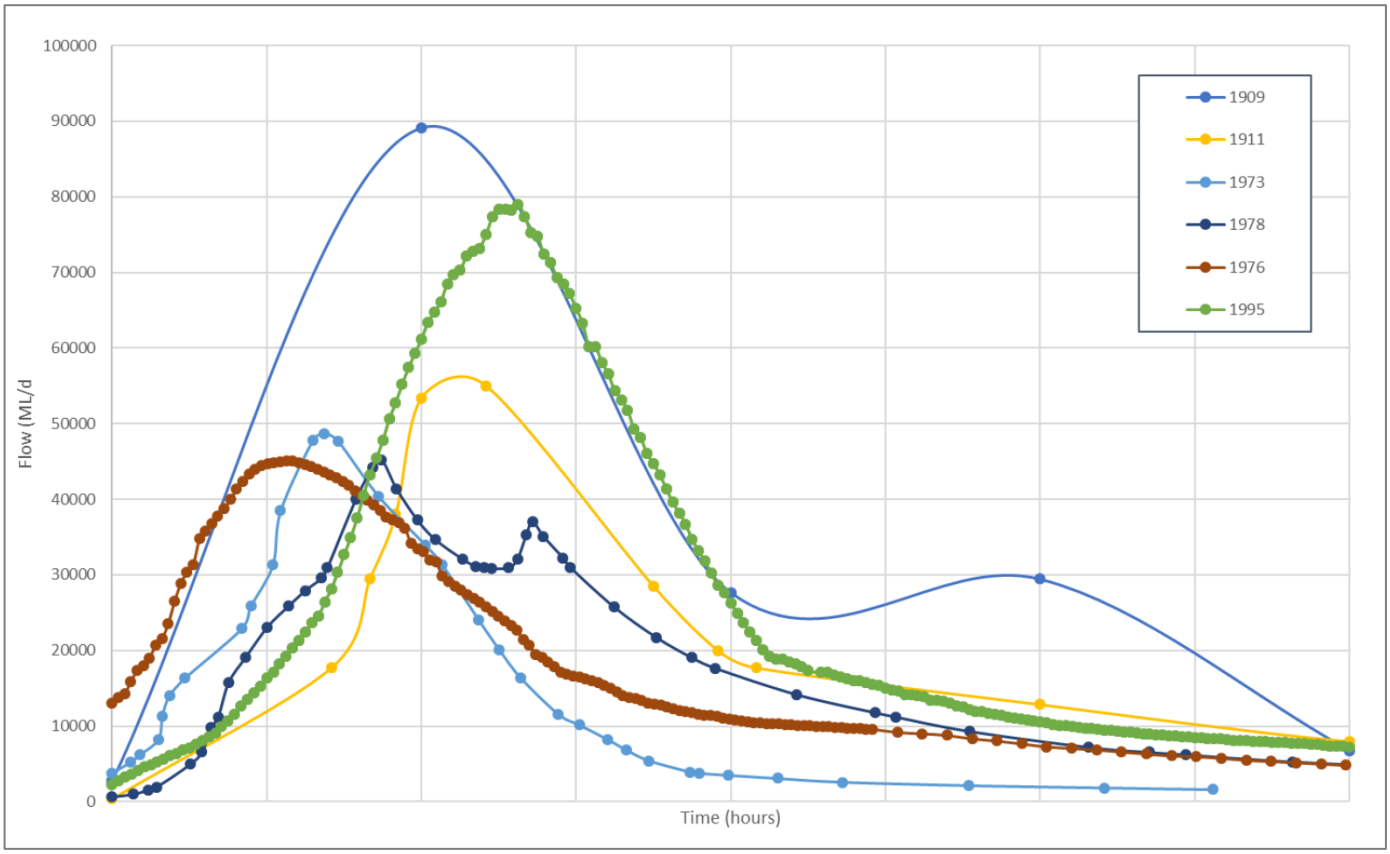


Figure 61. Barwon River historic flood event peak flows at the Pollocksford stream gauge (Water Technology 2018).

November 1995 flood event

The November 1995 flood was Geelong's largest recent flood event on record, estimated to be approximately a 1 in 100 AEP event. Refer to the photos below. The upper Barwon River catchment recorded 174 mm of rainfall over 3 days. Significant flooding occurred in Geelong between the 7th and 10th of November 1995. The flood peak of 5.94m is estimated to occur on the 8th of November at 4am in the morning (Water Technology 2018).

This event caused considerable damages to buildings, roads, bridges and other infrastructure. Low lying areas including Belmont Common, Queens Park and South Geelong experienced significant flood damage. Deep flooding impacted over 40 buildings in South Geelong alone.

Buildings impacted by flooding include;

- The Riverglen Holiday Park, Barwon Valley Lodge Motel, Geelong Discovery Caravan Park, Barwon River Holiday Caravan Park and the City Southside Caravan Park along Barrabool Road.
- Rowing sheds along Barwon Terrace.
- Industrial sheds along Gravel Pits Road and surrounding area in South Geelong.
- Large number of sports clubrooms including the Geelong Amateurs Football and Netball Clubrooms, Belmont Dog Obedience Clubrooms, South Barwon Cricket Clubrooms, Geelong Lawn Tennis Club, Geelong Canoe Clubrooms, Barwon Valley Activity Centre and the Barwon Valley Golf Club.
- City of Greater Geelong Council Depot buildings on Barwon Heads Road.

Minor and major roads are impacted by flooding within and sounding Geelong, these include the Hamilton Highway (Hyland Street), Queens Park Road, Lower Paper Mills Road, Barrabool Road, Promenade, Barwon Heads Road, Gravel Pits Road, Barwon Terrace, Marnock Road, High Street, Balcombe Road, Shannon Avenue, Wilsons Road, Tannery Road, Harriott Road and Lake Road. For more details regarding flood impacts refer to the Geelong Flood Intelligence Card and flood impact maps below.

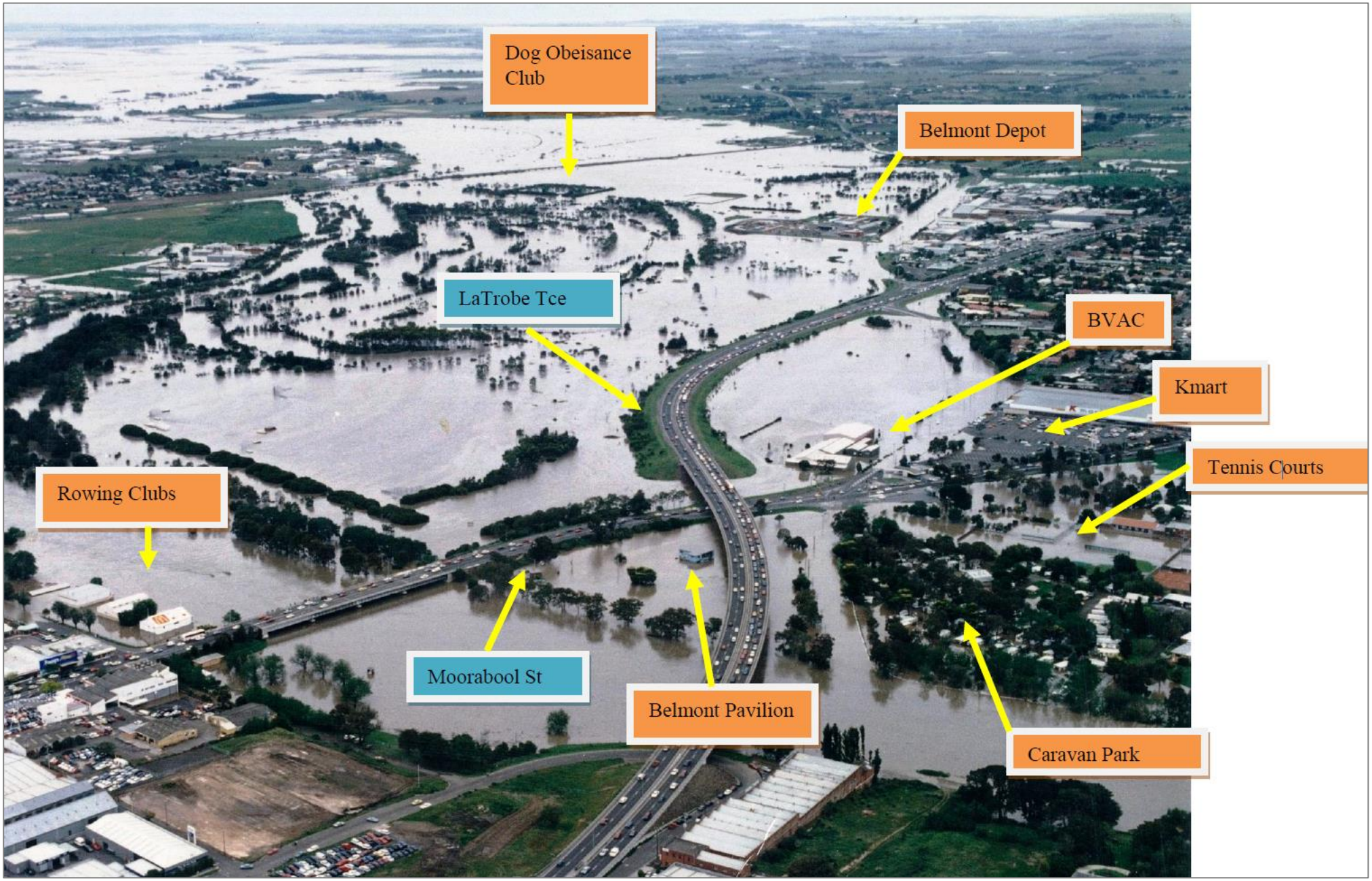


Figure 62. Flooding along the Barwon River in Geelong during the November 1995 flood event (COGG 2018).

Figure 63. Flooding along Belmont Common, Geelong during the January 2011 flood event (Water Technology 2016).

Figure 64. Flooding at the Queens Park Bridge, Geelong during the November 1995 flood event.

Figure 65. Flooding along Queens Park, Geelong during the January 2011 flood event (Water Technology 2016).

Figure 66. Flooding along Gundog Lane, Geelong during the January 2011 flood event (COGG 2018).

Figure 67. Flooding looking west along Barrabool Road, Geelong during the January 2011 flood event (COGG 2018).

Figure 68. Flooding adjacent to Geelong Rowing Clubs and the Moorabool Street Bridge during the January 2011 flood event (COGG 2018).

4.40 **Figure 69. Flooding adjacent to intersection of Settlement Road and High Street south of the Barwon River, Geelong during the April 2001 flood event (COGG 2018)**

4.41 **Figure 70. Flooding of the Barwon Rowing Clubrooms, Geelong during the 1983 flood event (COGG 2018)**

Flood Behaviour and Warning Time

4.42 **Flooding in within the Barwon River catchment at Geelong is highly complexed. There are three main waterways that contribute to flooding in Geelong, these include the Barwon River, Moorabool River and the Leigh River. Storms can impact different subcatchment areas in isolation, flooding in Geelong can be dominated by flood events in either the upper Barwon River, Moorabool River or the Leigh River. The dominant river contribution is highly dependent on the spatial variability and intensity of rainfall across the catchment during the flood event. The table below provides an indication of the contribution of flood flows for a range of flood events.**

An analysis of peak flood flows for these main waterways for a range of historic flood events shows that the Barwon River contributed the dominant flows during larger flood events in 1995 and 2001 (highlighted yellow in the table below). However, during more recent flood events the Leigh River contributed the dominant flood flows during the smaller flood events in 1973, 2011 and 2016. During the 1973 flood event both the Leigh River and Moorabool River contributed similar flows, 54% and 45% respectively.

Table 17. The contribution of flood flows in Geelong over a range of flood events.

Flood	Barwon River at Inverleigh peak flow (ML/d)	Barwon River % of total	Leigh River at Shelford peak flow (ML/d)	Leigh River % of total	Moorabool River at Batesford peak flow (ML/d)	Moorabool River % of total	Combined flows (ML/d)
February 1973	708	1	45,000	54	~36,893	45	82,601
October 1976	49,881	60	15,200	18	~18,000	22	83,081
November 1995	55,881	51	14,379	13	~40,000	36	110,260
April 2001	45,041	69	6,746	10	~13,910	21	65,697
January 2011	3,377	12	16,800	58	~8,726	30	28,903
September 2016	11,800	41	13,661	48	~3,000	11	28,461

An analysis of the travel time between heavy rainfall in across the Barwon River catchment to steep rise in streamflow at Geelong (McIntyre gauge) for four flood events varied between 2.25 to 4.8 days. Refer to the tables below. The November 1995 flood being the fastest, and the April 2001 being the slowest. The flood peak travel time between heavy rainfall in the upper catchment and the flood peak arriving in Geelong (McIntyre gauge) varied between 3 to 5.6 days, again the November 1995 flood event was the fastest event.

For many of these flood events the flood peak was maintained in Geelong for more than 4 of days, refer to the hydrographs below.

Table 18. Travel time of flood peaks within the Barwon River Catchment.

Flood Event	Travel time (hours) to steep rise/peak			
	Barwon River @ Ricketts Marsh	Leigh River @ Shelford	Moorabool River @ Batesford	Barwon River @ Geelong McIntyre Bridge
15th September 2016	14/9/2016 5:45 PM	14/9/2016 3:45 PM	15/9/2016 8:15 PM	15/9/2016 9:45 PM
16th January 2011	15/1/2011 12:00 AM	14/1/2011 * 7:45 PM	15/1/2011 11:30 PM	16/1/2011 12:00 AM
24th April 2001	22/4/2001 10:40 PM	24/4/2001 4:00 AM	24/4/2001 1:40 AM	24/4/2001# 9:00 PM
8th November 1995	6/11/1995 5:30 AM	7/11/1995* 1:00 AM	7/11/1995 4:30 AM	8/11/1995 6:00 AM

* Mt Mercer stream gauge data was used given there was no stream monitoring data available for the Shelford stream gauge.
# Estimated flood peak (Water Technology 2020).

Table 19. Travel time of Geelong flood peaks.

Flood Event	Travel time (hours)	
	From rainfall to steep rise (days)	From rainfall to peak (days)
8th November 1995	2.25 days	3 days
15th September 2016	3 days	3 days
16th January 2011	3.6 days	4.16 days
24th April 2001	4.8 days	5.6 days

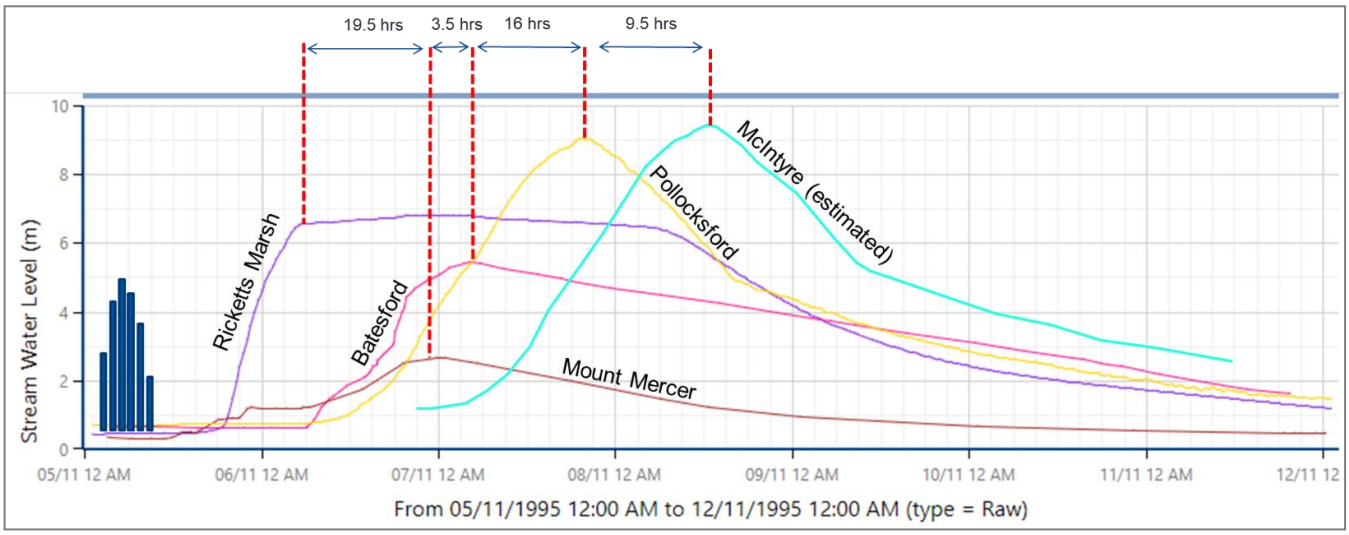


Figure 71. The travel time of flood peaks during the November 1995 (1 in 100 year AEP) flood event.

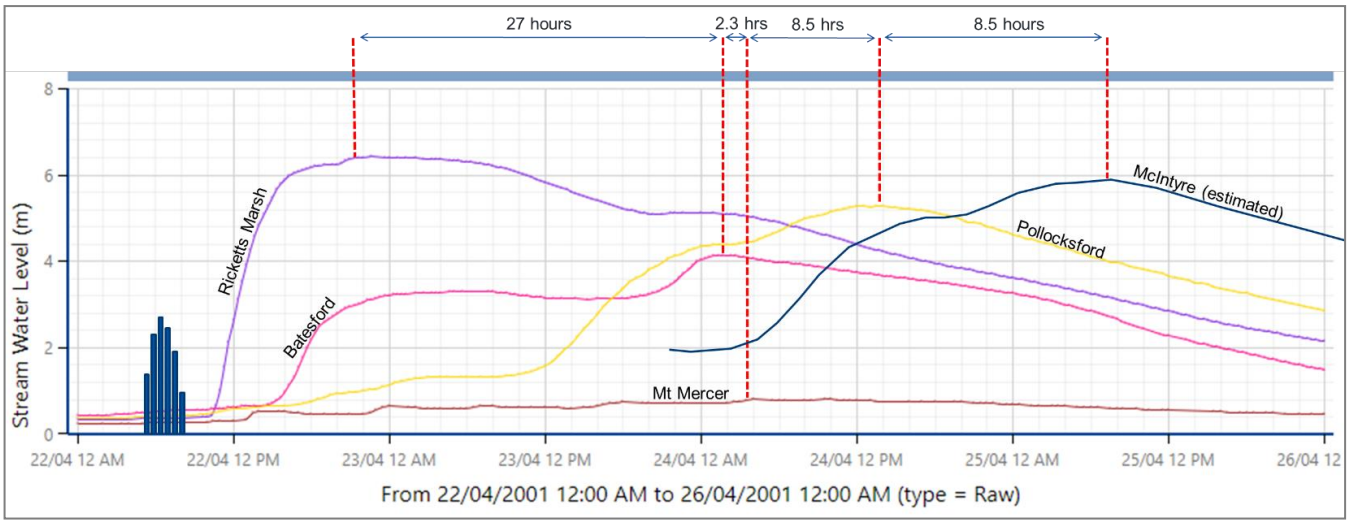


Figure 72. The travel time of flood peaks during the April 2001 (between 1 in 5 to 10 year AEP) flood event.

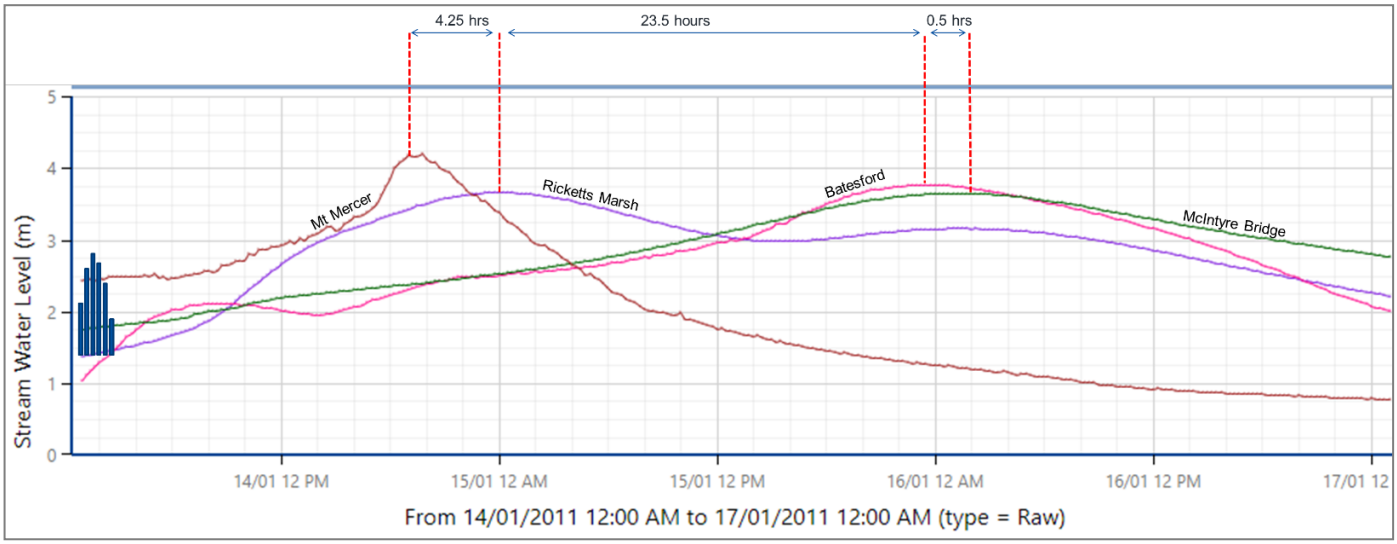


Figure 73. The travel time of flood peaks during the January 2011 (between 1 in 5 to 10 year AEP) flood event.

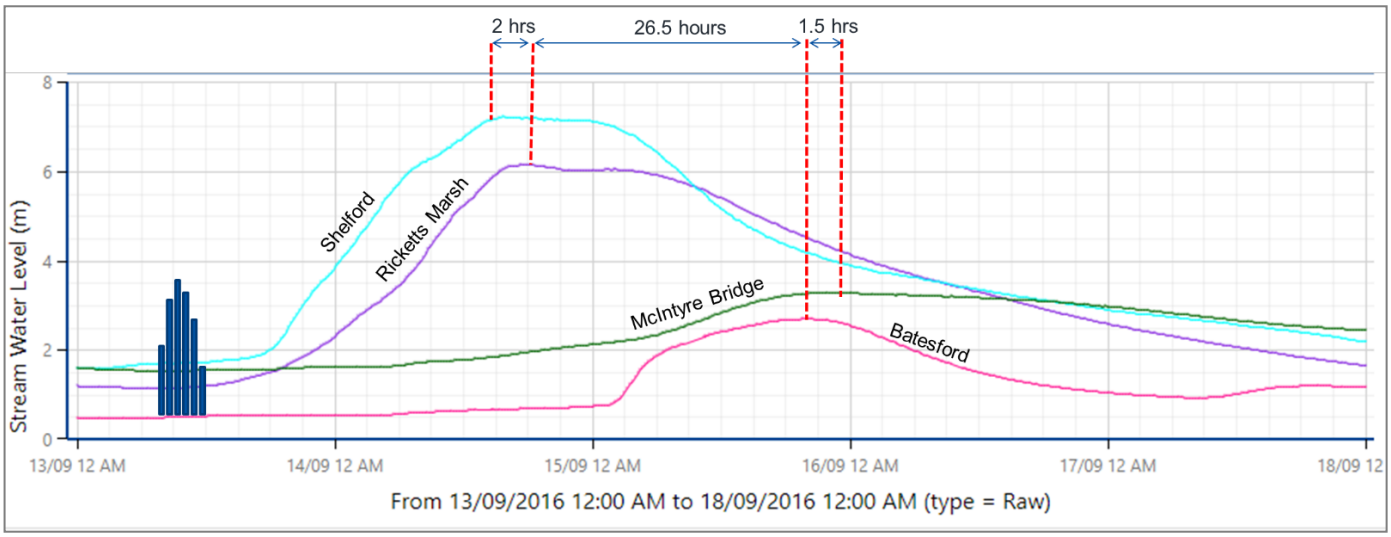


Figure 74. The travel time of flood peaks during the September 2016 (between 1 in 2 to 5 year AEP) flood.

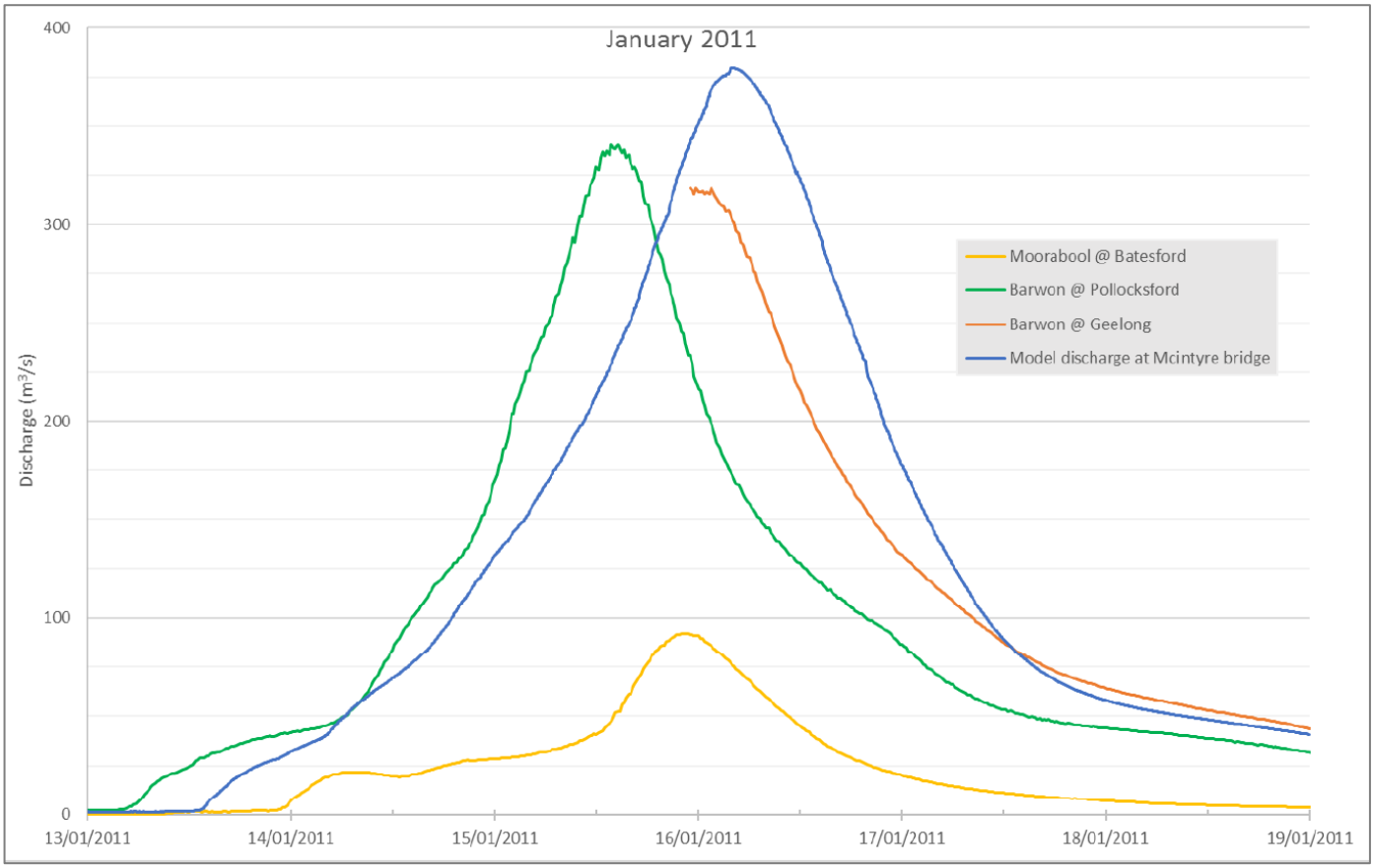


Figure 75. The travel time of flood peaks during the January 2011 flood event (Water Technology 2018).

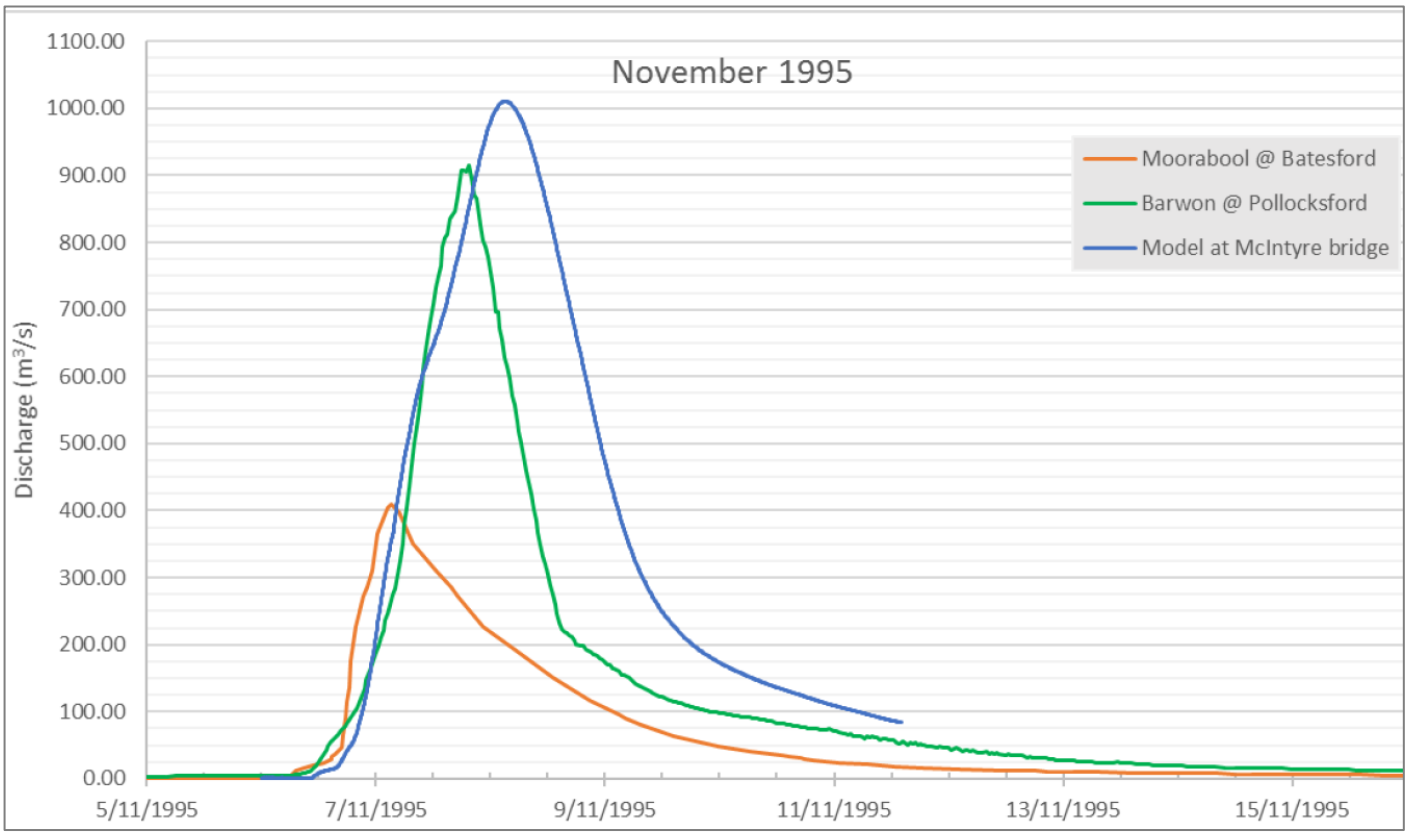


Figure 76. The travel time of flood peaks during the November 1995 flood (Water Technology 2018).

4.43

4.44

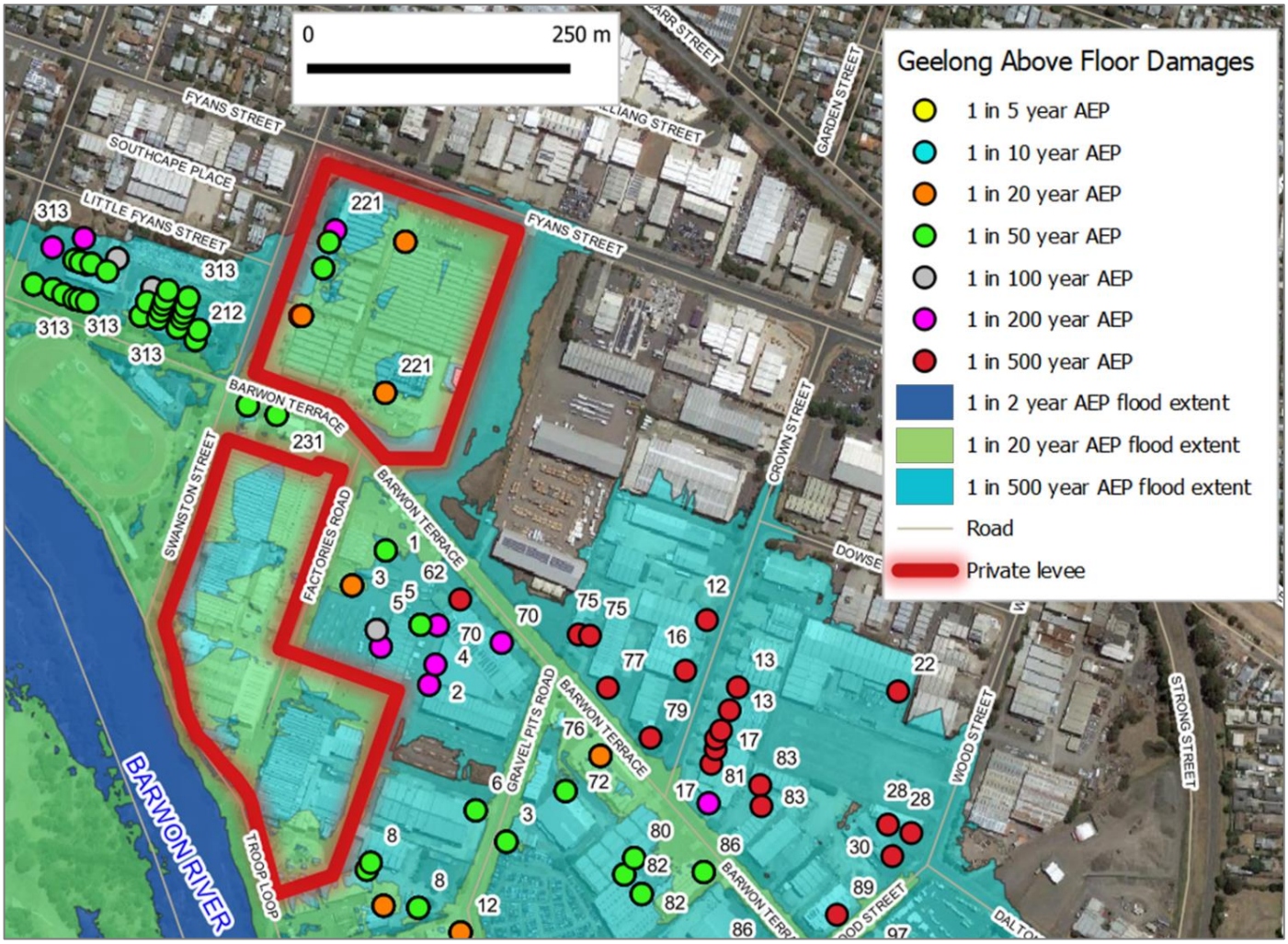
Private Levees

4.45 **Several private 2m high cement wall levees have been construted to protect buildings in South Geelong from flooding, these include Little Creatures and White Rabbit Breweries (221 Swanston Street) and Godfrey Hirst (7-9 Factories Road). Refe to the photo and flood map below. The flood protection of these levees is estimated to be approx up to a 1 in 200 year AEP flood. If flooding is greater than a 1 in 200 year AEP event, flooding is likely to overtop these levees. Also if the drive way flood levee gates are not closed and sealed before flooding occurs this levee will fail and these buildings will be impacted by flooding. Notes to this effect have been included in the Geelong Flood Intelligence Card (between Queens Park to Breakwater Road).**

4.46

4.47

4.48 **Figure 77. A cement levee wall protecting Godfrey Hirst buildings in Swanston Street, South Geelong.**



4.49 **Figure 78. Private levees protecting buildings from flooding in Swanston Street, South Geelong.**

Influence of the Lal Lal Reservoir

An analysis of the influence of the Lal Lal Reservoir was undertaken as part of the Moorabool River Flood Study (Corangamite CMA 2018). The model developed analysed peak flows for a range of flood magnitudes with and without the Lal Lal Reservoir. The stream data analysed as part of this analysis included;

- Post construction of the Lal Lal Reservoir from 1973 to 2015 (43 year record)
- Full record from 1908 to 1921 and 1945-2015 (80 year record)

Three of the largest flood events were included in this analysis, these include 1911, 1916 and 1952. The results of this analysis show that the Lal Lal Reservoir has a significant influence on downstream flooding in Batesford and Geelong. The results show that the Lal Lal Reservoir reduces the peak flood flows between 16.5% to 27.1%, refer to the table below.

Table 20. Analysis of the influence of the Lal Lal Reservoir on peak flood flows (Water Technology 2018).

Annual Exceedance Probability (1 in year)	Peak flow with the Lal Lal Reservoir (ML/d)	Peak flow without the Lal Lal Reservoir (ML/d)	Difference in peak flow (%)
5	9,850	11,923	27.1
10	16,675	19,526	17
20	24,019	27,994	16.5
50	33,696	39,917	18.5
100	40,522	49,162	21.3

It is expected that for the more frequent flood events (1 in 5 year AEP event) the Lal Lal Reservoir would reduce flows by more than 20% (Corangamite CMA 2018). The Lal Lal Reservoir controls approximately 27% of the catchment upstream of Batesford and attenuates flood flows from the West Moorabool Branch (assuming it spills), delaying peaks at Batesford for 9 hours. This allows local peak runoff to pass before the upper catchment flow arrives (CCMA 2018).

The Barwon River flood peak usually occurs 12 to 18 hours after the Moorabool River flood peak enters the Barwon River (CCMA 2018). Therefore the impact of this delay is likely to increase the flood peak in the Barwon River in Geelong, given the Moorabool River and Barwon River flood peak arrive at approximately the same time. This occurred during the 1995 flood event.

An analysis of the joint probability of the Barwon River and Moorabool River peak flows has shows that the Barwon River floods have a moderate correlation with concurrent Moorabool River flood flows (CCMA 2018). The June 1952 flood event, with an observed peak of 115,776 ML/d is similar to the November 1995 flood event. Both flood events had similar rainfall pattern over 4 days. Refer to the table below showing the flood peaks and peak travel time for a range of flood events. The time difference in peaks for the 1952 flood event reflects that the Lal Lal Reservoir was not present, allowing flood to arrive at Batesford some 9 hours earlier. The Barwon River Flood Study (Water Technology 2018) adopted a 10 hour difference in flood peaks arriving at Fyansford, being the average of the top 3 ranked flooding, 1995, 1973 and 1978.

Table 21. Moorabool River and Barwon River flood peak travel times for a range of flood events (Corangamite CMA 2018).

Flood	Moorabool River		Barwon River		Difference in peaks (hrs)
	Peak (ML/d)	Timing (hrs)	Peak (ML/d)	Timing (hrs)	
June 1952	48,730	84	87,264	108	24
Nov 1995	34,646	69	74,995	87	18
Feb 1973	18,230	57	43,373	64	7
Nov 1978	19,872	39	38,880	42	3
Jan 2011	5,789	136	26,006	133	-3

A sensitivity analysis was undertaken to assess the influence of the Lal Lal Reservoir (CCMA 2018). Two scenarios were analysed, without the Lal Lal Reservoir and with the Lal Lal Reservoir (starting water level of 90%). The model analysed the June 1952 flood event, approximately a 1 in 100 year AEP event. It is known that the Lal Lal Reservoir was built in 1972, these are modelled results and should be used as a guide only. The modelled scenario with the Lal Lal Reservoir caused an 11% reduction in peak and a 9 hour delay to peak at Batesford. This delay caused the Barwon River flood peak to coincide (arrive at the same time) with the Moorabool River peak, causing an increase in flood level in Geelong. This was reported to have occurred during the 1995 flood event.

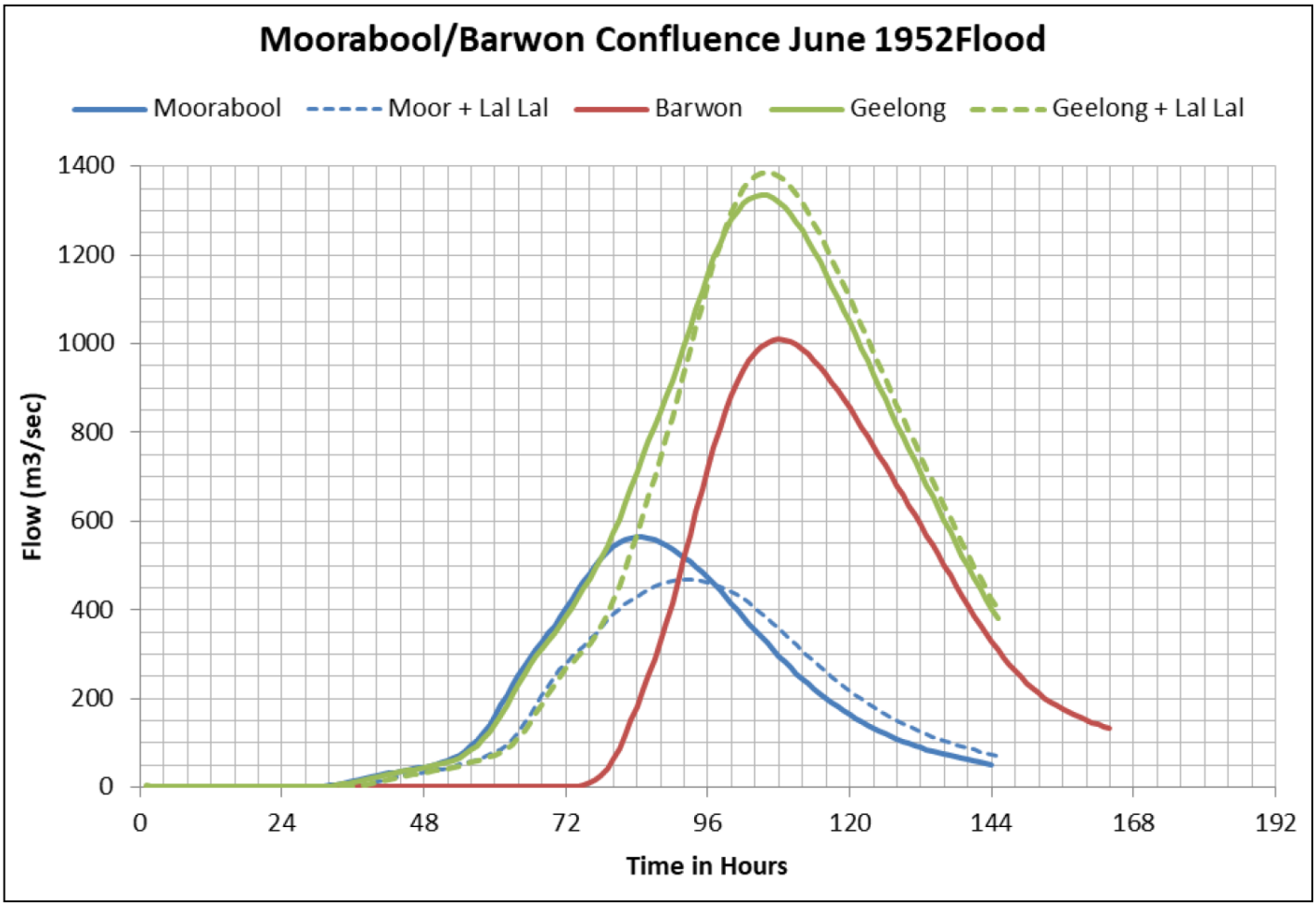


Figure 79. Sensitivity analysis of different Lal Lal Reservoir starting levels during the 1952 flood event (Corangamite CMA 2018).

The Corangamite CMA recommend that future work should include modelling both the 1952 or 1995 flood events with varying starting levels would provide a more comprehensive analysis of the effect the Lal Lal Reservoir (Corangamite CMA pers comm March 2021). This is something the Corangamite CMA team may be able to undertaken when time allows.

Flood Impacts and Actions Required

Flood mapping from the Barwon River flood study (Water Technology 2019) was used to estimate assets, buildings and roads impacted by flood for a range of design flood events.

Flood intelligence information clearly shows that during small flood events between a 1 in 2 to 10 year flood events (similar to the 2016, 2001, 2011 and 1983 floods), there are significant damages to buildings, roads and infrastructure. More than 24 buildings are flooded above floor, including Barwon Valley Golf Course Clubrooms, Geelong Water Ski Clubrooms, Geelong Amateurs Football and Netball Club buildings, Belmont Council Ops Depot, several Rowing Clubroom buildings, Geelong Canoe Clubrooms, the Barwon River Holiday Caravan Park, in addition to many industrial business sheds and houses. Deep flooding occurs surrounding Queens Park, Fyansford Common parkland, Barwon Valley Fun Park playground, Belmont Common parkland, King Lloyd Reserve, Balyang Sanctuary, Belmont Wildlife Reserve parkland, Landy Athletic Field, created high risk to life to pedestrians and motorists. Flooding cut access to minor and major roads including Gundog Road, Boundary Road, Barrabool Road, Marnock Road, Lower Paper Mills Road, Wilsons Road, Lake Road, The Promenade, Gravel Pits Road, Barwon Heads Road and Barwon Terrace.

During large flood events, between a 1 in 50 year to 100 year flood events (similar to the 1995 and 1952 floods), there are substantial flood impacts to buildings, roads and infrastructure. More than 174 buildings are flooded above floor, including Geelong Golf Course Clubrooms, Geelong Amateurs Football and Netball Club buildings, Riverglen Holiday Park, City Southside Caravan Park, Discovery Caravan Park, Barwon Valley Lodge Motel, Barwon Edge Boat House Bistro, Newtown City Hockey Clubrooms and the Murgheboluc Cricket Clubrooms in addition to a significant number of industrial business sheds and houses. Flooding cut access to most minor and major roads within the floodplain including Queens Park Bridge on Queens Park Road, Harriott Road, Breakwater Road, Shannon Avenue, High Street and Balcombe Road (in addition to the roads listed above).

For additional flood risk information refer to the Geelong Flood Intelligence Cards, tables and maps below.

Key assets at risk of flooding in Geelong are listed below.

Table 22. Key Geelong assets at risk of flooding.

Asset register				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
Barwon Valley Fun Park playground area, King Lloyd Reserve, Belmont Common parkland, Barwon Valley Golf Course area.	2 year flood	Deep flooding, in parts more than 1.7m surrounding the Barwon Valley Fun Park playground area, King Lloyd Reserve, Belmont Common parkland, Barwon Valley Golf Course parkland creates high risk to life to pedestrians and motorists.	Evacuate the Barwon Valley Fun Park playground area, King Lloyd Reserve, Belmont Common parkland, Barwon Valley Golf Course as needed.	Victoria Police.
Geelong Water Ski Clubrooms, 493 Wilsons Road, St Albans Park.	2 year flood	Deep flooding may impact the Geelong Water Ski Clubrooms above floor during a 2 year flood event.	Evacuate the Geelong Water Ski Clubrooms and sandbag the building as needed.	VICSES Victoria Police
Gundog Lane and Boundary Road, along the Barwon River in Belmont	2 year flood	Deep flooding greater than 0.30m depth may cut access to Gundog Lane and Boundary Road, during a 2 year flood event.	Deploy road closure signs and undertake traffic management as needed.	Vic Roads Council
Barrabool Road and Marnock Road, along the Barwon River near the Barwon Valley Park.	2 year flood	Shallow flooding starts to overtop the Barrabool Road and Marnock Road during a 2 year flood, depth may be greater than 0.10m.	Deploy road closure signs as needed.	Vic Roads Council

Lower Paper Mills Road, along Moorabool River, west of Queens Park.	5 year flood	Deep flooding greater than 0.30m depth may cut access to Lower Paper Mills Road, during a 5 year flood event.	Deploy road closure signs as needed.	Council
Queens Park, the Geelong Golf Course, Geelong **Amateurs** Football and Netball Club and Fyansford Common parkland, low lying areas along the Barwon River at Highton.	5 year flood	Deep flooding, greater than 3 m surrounding Queens Park, the Geelong Golf Course, Geelong Amateurs Football and Netball Club and Fyansford Common parkland creates high risk to life to pedestrians and motorists.	Evacuate Queens Park, the Geelong Golf Course and Fyansford Common parkland as needed.	Victoria Police
Wilsons Road and Lake Road, along the Barwon River southeast section of Geelong.	5 year flood	Deep flooding greater than 0.40m depth may cut access to Wilsons Road and Lake Road, during a 5 year flood event.	Deploy road closure signs and undertake traffic management as needed.	Vic Roads Council
The Promenade (Belmont) and Gravel Pits Road (South Geelong), along the Barwon River.	5 year flood	Deep flooding may cut access to The Promenade (Belmont) and Gravel Pits Road (South Geelong) during a 5 year flood, depth may be greater than 0.64 m.	Deploy road closure signs as needed.	Council
Balyang Sanctuary, Barwon Valley Golf Club, Balyang Golf Club (Newtown), Landy Athletics Field (South Geelong), Barwon Valley Activity Centre and the Belmont Wildlife Reserve and Wetland area.	5 year flood	Deep flooding, in parts may be greater than 1.7 m surrounding Balyang Sanctuary, Barwon Valley Golf Club, Balyang Golf Club, Landy Athletics Field, Barwon Valley Activity Centre and the Belmont Wildlife Reserve parkland creates high risk to life to pedestrians and motorists during a 5 year flood.	Evacuate the Balyang Sanctuary, Barwon Valley Golf Club, Balyang Golf Club, Landy Athletics Field, Barwon Valley Activity Centre and the Belmont Wildlife Reserve parkland as needed.	Victoria Police
Barwon River Holiday Caravan Park, 153 Barrabool Road, Belmont.	10 year flood	Deep flooding may impact buildings at the Barwon River Holiday Caravan Park above floor during a 10 year flood event.	Evacuate and sandbag buildings at the Barwon River Holiday Caravan Park as needed.	Victoria Police VICSES
Barwon Heads Road (Belmont) and Barwon Terrace (South Geelong), along the Barwon River in Belmont.	10 year flood	Deep flooding greater than 0.34m depth may cut access to Barwon Heads Road and Barwon Terrace, during a 10 year flood event.	Deploy road closure signs and undertake traffic management as needed.	Vic Roads
Riverglen Holiday Caravan Park (75 Barrabool Road) and City Southside Caravan Park (97 Barrabool Road).	20 year flood	Deep flooding may impact buildings above floor at the Riverglen Holiday Caravan Park and City Southside Caravan Park during a 20 year flood event.	Evacuate and sandbag buildings at the Riverglen Holiday Caravan Park and City Southside Caravan Park as needed.	Victoria Police VICSES
Queens Park Bridge, on Queens Park Road, along the Barwon River at Highton	20 year flood	Deep flooding may cut access to the Queens Park Bridge, on Queens Park Road during a 20 year flood, depth 0.34m	Deploy road closure signs and undertake traffic management as needed.	Vic Roads
Barwon Edge Boat House Bistro, 40 Windsor Road, Newtown.	50 year flood	Deep flooding may start to flood the Barwon Edge Boat House Bistro car park during a 50 year flood event. The Bistro building may be flooded above floor during a 100 year flood event.	Evacuate and sandbag Barwon Edge Boat House Bistro building as needed.	Victoria Police VICSES
Harriott Road, along the Barwon River in Charlemont.	50 year flood	Deep flooding greater than 1.18m depth may cut access to Harriott Road during a 50 year flood event.	Deploy road closure signs and undertake traffic management as needed.	Council
Discovery Park Geelong Caravan Park (59 Barrabool Road) and the Barwon Valley Lodge Motel (99 Barrabool Road), Belmont.	100 year flood	Deep flooding may impact buildings above floor at the Discovery Park Geelong Caravan Park and the Barwon Valley Lodge Motel during a 100 year flood event.	Evacuate and sandbag buildings at the Discovery Park Geelong Caravan Park and the Barwon Valley Lodge Motel as needed.	Victoria Police VICSES
Bupa Aged Care Home (55-57 Barrabool Road), Newtown Medical Centre (2 Balcombe Road), the Victory Faith Centre (313 Bellerine Street), Belmont Shopping Village Sushi & Dumpling House (65 High Street) and Little Creatures, White Rabbit Breweries (221 Swanston Street) and Geelong RSL (54 Barwon Heads Road).	200 year flood	Deep flooding may impact buildings above floor at the Bupa Aged Care Home, Newtown Medical Centre the Victory Faith Centre, Belmont Shopping Village Sushi & Dumpling House, Little Creatures, White Rabbit Breweries and the Geelong RSL during a 200 year flood event.	Evacuate and sandbag buildings at the Bupa Aged Care Home, Newtown Medical Centre the Victory Faith Centre, Belmont Shopping Village Sushi & Dumpling House, Little Creatures, White Rabbit Breweries and the Geelong RSL as needed.	Victoria Police VICSES

Japara Nursing Home, 355 Wilsons Road, St Albans Park.	200 year flood	Deep flooding may flood the Japara Nursing Home above floor during a 200 year flood event.	Evacuate and sandbag the Japara Nursing Home building as needed.	Victoria Police VICSES
Barwon Health Renal Services (38 Little Fyans Street), Belmont Village Shopping Centre TAB (65 High Street) and the Geelong Gymnasium (21 Mitchell Street).	500 year flood	Deep flooding may impact buildings above floor at the Barwon Health Renal Services, Belmont Village Shopping Centre TAB and the Geelong Gymnasium during a 500 year flood event.	Evacuate and sandbag buildings at the Barwon Health Renal Services, Belmont Village Shopping Centre TAB and the Geelong Gymnasium as needed.	Victoria Police VICSES
Hamilton Highway (Hyland Street), at Fyansford.	500 year flood	Deep flooding may cut access to the Hamilton Highway (Hyland Street), during a 500 year flood, depth 0.63m	Deploy road closure signs and undertake traffic management as needed.	Vic Roads

For more detailed information regarding buildings and roads impacted refer to the Geelong Flood Intelligence Card and flood impact maps below. Also refer to the Geelong flood depth maps in **Appendix E** and community sandbag collection points in **Appendix H**.

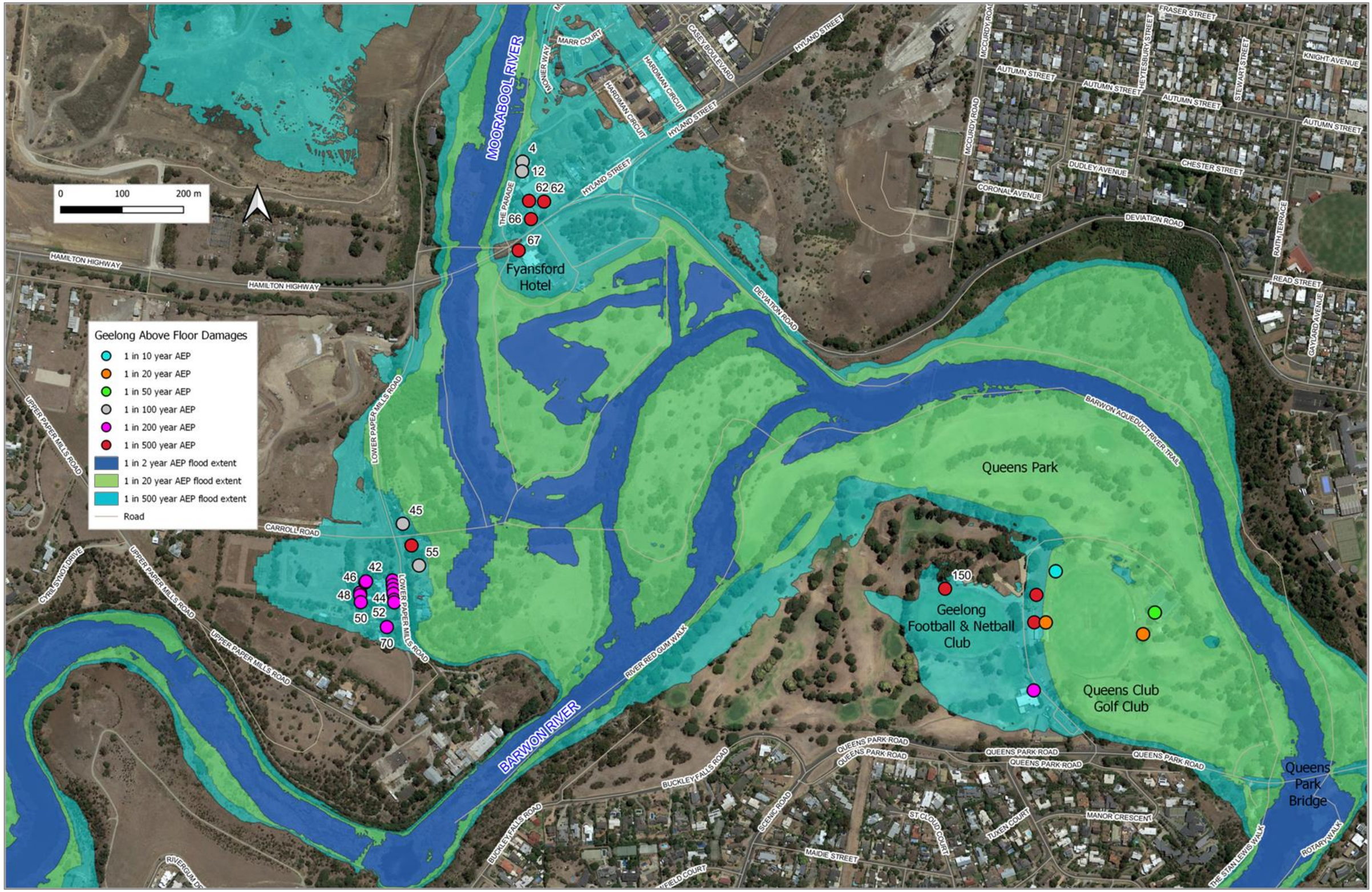


Figure 80. Geelong (upstream of Queens Park) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

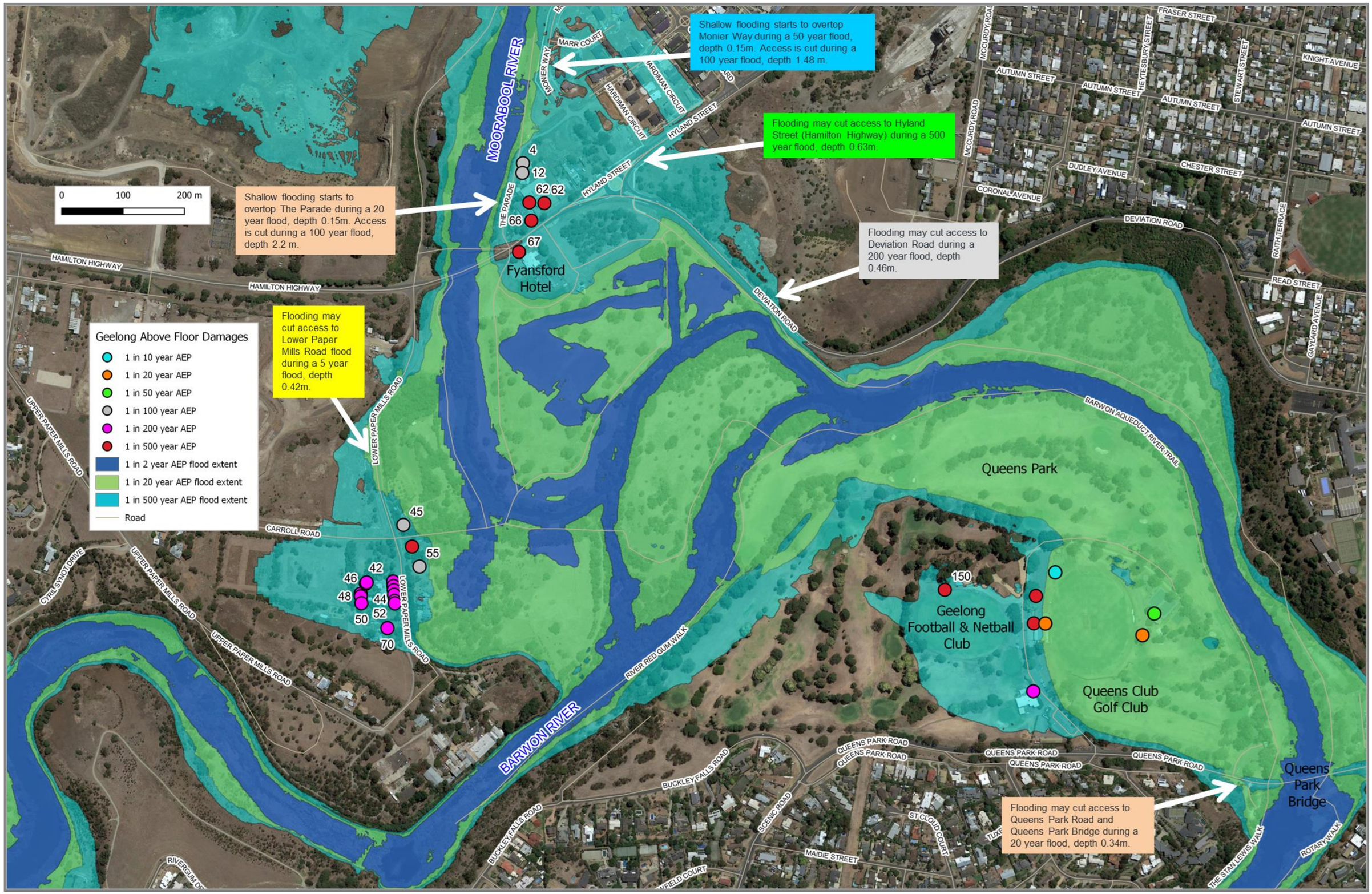


Figure 81. Geelong (upstream of Queens Park) roads impacted by flooding for a range of design flood events (Water Technology 2018).

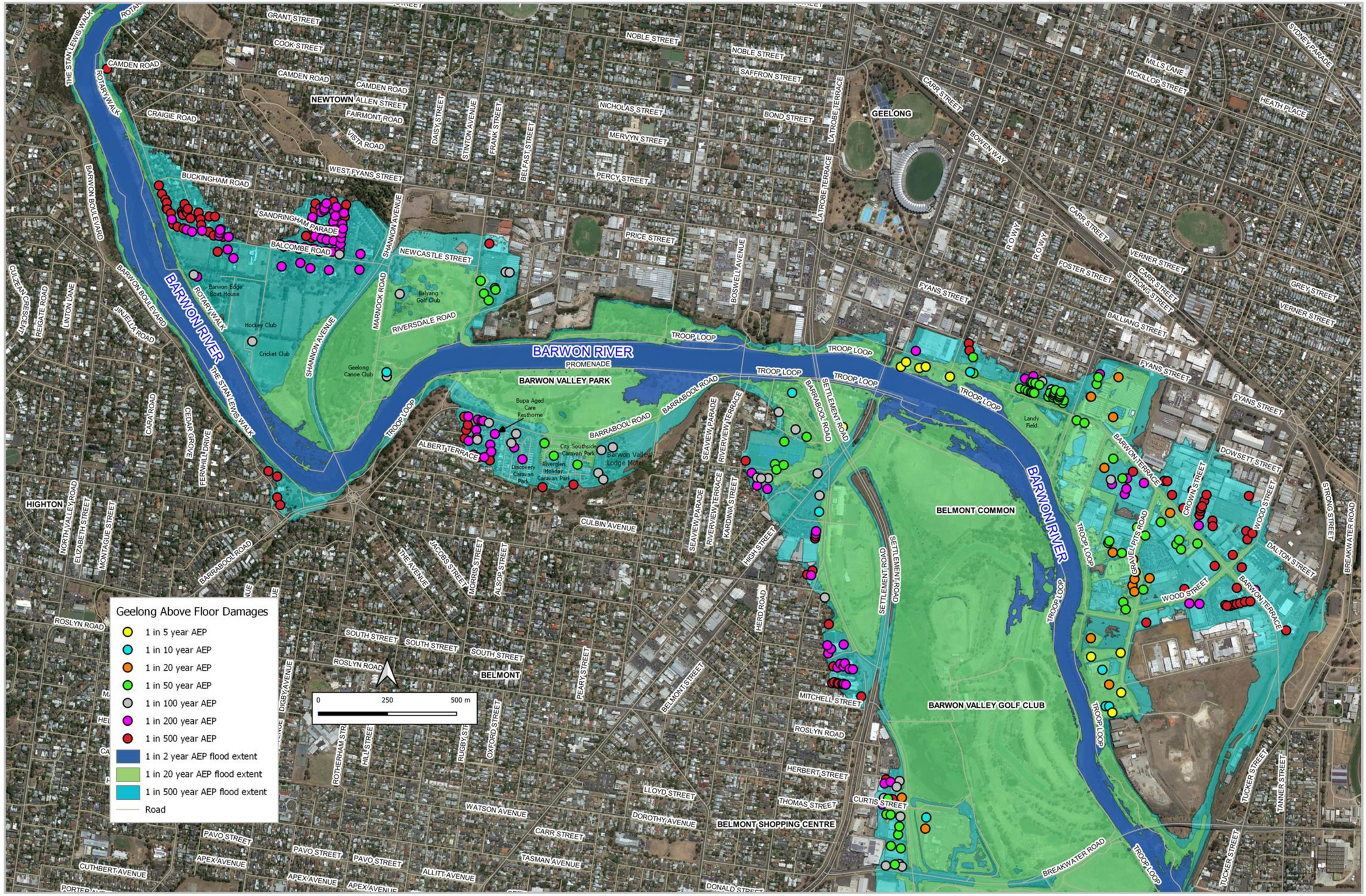


Figure 82. Geelong (between Queens Park to Breakwater Road) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

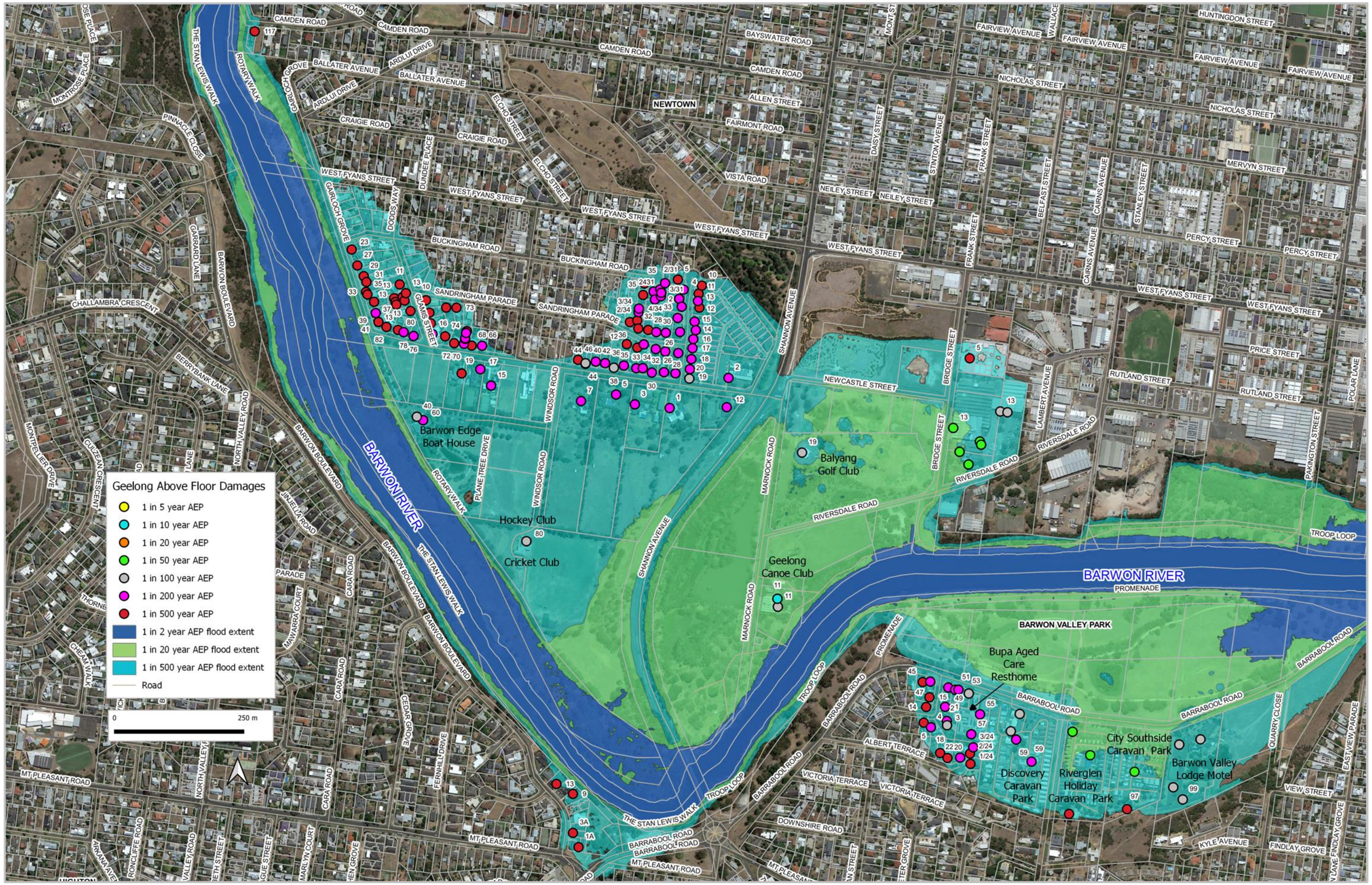


Figure 83. Geelong (between Queens Park to Breakwater Road) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

Figure 84. Geelong (between Queens Park to Breakwater Road) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

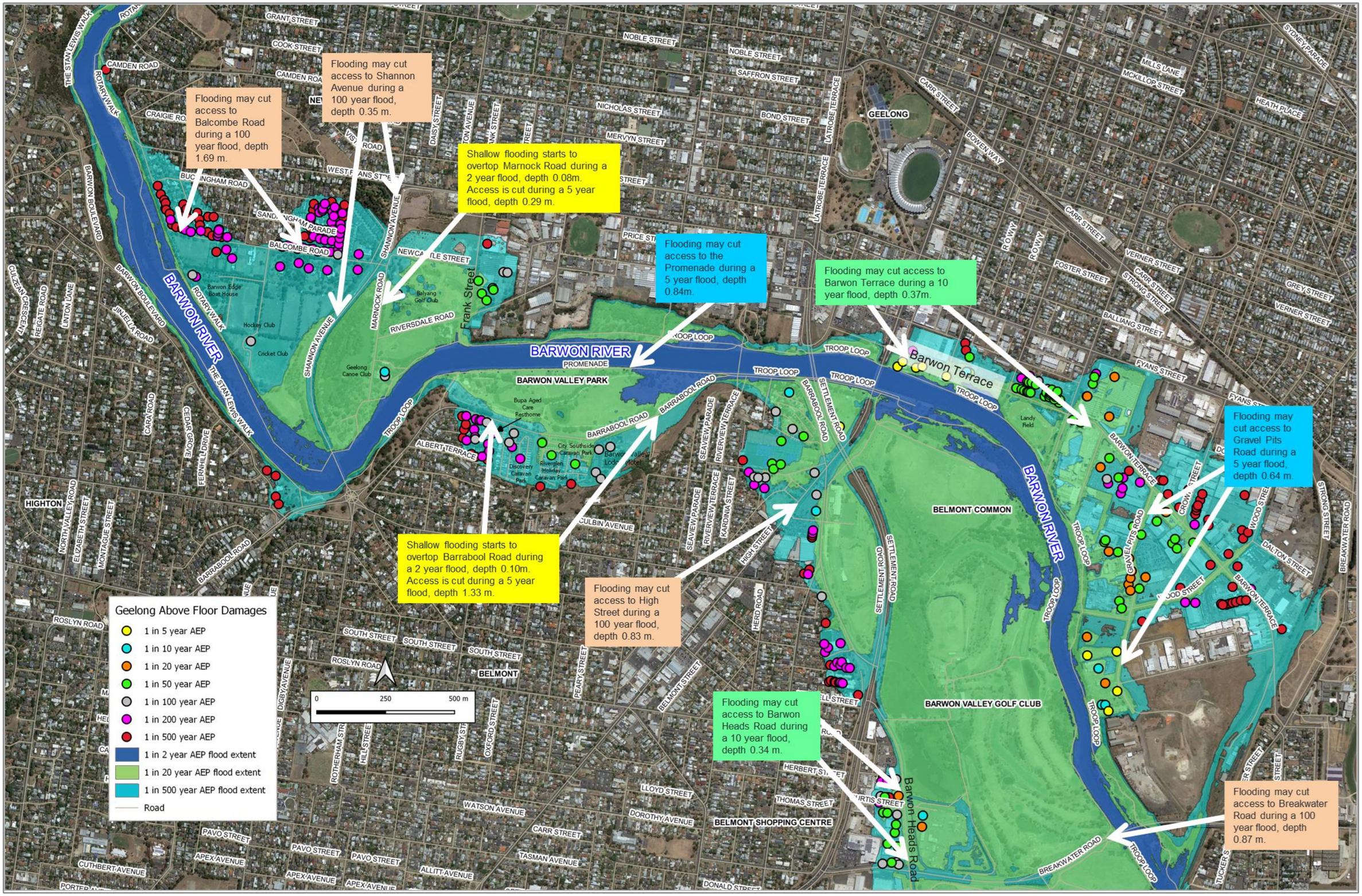


Figure 85. Geelong (between Queens Park to Breakwater Road) roads impacted by flooding for a range of design flood events (Water Technology 2018).

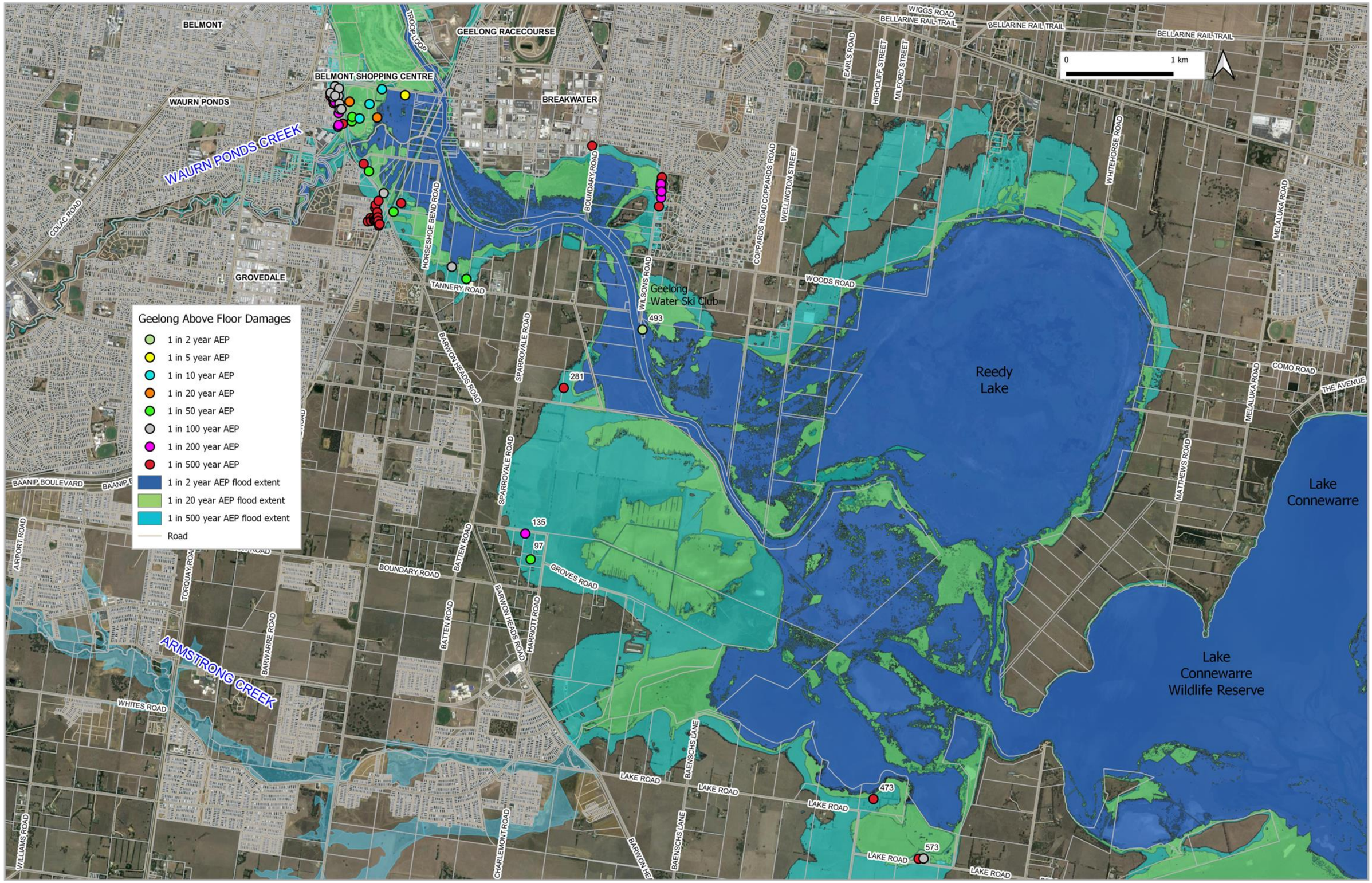


Figure 86. Geelong (downstream of Breakwater Road) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

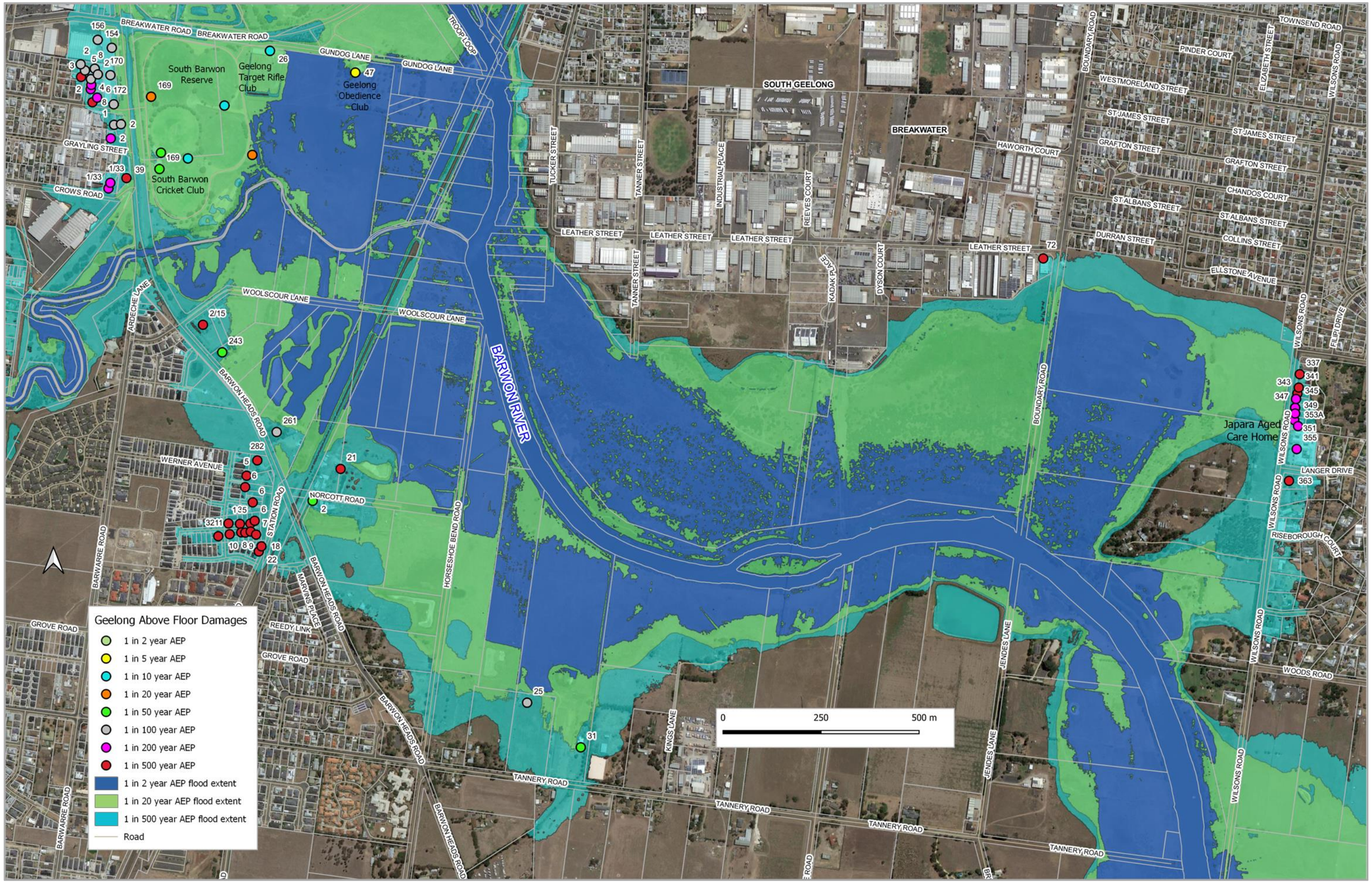


Figure 87. Geelong (downstream of Breakwater Road) buildings impacted by over floor flooding for a range of design flood events (Water Technology 2018).

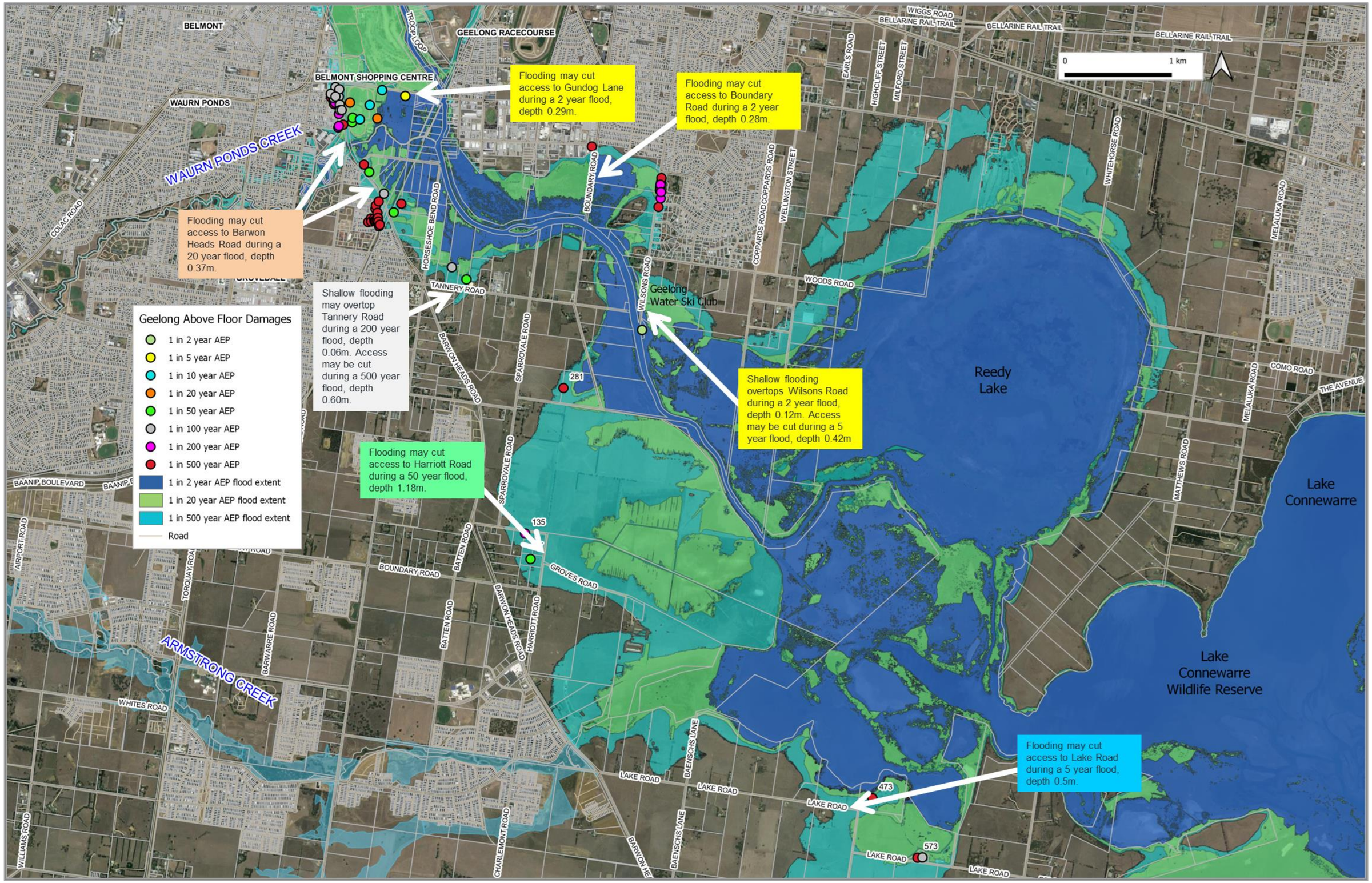


Figure 88. Geelong (downstream of Breakwater Road) roads impacted by flooding for a range of design flood events (Water Technology 2018).

Table 23. Geelong Flood Intelligence Card (Upstream of Queens Park)

Flood travel time	
	Time from start of rainfall in the upper Barwon River catchment to steep rise in floodwater at Geelong 1.5 - 2.3 days
	Time from start of rainfall in the upper Moorabool River catchment to steep rise in floodwater at the Moorabool River/Barwon River confluence (at Fyansford) 23 - 40 hours
	Time from start of rainfall in the upper Leigh (Yarrowee) River catchment to steep rise in floodwater at the Leigh River/Barwon River confluence at Inverleigh 22 - 36 hours
	Riverine flooding duration: 4 to 6 days

Moorabool River at Batesford gauge height 232202 (m)	Leigh River at Shelford gauge height 233213 (m)	Barwon River U/S Inverleigh gauge height 233218 (m)	Barwon River at Ricketts Marsh gauge height 233200 (m)	Barwon River at Pollocksford gauge height 233200 (m)	Barwon River at McIntyre Bridge Geelong gauge height 233217 (m)	Barwon River at Geelong Design Flows (ML/d)	Annual Exceedance Probability (1 in year)	Geelong damages US of Queens Park total number properties flooded (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Road flood depth (m)	Action
2.70 (3,212 ML)	6.0 (7,760 ML)			3.50	2.30		Minor					**VICSES** publish a community flood advice warning via EMCOP. **VICSES** activate ground observers to take photos and record flood levels at key crossings.
		2.55			2.51	10,627	2	0 (0)	Flooding starts to break out of the Moorabool River and the Barwon River along low lying parkland surrounding Queens Park and Fyansford Common.		Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 0m Monier Way depth 0m Lower Paper Mills Road depth 0m The Parade depth 0m Deviation Road depth 0m	In addition to actions listed above; **Council** clear debris from waterway crossings, drains and culverts as needed. **Council** staff when taking ground flood photos, share photos with VICSES via Snap Send Solve. **Barwon Water** staff provide updates regarding the Lal Lal Reservoir storage level and potential spill risk.
4.00 (10,000 ML)	7.00 (12,500 ML)			4.50	3.10		Moderate					
3.66		3.19	6.14	5.27	3.28	19,284	2016					
					3.52	26,957	5	2 (0)	More extensive flooding within parkland surrounding Queens Park and Fyansford Common, depth up to 3m. Deep flooding may cut access to Lower Paper Mills Road.		Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 0m Monier Way depth 0m Lower Paper Mills Road depth 0.42m The Parade depth 0m Deviation Road depth 0m	In addition to actions listed above; Deep flooding creates high risk to life to pedestrians and motorists, **Victoria Police** evacuate Queens Park, adjacent parkland, Geelong Golf Course and the Geelong Amateurs Football and Netball Club grounds. **Council** deploy road signs to close roads and undertake traffic management as needed.
	5.70			5.28	3.60		2001					
				6.09	3.68	28,100	2011					
					3.80	31,100	1983					
		3.99			4.22	42,595	10	4 (1)	Deep flooding impacts the Queens Park Golf Course and the Queens Park playground, Netball courts and ovals, flood depth between 1m to 3m. A shed at the Geelong Amateurs Football and Netball Club (150B Queens Park Road Highton) may be flooded above floor. Flood depth along Lower Paper Mills Road and the surrounding Queens Park and Fyansford Common parkland is very deep, greater than 1m creating high risk to life to pedestrians and motorists.	A shed at the Geelong Amateurs Football and Netball Club, 150B QUEENS PARK ROAD HIGHTON may be flooded above floor.	Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 0m Monier Way depth 0m Lower Paper Mills Road depth 1.06m The Parade depth 0m Deviation Road depth 0m	In addition to actions listed above; **Council** deploy road signs to close roads and undertake traffic management as needed.
4.90 (37,000 ML)	8.00			6.50	4.30		Major					
					4.55	54,400	1978					
		4.57			4.52	59,962	20 year flood 1909	4 (3)	Access to the Queens Park Bridge and Queens Park Road is cut by deep flooding, may be up to 0.34m. Shallow flooding starts to overtop The Parade. Two additional buildings may be flooded above floor the Geelong Amateurs Football and Netball Clubrooms and shed (150B Queens Park Road, Highton).	Two additional buildings may be flooded above floor; Geelong Amateurs Football and Netball Clubrooms and shed (150B Queens Park Road, Highton).	Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 0.34m Monier Way depth 0m Lower Paper Mills Road depth 1.35m The Parade depth 0.15m Deviation Road depth 0m	In addition to actions listed above; **Vic Roads** deploy road signs to close the Queens Park Road and Queens Park Bridge and undertake traffic management as needed. **VICSES** sandbag buildings and assist to protect assets at the Geelong Amateurs Football and Netball Clubrooms as needed.
	8.31	5.38			5.32	90,288	50	5 (4)	One additional building may be flooded above floor including the Queens Park Golf Clubroom 150A Queens Park Road Highton. Shallow flooding starts to overtop roads including Monier Way.	One additional building may be flooded above floor; the Queens Park Golf Clubroom 150A Queens Park Road Highton.	Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 0.34m Monier Way depth 0.15m Lower Paper Mills Road depth 1.53m The Parade depth 0m Deviation Road depth 0m	In addition to actions listed above; **VICSES** sandbag buildings and assist to protect assets at the Geelong Golf Clubrooms as needed. **Barwon Water** staff provide intelligence regarding impact of flooding on waste water network and provide advise to ICC of problems that may occur.
5.44 (40,000 ML)	7.35	5.59		9.05	5.23	97,900	1995					
					5.47	116,000	1952					
	8.44	6.04			5.94	118,109	100	14 (9)	Five additional buildings may be flooded above floor, four houses and a shed in Fyansford and Ceres. Flooding may cuts access to The Parade and Monier Way.	5 additional buildings may be flooded above floor; **FYANSFORD :**x2 THE PARADE (4, 12-14) X2 LOWER PAPER MILLS ROAD (45, 55)	Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 2.08m Monier Way depth 1.48m Lower Paper Mills Road depth 2.94m The Parade depth 2.2m	In addition to actions listed above; **VICSES** sandbag buildings and assist to protect assets at risk of flooding as needed.

										CERES: 195 MERRAWARP ROAD	Deviation Road depth 0m	
	8.50				6.61	146,880	200	28 (22)	Thirteen additional buildings may be flooded above floor including 12 houses and one building at the Queens Park Golf Club building. Flooding may cut access to Deviation Road.	13 additional building may be flooded above floor; **FYANSFORD :** x12 LOWER PAPER MILLS ROAD (42, 44, 46, 48, 50, 52, 70) **HIGHTON:**150 QUEENS PARK ROAD (Queens Park Golf Club building)	Hyland Street (Hamilton Highway) depth 0m Queens Park Road depth 2.93m Monier Way depth 2.26m Lower Paper Mills Road depth 3.25m The Parade depth 2.98m Deviation Road depth 0.46m	Refer to actions listed above.
					7.48	195,696	500	40 (30)	Eight additional buildings may be flooded above floor including Geelong Amateurs Football and Netball Clubrooms (150 Queens Park Road), Fyansford Hotel (67 Hyland Street) and two shops in Hyland Street. Flooding may cut access to the Hamilton Highway (Hyland Street).	8 additional buildings may be flooded above floor.	Hyland Street (Hamilton Highway) depth 0.63m Queens Park Road depth 4.06m Monier Way depth 3.41m Lower Paper Mills Road depth 4.32m The Parade depth 4.12m Deviation Road depth 1.54m	In addition to actions listed above; **Vic Roads** deploy road signs to close the Hamilton Highway where the Hyland Street intersects the Moorabool River and undertake traffic management as needed.

Table 24. Geelong Flood Intelligence Card (Queens Park to Breakwater Road)

Flood travel time					Time from start of rainfall in the upper Barwon River catchment to steep rise in floodwater at Geelong 1.5 - 2.3 days Time from start of rainfall in the upper Moorabool River catchment to steep rise in floodwater at the Moorabool River/Barwon River confluence (at Fyansford) 23 - 40 hours Time from start of rainfall in the upper Leigh (Yarrowee) River catchment to steep rise in floodwater at the Leigh River/Barwon River confluence at Inverleigh 22 - 36 hours Riverine flooding duration: 4 to 6 days		
Barwon River at McIntyre Bridge Geelong gauge height 233217 (m)	**Barwon River at Geelong Design Flows (ML/d)**	**Annual Exceedance Probability (1 in year)**	**Geelong damages between Queens Pk and Breakwater Rd total number properties flooded (above floor)**	**Consequence / Impact**	**Houses/ buildings flooded / isolated**	**Road flood depth (m)**	**Action**
2.30		Minor		Flooding starts to impact the Barrabool Road, Breakwater Road Causeway and the Steel Street access track.			**VICSES** publish a community flood advice warning via EMCOP. **VICSES** activate ground observers to take photos and record flood levels at key crossings.
2.51	10,627	2	0 (0)	Only very localised out of bank flooding. Flooding starts to impact the Barwon River Canoe Club, Rowing Club under threat approaching 3 metres, Belmont Common and the Barwon Valley Golf Course. Flooding starts to impact King Lloyde Reserve, the south/east end near Shannon Ave. Access is cut to the Barwon Valley Fun Park.		Barrabool Road depth 0.10m Marnock Road depth 0.08m	In addition to actions listed above; Deep flooding creates high risk to life to pedestrians and motorists, **Victoria Police** evacuate Barwon Valley Fun Park playground area, King Lloyde Reserve area, Belmont Common parkland area, the Barwon Valley Golf Course, Barwon River Canoe Club and Rowing Club area. **Council** clear debris from waterway crossings, drains and culverts as needed. **Council** deploy road signs to close Barrabool Road and Marnock Road and others as needed. **Council** staff when taking ground flood photos, share photos with VICSES via Snap Send Solve. **Barwon Water** staff provide updates regarding the Lal Lal Reservoir storage level and potential spill risk. **Barwon Water** staff provide intelligence regarding impact of flooding on waste water network and provide advise to ICC of problems that may occur.
3.10		Moderate					
3.28	19,284	2016					
3.52	26,957	5	12 (10)	Ten buildings may be flooded above floor in Barwon Terrace, Gravel Pits Road and Barrabool Road. Flooding impacts the Balyang Sanctuary and the Balyang Golf Course. Flooding starts to impact the Landy Athletics Field. Barwon River bursts its banks and low areas along the river, the area between Shannon Avenue and Moorabool Street Bridge is impacted by flooding. Deep flooding cuts access to the Promenade, Barrabool Road, Gravel Pits Road and Marnock Road, depth is between 0.3m to 1.3m. The Barwon Valley Fun Park is partially flooded. The Barwon Valley Golf Club, Wildlife Reserve and Wetlands in Belmont are inundated with depths mostly between 0.5 and 1.5m. Barwon Valley Activity Centre (1 Barwon Heads Rd, Belmont) is impacted by floodwaters up to 0.75m deep. Most of ovals east of Moorabool Street are inundated. Monitor main entrance to the Council Belmont Ops building (135 Barwon Heads Road), at 3.67m at McIntyre Bridge, flood waters are nearing the entrance.	Ten buildings are flooded above floor; **SOUTH GEELONG** x5 BARWON TERRACE (6, 8, 10, 10B, 12-98), Rowing Club buildings. X4 GRAVEL PITS ROAD (26,28-30, 40, 42), industrial sheds. **BELMONT** 162 BARRABOOL ROAD	Barrabool Road depth 1.33m Promenade depth 0.84m Gravel Pits Road depth 0.64m Marnock Road depth 0.29m	In addition to actions listed above; **Victoria Police** evacuate Balyang Sanctuary, Barwon Valley Golf Club, Balyang Golf Club, Landy Athletics Field, Barwon Valley Activity Centre and the Belmont Wildlife Reserve and Wetland area. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads at Promenade, Barrabool Road, Gravel Pits Road and Marnock Road and others, and undertake traffic management as needed.
3.60		2001					
3.68	28,100	2011 4.5 year flood					
3.80	31,100	1983					
4.22	42,595	10	22 (18)	An additional eight buildings are flooded above floor including the Council Ops Depot (135 Barwon Heads Road), Barwon River Holiday Caravan Park (153-163 Barrabool Road), My Car Tyre and Auto Centre (65 Barwon Heads Road), Geelong Canoe Clubrooms (11 Marnock Street) and buildings in Gravel Pits Road, Barwon Terrace, Barrabool Road and Barwon Heads Road. Deep flooding cuts access to the Barwon Heads Road and Barwon Terrace.	8 additional buildings are flooded above floor; **SOUTH GEELONG** X3 GRAVEL PITS ROAD (32, 42), 29 BARWON TERRACE (Norris Construction Group and other industrial buildings) **BELMONT** 163 BARRABOOL RD (Barwon River Caravan Park), 65 BARWON HEADS ROAD (My Car Tyre and Auto), 135 BARWON HEADS ROAD (Council Ops Depot), 65 HIGH STREET. **NEWTOWN** 11 MARNOCK STREET (Geelong Canoe Club)	Barrabool Road depth 1.86m Promenade depth 1.47m Barwon Heads Road depth 0.34m Gravel Pits Road depth 1.07m Barwon Tce depth 0.37m Marnock Road depth 0.91m	In addition to actions listed above; **Victoria Police** evacuate Barwon River Holiday Caravan Park, Geelong Canoe Clubrooms, Council Ops Depot and other buildings impacted. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads at Barwon Heads Road and Barwon Terrace,and undertake traffic management as needed.
4.30		Major					
4.55	54,400	1978					
4.52	59,962	20 year flood 1909	47 (35)	An additional 17 buildings are flooded above floor. Deep flooding impacts the South of Barwon Valley Park in Belmont, Barrabool Street is overtopped: the Riverglen Holiday Park (75 Barrabool Road) and City Southside Caravan Park (97 Barrabool Road), are partially inundated. Barwon River Holiday Caravan Park and the Geelong Lawn Tennis Club in Belmont are flooded. Deep flooding occurs along Swanston Street and Factories Road, as well as through Barwon Terrace to Wood Street. Impacted properties include: commercial buildings on both sides of Factories Road are flooded and additional industrial buildings in Barwon Terrace, Gravel Pits Road. The Commercial area in Belmont is entirely flooding including an additional building at the Council Ops Depot (135 Barwon Heads Road).	17 additional buildings are flooded above floor; **SOUTH GEELONG** x9 GRAVEL PITS ROAD (8-10 (and Boots 4 All), 9, 12 (Grants Auto Dismantlers), 14, 16, 21, 36-38 (O'Malley Fitness)), 3 FACTORIES ROAD, 76-78 BARWON TERRACE Vic Joinery Suppliers. **BELMONT** x2 BARWON HEADS ROAD (88-92 (Geelong Boating Centre),135 (Council Ops Depot)).	Barrabool Road depth 2.42m Promenade depth 2.07m Barwon Heads Road depth 0.53m Gravel Pits Road depth 1.45m Barwon Tce depth 0.68m Marnock Road depth 1.38m	In addition to actions listed above; **Victoria Police** evacuate Riverglen Holiday Park, City Southside Caravan Park, Barwon River Holiday Caravan Park, and other buildings as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads and undertake traffic management as needed.

5.32	90,288	50	113 (101)	An additional 66 buildings are flooded above floor including Riverglen Holiday Park (75 Barrabool Road), City Southside Caravan Park (97 Barrabool Road), Barwon River Holiday Park (153 Barrabool Road), EP Robinson industrial sheds in Bridge Street, Surf Coast Racquets (16 Sommers Street), Geelong Lawn Tennis Clubrooms (18 Sommers Street), Falcon Signs industrial sheds (313 Bellerine Street), Belmont Petstock (150 Barwon Heads Road), PFD Food Service (138 Barwon Heads Road), John Deere (8 Breakwater Road). Additional houses are flooded in Bellerine Street, Barwon Terrace, Swanston Street, Barwon Heads Road, Sommers Street, and Barrabool Road. In Newtown, the car park of the Barwon Edge Boat House Bistro (40 Windsor Road) is flooded.	66 additional buildings are flooded above floor; **NEWTOWN** x5 BRIDGE STREET (13 EP Robinson industrial sheds). **SOUTH GEELONG** x22 BELLERINE STREET (313 (Falcon Signs industrial sheds)), x8 BARWON TERRACE (31, 72-74, 80, 82, 86), x8 GRAVEL PITS ROAD (3, 6, 8-10, 18, 20-22, 23), x6 SWANSTON STREET (212-216, 221, 231) industrial sheds, x2 FACTORIES ROAD (1-5, 5), 42 LITTLE FYANS STREET. **BELMONT** x3 BARWON HEADS ROAD (138 (PFD Food Service), 140 (B&B Aluminium), 150 (Belmont Petstock)), x3 SOMMERS STREET (16 (Surf Coast Racquets), 18 (Geelong Lawn Tennis Club)), x2 BARRABOOL ROAD (75-85 (Riverglen Holiday Park), 97 (City Southside Caravan Park), 153 (Barwon River Holiday Park)), x3 CURTIS STREET (2, 4, 6-8) (industrial sheds next to Belmont Shopping Centre), 18 SOMMERS STREET, 8 BREAKWATER ROAD (John Deer industrial shed).	Barrabool Road depth 2.42m Promenade depth 2.45m Barwon Heads Road depth 0.53m Gravel Pits Road depth 1.45m Barwon Tce depth 0.89m Marnock Road depth 1.38m	In addition to actions listed above; **Victoria Police** evacuate Barwon Edge Boat House Bistro and other buildings as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads and undertake traffic management as needed.
5.23	97,900	1995					
5.47	116,000	1952					
5.94	118,109	100	176 (138)	37 additional buildings are flooded above floor including Discovery Park Geelong Caravan Park (59 Barrabool Road), Barwon Valley Lodge Motel (99 Barrabool Road), Barwon River Holiday Caravan Park (153-163 Barrabool Road), Barwon Edge Boat House Bistro (40 Windsor Road), Newtown City Hockey Clubrooms and Murgheboluc Cricket Clubrooms (80 Windsor Road) and the King Lloyd Recreation Reserve Oval and the Wizard Car Wash (153 Barrabool Road). Additional houses are flooded in Balcombe Road, Riverside Road, Barrabool Road, Shannon Avenue, Sommers Street and Mt Pleasant Road. Deep flooding cuts access to Breakwater Road, Shannon Avenue, High Street and Balcombe Road.	37 additional buildings are flooded above floor; **NEWTOWN** x5 BALCOMBE ROAD (1A, 20, 38, 1/44, 2/44), x3 MARNOCK ROAD (11, 19-33), x2 BRIDGE STREET (13), x2 WINDSOR ROAD (40-70 (Barwon Edge Boat House Bistro), 80 (Newtown City Hockey Clubrooms and Murgheboluc Cricket Clubrooms)). **SOUTH GEELONG** x3 BELLERINE STREET (313), 5 FACTORIES ROAD, 18 WOOD STREET. **BELMONT** x10 BARRABOOL ROAD (53, 59 (Discovery Caravan Park), 99-121 (Barwon Valley Lodge Motel), 153-163 (Barwon River Holiday Caravan Park), x3 BREAKWATER ROAD (2, 4-6, 10), x2 HIGH STREET (1-3, 6), 1 MT PLEASANT ROAD, 3 RIVERGLEN COURT, 84 BARWON HEADS ROAD, 2 GLENBRAE COURT, 2 CURTIS STREET, 11 SOMMERS STREET. **WAURN PONDS** 160 WAURN PONDS DRIVE	Barrabool Road depth 3.97m Promenade depth 3.65m Breakwater Road depth 0.87m Barwon Heads Road depth 1.63m Gravel Pits Road depth 2.58m Barwon Tce depth 2.0m High Street depth 0.83m Balcombe Road depth 1.01m Shannon Avenue depth 0.35m Marnock Road depth 3.25m	In addition to actions listed above; **Victoria Police** evacuate Discovery Park Geelong Caravan Park, Barwon Valley Lodge Hotel, Newtown City Hockey Clubrooms and Murgheboluc Cricket Clubrooms and other buildings as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads at Breakwater Road, Shannon Avenue, High Street, Balcombe Road and others, and undertake traffic management as needed.
6.61	146,880	200	311 (237)	99 additional buildings may be flooded above floor including the Bupa Aged Care Home (55-57 Barrabool Road), Newtown Medical Centre (2 Balcombe Road), Discovery Park Geelong Caravan Park (59 Barrabool Road), Barwon Edge Boat House Bistro (40 Windsor Road), the Victory Faith Centre (313 Bellerine Street), Belmont Shopping Village Sushi & Dumpling House (65 High Street) and Geelong RSL (54 Barwon Heads Road). Additional houses are flooded above floor in Balcombe Road, Sandringham Parade, Buckingham Road, Braemar Court, Frank Street, Sommers Street, Clyde Street, Guthridge Street, Hurst Street and Whitton Street. A levee has been constructed around the Little Creatures and White Rabbit Breweries (221 Swanston Street), if the levee holds these buildings are not likely to be impacted by flooding. The levee protection level for these buildings is estimated to be to a 200 year event (if the levee fails they will be flooded during a 20 year flood event). The Discovery Park in Belmont is entirely impacted by floodwater.	99 additional buildings are flooded above floor; **NEWTOWN** x22 BALCOMBE ROAD (1, 2-10 (Medical Centre), 3, 5, 7, 15, 17, 26, 28, 30, 32, 34, 36, 40, 42, 66, 1/70, 2/70, 3/70, 4/70, 76, 78), x11 BRAEMAR COURT (1, 3, 2, 4, 12, 14, 15, 16, 17, 18, 19), x10 SANDRINGHAM PARADE (26, 27, 28, 29, 30, 31, 33, 3/34, 4/34), x6 BUCKINGHAM ROAD (2/31, 3/31, 4/31, 5/31, 33, 2/33), 39 GAIRLOCH GROVE, 40-70 WINDSOR ROAD (Barwon Edge Boat House Bistro), 16 GLAMIS STREET. **BELMONT** x9 BARWON HEADS ROAD (50-54, 54 (Geelong RSL), 56, 56-58, 58), x8 BARRABOOL ROAD (47, 49, 51A, 51A, 55-57 (Bupa Aged Care Home), 57, 59), x3 RIVERGLEN COURT (1, 2, 4), x2 MAXWELL AVENUE (2, 4A), x2 BATMAN CLOSE (1/10, 2/10), x2 ALBERT TERRACE (22, 3/24), x2 HIGH STREET (13B/65 (Belmont Village Shopping Centre Sushi & Dumpling House)), 2B FRANCIS STREET, 1 FRANK STREET, 3-7 CURTIS STREET, 5 SOMMERS STREET, 18 CLYDE STREET. **SOUTH GEELONG** x5 BARWON TERRACE (1-9, 70, 81, 99), x2 BELLERINE STREET (313 (Victory Faith Centre)), x2 GRAVEL PITS ROAD (2, 4), x2 WOOD STREET (57), 221 SWANSTON STREET, 5 FACTORIES ROAD, x4 SWANSTON STREET (221) Little Creatures and White Rabbit Breweries (estimated protection level up to a 200 year flood). **WAURN PONDS** 19 GUTHRIDGE STREET, 17 HURST STREET, 12 WHITTON STREET.	Barrabool Road depth 4.66m Promenade depth 4.40m Breakwater Road depth 1.51m Barwon Heads Road depth 2.17m Gravel Pits Road depth 3.13m Barwon Tce depth 2.54m High Street depth 1.40m Balcombe Road depth 1.69m Shannon Avenue depth 1.27m Marnock Road depth 4.06m	In addition to actions listed above; **Victoria Police** evacuate the Bupa Aged Care Home, Newtown Medical Centre, Victory Faith Centre, Belmont Shopping Village Sushi & Dumpling House, the Little Creatures and While Rabbit Breweries and Geelong RSL and other buildings as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads and undertake traffic management as needed.
7.48	195,696	500	421 (347)	110 additional buildings are flooded above floor including Barwon Health Renal Services (38 Little Fyans Street), City Southside Caravan Park (97 Barrabool Road), Belmont Village Shopping Centre TAB (65 High Street) and the Geelong Gymnasium (21 Mitchell Street). Additional houses are flooded above floor in Glamis Street, Albert Terrace, Riverglen Court, Gairloch Grove, Clyde Street, Crown Street, Curtis Street, Ewing Blyth Drive, Francis Street, Batman Close, Sommers Street, Maxwell Avenue and Barwon Boulevard.	110 additional buildings are flooded above floor (refer to the Property inundation table and building damages maps for building locations).	Barrabool Road depth 5.61m Promenade depth 5.38m Breakwater Road depth 2.22m Barwon Heads Road depth 2.93m Gravel Pits Road depth 3.90m Barwon Tce depth 3.28m High Street depth 2.15m Balcombe Road depth 2.79m Shannon Avenue depth 2.39m Marnock Road depth 5.21m	In addition to actions listed above; **Victoria Police** evacuate Barwon Health Renal Services, Belmont Village Shopping Centre TAB and other buildings as needed. **VICSES** sandbag buildings and assist to protect assets as needed. **Vic Roads** and **Council** deploy road signs to close roads and undertake traffic management as needed.

Table 25. Geelong Flood Intelligence Card (Breakwater Road to Wilson Road)

Flood travel time	Time from start of rainfall in the upper Barwon River catchment to steep rise in floodwater at Geelong 1.5 - 2.3 days Time from start of rainfall in the upper Moorabool River catchment to steep rise in floodwater at the Moorabool River/Barwon River confluence (at Fyansford) 23 - 40 hours Time from start of rainfall in the upper Leigh (Yarrowee) River catchment to steep rise in floodwater at the Leigh River/Barwon River confluence at Inverleigh 22 - 36 hours Riverine flooding duration: 4 to 6 days

Barwon River at Pollocksford gauge height 233200 (m)	Barwon River at McIntyre Bridge Geelong gauge height 233217 (m)	Barwon River at Geelong Design Flows (ML/d)	Annual Exceedance Probability (1 in year)	Geelong damages between Queens Pk and Breakwater Rd total number properties flooded (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Road flood depth (m)	Action
3.50	2.30		Minor		Flooding starts to impact the Barrabool Road, Breakwater Road Causeway and Steel Street access track. Flooding starts to impact the Queens Park Golf Course.			**VICSES** activate ground observers to take photos and record flood levels at key locations. **Council** clear debris from waterway crossings, drains and culverts as needed.
	2.51	10,627	2	1 (1)	Only very localised out of bank flooding. One building is flooded above floor, the Geelong Water Ski Clubrooms at 493 Wilsons Road (anecdotal information suggests this building has been raised and may not be impacted above floor), St Albans Park. Deep flooding may cut access to Gundog Lane and Boundary Road, depth may be greater than 0.30m. Shallow flooding starts to overtop Wilsons Road, depth 0.12m.	One building may be flooded above floor; **ST ALBANS PARK** Geelong Water Ski Clubrooms at 493 WILSONS ROAD (may not be impacted above floor).	Gundog Lane depth 0.29m Barwon Heads Road depth 0m Wilsons Road depth 0.12m Boundary Road depth 0.28m Tannery Road depth 0m Harriott Road depth 0m Lake Road depth 0m	In addition to actions listed above; **VICSES** and **Victoria Police** evacuate and sandbag the Geelong Water Ski Clubrooms as needed. **Council** and **Vic Roads** deploy road signs to close Gundog Lane and Boundary Road,and undertake traffic management as needed.
4.50	3.10		Moderate					**Barwon Water** staff provide updates regarding the Lal Lal Reservoir storage level and potential spill risk. **Barwon Water** staff check assets to ensure they are operational, request VICSES to assist with asset protection as needed, provide updates to the ICC.
	3.28	19,284	2016					
	3.52	26,957	5	2 (2)	One additional building may be flooded above floor, the Belmont Dog Obedience Clubrooms at 47 Gundog Lane, Belmont. Deep flooding may cut access to Wilsons Road and Lake Road, depth greater than 0.4m.	One additional building may be flooded above floor; **BELMONT** Dog Obedience Clubrooms at 47 GUNDOG LANE.	Gundog Lane depth 0.98m Barwon Heads Road depth 0m Wilsons Road depth 0.42m Boundary Road depth 0.69m Tannery Road depth 0m Harriott Road depth 0m Lake Road depth 0.50m	In addition to actions listed above; **VICSES** and **Victoria Police** evacuate and sandbag the Belmont Dog Obedience Clubrooms as needed. **Council** and **Vic Roads** deploy road signs to close Wilsons Road and Lake Road, and undertake traffic management as needed.
5.28	3.60		2001					
6.09	3.68	28,100	2011 4.5 year flood					
	3.80	31,100	1983					
	4.22	42,595	10	7 (5)	An additional three buildings may be flooded above floor at the South Barwon Reserve, these include the South Barwon Cricket Clubrooms and Barwon Valley Activity Centre.	3 additional buildings may be flooded above floor; **BELMONT** South Barwon Cricket Clubrooms and Barwon Valley Activity Centre at the South Barwon Reserve, 169 BARWON HEADS ROAD BELMONT.	Gundog Lane depth 1.46m Barwon Heads Road depth 0m Wilsons Road depth 0.63m Boundary Road depth 1.06m Tannery Road depth 0m Harriott Road depth 0m Lake Road depth 0.83m	In addition to actions listed above; **VICSES** and **Victoria Police** evacuate and sandbag the Belmont South Barwon Cricket Clubrooms and the Barwon Valley Activity Centre as needed.
6.50	4.30		Major					
	4.55	54,400	1978					
	4.52	59,962	20 year flood 1909	9 (7)	An additional two buildings may be flooded above floor including two public toilet blocks at the South Barwon Reserve, 169 Barwon Heads Road Belmont. Deep flooding impacts all five ovals at the South Barwon Reserve	2 additional buildings may be flooded above floor; **BELMONT** Two toilet blocks at the South Barwon Reserve, 169 BARWON HEADS ROAD BELMONT	Gundog Lane depth 1.87m Barwon Heads Road depth 0.37m Wilsons Road depth 0.90m Boundary Road depth 1.40m Tannery Road depth 0m Harriott Road depth 0m Lake Road depth 1.06m	**VICSES** sandbag the South Barwon Reserve toilet blocks as needed.
	5.32	90,288	50	15 (13)	An additional six buildings may be flooded above floor including the South Barwon Cricket Clubrooms (169 Barwon Heads Road Belmont), and five houses. Deep flooding may cut access to Harriott Road, depth greater than 1m.	6 additional buildings may be flooded above floor; **BELMONT** South Barwon Cricket Clubrooms (169 Barwon Heads Road Belmont) **MARSHALL** 243-259 BARWON HEADS ROAD, 2 NORCOTTE ROAD. **CHARLEMONT** 31-39 TANNERY ROAD, 97 HARRIOTT ROAD	Gundog Lane depth 1.87m Barwon Heads Road depth 0.37m Wilsons Road depth 0.90m Boundary Road depth 1.40m Tannery Road depth 0m Harriott Road depth 1.18m Lake Road depth 1.10m	**VICSES** and **Victoria Police** evacuate and sandbag the South Barwon Cricket Clubrooms and houses as needed. **Council** deploy road signs to close Harriott Road, and undertake traffic management as needed.
9.05	5.23	97,900	1995					
	5.47	116,000	1952					
	5.94	118,109	100	34 (27)	14 additional buildings may be flooded above floor including the Belmont Mitre 10 (156-160 Barwon Heads Road).	14 additional buildings may be flooded above floor;	Gundog Lane depth 2.91m Barwon Heads Road depth 1.43m Wilsons Road depth 1.33m	**VICSES** and **Victoria Police** evacuate and sandbag the 14 additional buildings as needed.

						BELMONT: x4 BARWON HEADS ROAD (154-178, 156-160, 170, 172), x3 TEGWEN STREET (4, 5, 8), 2 CURTIS STREET, 1 PARK STREET, 2 FRANK STREET, 2 HIGH STREET. **MARSHALL**: 261-279 BARWON HEADS ROAD **SOUTH GEELONG:**25 BARWON TERRACE **CONNEWARRE:**573-593 LAKE ROAD	Boundary Road depth 2.37m Tannery Road depth 0m Harriott Road depth 1.47m Lake Road depth 1.76m	
	6.61	146,880	200	53 (40)	13 additional buildings may be flooded above floor including the Japara Nursing Home (355 Wilsons Road At Albans Park).	13 additional buildings may be flooded above floor; **BELMONT:** x2 TEGWEN STREET (2, 2A), 1/33 CROWS ROAD, 2 OBERON DRIVE, 6 PARK STREET. **ST ALBANS PARK:** x6 WILSONS ROAD (345, 347, 349, 351, 353A, 355-361 (Japara Nursing Home)). **CHARLEMONT:** 135 HARRIOTT ROAD.	Gundog Lane depth 3.62m Barwon Heads Road depth 2.04m Wilsons Road depth 1.53m Boundary Road depth 2.82m Tannery Road depth 0.06m Harriott Road depth 1.78m Lake Road depth 2.12m	**VICSES** and **Victoria Police** evacuate and sandbag the Japara Nursing Home at 355 Wilsons Road St Albans Park, in addition to 12 houses impacted by flooding above floor as needed.
	7.48	195,696	500	74 (69)	29 additional buildings may be flooded above floor mostly including houses in Marshall, St Albans Park, Connewarre, Breakwater and Charlemont. Deep flooding may cut Tannery Road, depth greater than 0.6m.	69 additional buildings may be flooded above floor.	Gundog Lane depth 4.27m Barwon Heads Road depth 2.83m Wilsons Road depth 1.91m Boundary Road depth 3.46m Tannery Road depth 0.60m Harriott Road depth 2.24m Lake Road depth 2.63m	**VICSES** and **Victoria Police** evacuate and sandbag the 29 additional houses impacted by flooding above floor as needed.

Table 26. Geelong (upstream of Queens Park) Property Inundation Table

Colours used in the table below are the same used in the Geelong flood risk maps above. Blue, buildings flooded above floor in a 1 in 10 year AEP. Orange, buildings flooded above floor in a 1 in 20 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)						Building Type
		10	20	50	100	200	500	
1	150B QUEENS PARK ROAD HIGHTON	0.26	1.08	2.32	3.2	3.983	5.096	Geelong Amateurs Football and Netball Club shed
2	150B QUEENS PARK ROAD HIGHTON		0.75	1.99	2.9	3.653	4.769	Geelong Amateurs Football and Netball Club shed
3	150B QUEENS PARK ROAD HIGHTON		0.13	1.37	2.3	3.032	4.145	Geelong Amateurs Football and Netball Club Clubrooms
4	150A QUEENS PARK ROAD HIGHTON			0.53	1.4	2.186	3.301	Queens Park Golf Club & Kiosk
5	4 THE PARADE FYANSFORD				0.8	1.551	2.688	Fibro Cement Sheet
6	12-14 THE PARADE FYANSFORD				0.7	1.447	2.586	Fibro Cement Sheet
7	195 MERRAWARP ROAD CERES				0.5	1.204	2.083	Shed
8	45 LOWER PAPER MILLS ROAD FYANSFORD				0.4	0.471	1.601	Weatherboard
9	55 LOWER PAPER MILLS ROAD FYANSFORD				0.3	0.32	1.448	Weatherboard
10	48 LOWER PAPER MILLS ROAD FYANSFORD					1.291	2.218	Shed
11	46 LOWER PAPER MILLS ROAD FYANSFORD					1.263	2.19	Shed
12	50 LOWER PAPER MILLS ROAD FYANSFORD					1.26	2.143	Shed
13	70 LOWER PAPER MILLS ROAD FYANSFORD					0.98	1.735	Weatherboard
14	42 LOWER PAPER MILLS ROAD FYANSFORD					0.977	1.963	Shed
15	42 LOWER PAPER MILLS ROAD FYANSFORD					0.752	1.738	Shed
16	50 LOWER PAPER MILLS ROAD FYANSFORD					0.294	1.319	Brick Veneer Standard
17	52 LOWER PAPER MILLS ROAD FYANSFORD					0.221	1.255	Brick Veneer Standard
18	48 LOWER PAPER MILLS ROAD FYANSFORD					0.179	1.225	Brick Veneer Standard
19	46 LOWER PAPER MILLS ROAD FYANSFORD					0.178	1.243	Brick Veneer Standard
20	42 LOWER PAPER MILLS ROAD FYANSFORD					0.133	1.219	Brick Veneer Period
21	44 LOWER PAPER MILLS ROAD FYANSFORD					0.124	1.197	Brick Veneer Standard
22	150 QUEENS PARK ROAD HIGHTON					0.085	1.198	Queens Park Golf Clubrooms
23	55 LOWER PAPER MILLS ROAD FYANSFORD						0.789	Shed
24	1/62-64 HYLAND STREET FYANSFORD						0.558	Shop
25	150B QUEENS PARK ROAD HIGHTON						0.548	Geelong Amateurs Football and Netball Club shed
26	1/62-64 HYLAND STREET FYANSFORD						0.505	Shop
27	150B QUEENS PARK ROAD HIGHTON						0.446	Geelong Amateurs Football and Netball Club Clubrooms
28	66 HYLAND STREET FYANSFORD						0.391	Reception Centre
29	67 HYLAND STREET FYANSFORD						0.265	Fyansford Hotel
30	150B QUEENS PARK ROAD HIGHTON						0.206	Geelong Amateurs Football and Netball Club shed

Table 27. Geelong (between Queens Park to Breakwater Road) Property Inundation Table

Colours used in the table below are the same used in the Geelong flood risk maps above. Yellow, buildings flooded above floor in a 1 in 5 year AEP. Blue, buildings flooded above floor in a 1 in 10 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)							Building Type
		5	10	20	50	100	200	500	
1	40 GRAVEL PITS ROAD SOUTH GEELONG	0.509	0.933	1.313	1.924	2.455	3.013	3.78	Metal Factory
2	10B BARWON TERRACE SOUTH GEELONG	0.472	0.898	1.3	1.923	2.447	2.985	3.719	Rowing Clubhouse
3	6 BARWON TERRACE SOUTH GEELONG	0.443	0.873	1.284	1.911	2.446	2.979	3.713	Rowing Clubhouse
4	10 BARWON TERRACE SOUTH GEELONG	0.323	0.751	1.156	1.782	2.307	2.847	3.58	Rowing Clubhouse
5	42 GRAVEL PITS ROAD SOUTH GEELONG	0.209	0.628	1.009	1.623	2.148	2.704	3.47	
6	28-30 GRAVEL PITS ROAD SOUTH GEELONG	0.124	0.548	0.928	1.539	2.075	2.63	3.387	
7	162 BARRABOOL ROAD BELMONT	0.052	0.456	0.888	1.599	2.181	2.754	3.514	Belmont Park Pavilion
8	8 BARWON TERRACE SOUTH GEELONG	0.04	0.47	0.879	1.508	2.036	2.572	3.302	Rowing Clubhouse
9	26 GRAVEL PITS ROAD SOUTH GEELONG	0.035	0.433	0.811	1.424	1.953	2.505	3.272	
10	12-98 BARWON TERRACE SOUTH GEELONG	0.02	0.441	0.838	1.454	1.973	2.508	3.242	Rowing Clubhouse
11	42 GRAVEL PITS ROAD SOUTH GEELONG		0.49	0.871	1.482	2.009	2.567	3.333	
12	163 BARRABOOL RD BELMONT		0.428	1.578	2.296	2.882	3.458	4.227	Barwon Caravan & Tourist Park
13	29 BARWON TERRACE SOUTH GEELONG		0.412	0.809	1.428	1.942	2.48	3.213	Concrete Block Factory
14	11 MARNOCK ROAD NEWTOWN		0.265	0.955	2.013	2.827	3.65	4.794	Geelong Canoe Club
15	32 GRAVEL PITS ROAD SOUTH GEELONG		0.211	0.593	1.204	1.737	2.292	3.056	Construction Group
16	135 BARWON HEADS ROAD BELMONT		0.039	0.598	1.189	1.678	2.226	2.99	City of Greater Geelong Council Belmont Depot Office
17	42 GRAVEL PITS ROAD SOUTH GEELONG		0.029	0.41	1.021	1.549	2.107	2.873	Metal Factory
18	65 HIGH STREET BELMONT		0.02	0.131	0.381	0.884	1.614	2.393	MyCar Tyre & Auto
19	221 SWANSTON STREET SOUTH GEELONG			2.755	3.408	3.927	4.471	5.216	Little Creatures Brewery Geelong
20	135 BARWON HEADS ROAD BELMONT			0.466	1.055	1.539	2.087	2.849	
21	9 GRAVEL PITS ROAD SOUTH GEELONG			0.414	1.087	1.625	2.182	2.933	
22	88-92 BARWON HEADS ROAD BELMONT			0.326	0.922	1.422	1.966	2.722	
23	12 GRAVEL PITS ROAD SOUTH GEELONG			0.281	0.922	1.46	2.017	2.767	
24	16 GRAVEL PITS ROAD SOUTH GEELONG			0.23	0.867	1.405	1.961	2.712	
25	21 GRAVEL PITS ROAD SOUTH GEELONG			0.229	0.83	1.352	1.898	2.658	
26	3 FACTORIES ROAD SOUTH GEELONG			0.213	0.863	1.379	1.921	2.66	
27	221 SWANSTON STREET SOUTH GEELONG			0.148	0.803	1.321	1.865	2.607	
28	14-16 GRAVEL PITS ROAD SOUTH GEELONG			0.134	0.777	1.315	1.872	2.623	
29	8-10 GRAVEL PITS ROAD SOUTH GEELONG			0.129	0.751	1.288	1.843	2.593	
30	16 GRAVEL PITS ROAD SOUTH GEELONG			0.12	0.759	1.297	1.853	2.604	
31	16 GRAVEL PITS ROAD SOUTH GEELONG			0.115	0.758	1.296	1.852	2.603	
32	221 SWANSTON STREET SOUTH GEELONG			0.111	0.764	1.283	1.826	2.571	
33	76-78 BARWON TERRACE SOUTH GEELONG			0.105	0.749	1.287	1.844	2.596	
34	221 SWANSTON STREET SOUTH GEELONG			0.072	0.727	1.246	1.789	2.526	

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)							Building Type
		5	10	20	50	100	200	500	
35	36-38 GRAVEL PITS ROAD SOUTH GEELONG			0.016	0.628	1.158	1.716	2.483	
36	221 SWANSTON STREET SOUTH GEELONG				1.629	2.15	2.692	3.433	
37	42 LITTLE FYANS STREET SOUTH GEELONG				1.452	1.971	2.509	3.244	
38	82 BARWON TERRACE SOUTH GEELONG				0.967	1.505	2.063	2.814	
39	13 BRIDGE STREET NEWTOWN (GEELONG)				0.952	1.778	2.604	3.744	
40	13 BRIDGE STREET NEWTOWN (GEELONG)				0.912	1.727	2.561	3.703	
41	13 BRIDGE STREET NEWTOWN (GEELONG)				0.87	1.694	2.523	3.664	
42	13 BRIDGE STREET NEWTOWN (GEELONG)				0.865	1.687	2.513	3.653	
43	13 BRIDGE STREET NEWTOWN (GEELONG)				0.772	1.597	2.423	3.564	
44	86 BARWON TERRACE SOUTH GEELONG				0.725	1.263	1.821	2.572	
45	82 BARWON TERRACE SOUTH GEELONG				0.68	1.218	1.775	2.527	
46	80 BARWON TERRACE SOUTH GEELONG				0.583	1.122	1.679	2.431	
47	18 GRAVEL PITS ROAD SOUTH GEELONG				0.536	1.072	1.626	2.38	
48	1-5 FACTORIES ROAD SOUTH GEELONG				0.51	1.027	1.568	2.307	
49	8-10 GRAVEL PITS ROAD SOUTH GEELONG				0.506	1.043	1.598	2.348	
50	20-22 GRAVEL PITS ROAD SOUTH GEELONG				0.502	1.037	1.592	2.347	
51	97 BARRABOOL ROAD BELMONT				0.486	1.213	1.926	2.928	
52	72-74 BARWON TERRACE SOUTH GEELONG				0.485	1.022	1.579	2.333	
53	153 BARRABOOL RD BELMONT				0.455	1.044	1.606	2.362	
54	313 BELLERINE STREET SOUTH GEELONG				0.425	0.94	1.479	2.209	
55	6-8 CURTIS STREET BELMONT				0.406	0.905	1.451	2.206	Metal Factory
56	8-10 GRAVEL PITS ROAD SOUTH GEELONG				0.392	0.928	1.483	2.233	Boots 4 All
57	221 SWANSTON STREET SOUTH GEELONG				0.372	0.892	1.435	2.179	Little Creatures Brewery
58	231 SWANSTON STREET SOUTH GEELONG				0.37	0.887	1.429	2.166	
59	231 SWANSTON STREET SOUTH GEELONG				0.357	0.875	1.417	2.154	
60	18 SOMMERS STREET BELMONT				0.339	0.926	1.488	2.235	Geelong Lawn Tennis Clubrooms
61	3 GRAVEL PITS ROAD SOUTH GEELONG				0.336	0.875	1.431	2.184	Metal Factory
62	313 BELLERINE STREET SOUTH GEELONG				0.331	0.846	1.384	2.114	
63	8-10 GRAVEL PITS ROAD SOUTH GEELONG				0.299	0.837	1.393	2.143	Metal Factory
64	313 BELLERINE STREET SOUTH GEELONG				0.298	0.815	1.356	2.093	Falcon Signs
65	313 BELLERINE STREET SOUTH GEELONG				0.284	0.796	1.336	2.074	Falcon Signs
66	313 BELLERINE STREET SOUTH GEELONG				0.269	0.781	1.322	2.057	Falcon Signs
67	313 BELLERINE STREET SOUTH GEELONG				0.267	0.782	1.317	2.047	
68	313 BELLERINE STREET SOUTH GEELONG				0.263	0.777	1.317	2.057	Falcon Signs
69	313 BELLERINE STREET SOUTH GEELONG				0.261	0.77	1.303	2.033	
70	313 BELLERINE STREET SOUTH GEELONG				0.255	0.77	1.311	2.044	Falcon Signs
71	18 SOMMERS STREET BELMONT				0.247	0.834	1.396	2.144	Geelong Lawn Tennis Clubrooms
72	212-216 SWANSTON STREET SOUTH GEELONG				0.238	0.753	1.293	2.032	Geelong Community Nursery
73	313 BELLERINE STREET SOUTH GEELONG				0.237	0.75	1.29	2.026	Falcon Signs

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)							Building Type
		5	10	20	50	100	200	500	
74	212-216 SWANSTON STREET SOUTH GEELONG				0.231	0.747	1.287	2.027	Geelong Community Nursery
75	313 BELLERINE STREET SOUTH GEELONG				0.214	0.726	1.266	2.004	Falcon Signs
76	313 BELLERINE STREET SOUTH GEELONG				0.213	0.725	1.266	2.001	Falcon Signs
77	6 GRAVEL PITS ROAD SOUTH GEELONG				0.212	0.751	1.307	2.057	Calco Trusses & Timber
78	313 BELLERINE STREET SOUTH GEELONG				0.188	0.703	1.242	1.972	
79	75-85 BARRABOOL ROAD BELMONT				0.176	0.904	1.62	2.627	Riverglen Holiday Park Caravan Park
80	313 BELLERINE STREET SOUTH GEELONG				0.173	0.685	1.225	1.96	Falcon Signs
81	5 FACTORIES ROAD SOUTH GEELONG				0.168	0.684	1.227	1.969	
82	313 BELLERINE STREET SOUTH GEELONG				0.161	0.674	1.214	1.944	
83	31 BARWON TERRACE SOUTH GEELONG				0.153	0.671	1.208	1.941	Concrete Block Factory
84	75-85 BARRABOOL ROAD BELMONT				0.144	0.866	1.583	2.584	Riverglen Holiday Park Caravan Park
85	150 BARWON HEADS ROAD BELMONT				0.132	0.601	1.149	1.918	Petstock Belmont
86	313 BELLERINE STREET SOUTH GEELONG				0.117	0.63	1.165	1.899	
87	16 SOMMERS STREET BELMONT				0.112	0.699	1.263	2.009	Gymnasium - Single Storey
88	313 BELLERINE STREET SOUTH GEELONG				0.112	0.627	1.167	1.906	Falcon Signs
89	313 BELLERINE STREET SOUTH GEELONG				0.098	0.613	1.153	1.893	Falcon Signs
90	2-4 CURTIS STREET BELMONT				0.09	0.595	1.138	1.89	
91	4 CURTIS STREET BELMONT				0.085	0.579	1.126	1.883	Metal Factory
92	18 SOMMERS STREET BELMONT				0.072	0.66	1.219	1.968	Geelong Lawn Tennis Club Shed
93	150 BARWON HEADS ROAD BELMONT				0.054	0.53	1.076	1.844	Petstock Belmont
94	313 BELLERINE STREET SOUTH GEELONG				0.045	0.56	1.093	1.827	
95	8 BREAKWATER ROAD BELMONT				0.037	0.58	1.141	1.918	Brick Factory
96	138 BARWON HEADS ROAD BELMONT				0.025	0.512	1.06	1.822	Metal Factory
97	313 BELLERINE STREET SOUTH GEELONG				0.022	0.536	1.07	1.804	
98	313 BELLERINE STREET SOUTH GEELONG				0.017	0.532	1.072	1.812	Falcon Signs
99	23 GRAVEL PITS ROAD SOUTH GEELONG				0.013	0.549	1.106	1.856	
100	313 BELLERINE STREET SOUTH GEELONG				0.012	0.525	1.061	1.795	
101	140 BARWON HEADS ROAD BELMONT				0.003	0.484	1.031	1.796	Metal Factory
102	40-70 WINDSOR ROAD NEWTOWN					0.815	1.499	2.543	Ground Shop
103	1/44 BALCOMBE ROAD NEWTOWN					0.642	1.319	2.387	Brick Veneer Unit
104	2/44 BALCOMBE ROAD NEWTOWN					0.636	1.313	2.38	Brick Veneer Unit
105	18 WOOD STREET SOUTH GEELONG					0.557	1.115	1.864	A/C Sheet / Fibro Cement Sheet
106	153 BARRABOOL RD BELMONT					0.51	1.067	1.823	Barwon River Holiday Park
107	13 BRIDGE STREET NEWTOWN					0.504	1.332	2.471	EP Robinson PTY LTD
108	84 BARWON HEADS ROAD BELMONT					0.497	1.033	1.787	Metal Factory
109	313 BELLERINE STREET SOUTH GEELONG					0.482	1.023	1.755	Falcon Signs
110	20 BALCOMBE ROAD NEWTOWN					0.459	1.133	2.212	Brick Veneer Standard
111	2 GLENBRAE COURT BELMONT					0.446	0.985	1.739	Metal Factory
112	2 CURTIS STREET BELMONT					0.419	0.968	1.727	
113	11 SOMMERS STREET BELMONT					0.403	0.963	1.712	Brick Veneer Standard
114	19-33 MARNOCK ROAD NEWTOWN					0.398	1.224	2.356	Balyang Golf Clubhouse
115	4-6 BREAKWATER ROAD BELMONT					0.398	0.959	1.734	
116	11 MARNOCK ROAD NEWTOWN					0.352	1.174	2.32	Community Rec Centre
117	163 BARRABOOL RD BELMONT					0.33	0.89	1.639	Barwon Caravan & Tourist Park
118	313 BELLERINE STREET SOUTH GEELONG					0.294	0.829	1.563	

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		5	10	20	50	100	200	500	
119	1A BALCOMBE ROAD NEWTOWN					0.282	0.821	1.569	
120	10 BREAKWATER ROAD BELMONT					0.261	0.818	1.592	Metal Factory
121	13 BRIDGE STREET NEWTOWN					0.26	1.09	2.229	EP Robinson PTY LTD
122	6 HIGH STREET BELMONT					0.255	0.921	1.696	Wizard Car Wash
123	1-3 HIGH STREET BELMONT					0.252	0.822	1.575	Lewis Tyerpower Geelong
124	2 BREAKWATER ROAD BELMONT					0.247	0.809	1.586	
125	53 BARRABOOL ROAD BELMONT					0.214	0.929	1.934	Brick Veneer Standard
126	99-121 BARRABOOL ROAD BELMONT					0.202	0.92	1.914	Barwon Valley Lodge Motel
127	313 BELLERINE STREET SOUTH GEELONG					0.189	0.724	1.459	
128	1 MT PLEASANT ROAD BELMONT					0.18	0.914	1.687	Brick Veneer Standard
129	99-121 BARRABOOL ROAD BELMONT					0.156	0.873	1.873	Barwon Valley Lodge Motel
130	99-121 BARRABOOL ROAD BELMONT					0.148	0.864	1.869	Barwon Valley Lodge Motel
131	5 FACTORIES ROAD SOUTH GEELONG					0.125	0.67	1.412	
132	160 WAURN PONDS DRIVE WAURN PONDS					0.121	0.675	1.426	Brick Veneer Standard
133	99-121 BARRABOOL ROAD BELMONT					0.119	0.832	1.836	Motel - Medium
134	59 BARRABOOL ROAD BELMONT					0.111	0.814	1.807	Discovery Parks Geelong Caravan Park
135	38 BALCOMBE ROAD NEWTOWN					0.098	0.777	1.852	Brick Veneer Standard
136	80 WINDSOR ROAD NEWTOWN					0.052	0.736	1.808	Newtown City Hockey Club
137	59 BARRABOOL ROAD BELMONT					0.038	0.746	1.739	Discovery Parks Geelong Caravan Park
138	3 RIVERGLEN COURT BELMONT					0.005	0.717	1.714	Brick Veneer Standard
139	42 BALCOMBE ROAD NEWTOWN						0.668	1.737	Brick Veneer Standard
140	59 BARRABOOL ROAD BELMONT						0.638	1.63	Discovery Parks Geelong Caravan Park
141	5 BALCOMBE ROAD NEWTOWN						0.612	1.69	Brick Veneer Standard
142	26 BALCOMBE ROAD NEWTOWN						0.603	1.682	Brick Veneer Standard
143	28 BALCOMBE ROAD NEWTOWN						0.603	1.681	Brick Veneer Standard
144	2 RIVERGLEN COURT BELMONT						0.597	1.594	Brick Veneer Standard
145	19 BRAEMAR COURT NEWTOWN						0.596	1.676	Brick Veneer Standard
146	36 BALCOMBE ROAD NEWTOWN						0.595	1.671	Brick Veneer Standard
147	59 BARRABOOL ROAD BELMONT						0.581	1.583	Discovery Parks Geelong Caravan Park
148	51A BARRABOOL ROAD BELMONT						0.577	1.578	Weatherboard
149	40 BALCOMBE ROAD NEWTOWN						0.575	1.647	Brick Veneer Standard
150	32 BALCOMBE ROAD NEWTOWN						0.566	1.643	Brick Veneer Standard
151	30 BALCOMBE ROAD NEWTOWN						0.549	1.627	Brick Veneer Standard
152	1 FRANK STREET BELMONT						0.539	1.286	Brick Veneer Standard
153	5 FACTORIES ROAD SOUTH GEELONG						0.528	1.271	
154	1 RIVERGLEN COURT BELMONT						0.522	1.52	Brick Veneer Standard
155	3-7 CURTIS STREET BELMONT						0.52	1.269	
156	27 SANDRINGHAM PARADE NEWTOWN						0.519	1.597	Brick Veneer Standard
157	49 BARRABOOL ROAD BELMONT						0.518	1.516	Brick Veneer Standard
158	16 BRAEMAR COURT NEWTOWN						0.49	1.566	Brick Veneer Standard
159	51B BARRABOOL ROAD BELMONT						0.49	1.493	Weatherboard
160	313 BELLERINE STREET SOUTH GEELONG						0.482	1.213	
161	4 BRAEMAR COURT NEWTOWN						0.477	1.554	Brick Veneer Standard
162	55-57 BARRABOOL ROAD BELMONT						0.472	1.47	
163	7 BALCOMBE ROAD NEWTOWN						0.471	1.55	Brick Veneer Standard
164	1 BRAEMAR COURT NEWTOWN						0.466	1.542	Brick Veneer Standard
165	14 BRAEMAR COURT NEWTOWN						0.464	1.541	Brick Veneer Standard
166	19 BARWON HEADS ROAD BELMONT						0.459	1.232	Brick Veneer Standard
167	18 BRAEMAR COURT NEWTOWN						0.45	1.529	Brick Veneer Standard
168	26 SANDRINGHAM PARADE NEWTOWN						0.45	1.525	Brick Veneer Standard

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		5	10	20	50	100	200	500	
169	5 SOMMERS STREET BELMONT						0.436	1.186	Weatherboard
170	70 BARWON TERRACE SOUTH GEELONG						0.434	1.177	Calco Trusses & Timber
171	54 BARWON HEADS ROAD BELMONT						0.429	1.205	Geelong RSL
172	4 RIVERGLEN COURT BELMONT						0.428	1.417	Weatherboard
173	28 SANDRINGHAM PARADE NEWTOWN						0.417	1.493	Brick Veneer Standard
174	15 BRAEMAR COURT NEWTOWN						0.416	1.492	Brick Veneer Standard
175	57 BARRABOOL ROAD BELMONT						0.416	1.41	Bupa Aged Care Centre Barrabool
176	13B/65 HIGH STREET BELMONT						0.414	1.19	Sushi & Dumpling House
177	34 BALCOMBE ROAD NEWTOWN						0.413	1.49	Brick Veneer Standard
178	2/31 BUCKINGHAM ROAD NEWTOWN						0.409	1.484	Flats Western Suburbs
179	17 BRAEMAR COURT NEWTOWN						0.408	1.486	Brick Veneer Standard
180	3 BALCOMBE ROAD NEWTOWN						0.406	1.482	Brick Veneer Standard
181	5/31 BUCKINGHAM ROAD NEWTOWN						0.395	1.471	Flats Western Suburbs
182	3/31 BUCKINGHAM ROAD NEWTOWN						0.386	1.462	Flats Western Suburbs
183	16 GLAMIS STREET NEWTOWN						0.381	1.408	Brick Veneer Standard
184	4/31 BUCKINGHAM ROAD NEWTOWN						0.376	1.452	Flats Western Suburbs
185	22 ALBERT TERRACE BELMONT						0.374	1.37	Brick Veneer Standard
186	2 BRAEMAR COURT NEWTOWN						0.368	1.445	Brick Veneer Standard
187	54 BARWON HEADS ROAD BELMONT						0.368	1.142	Geelong RSL
188	70 BARWON TERRACE SOUTH GEELONG						0.367	1.12	Calco Trusses & Timber
189	2-10 BALCOMBE ROAD NEWTOWN						0.366	1.455	Medical Centre / Vet / Dentist
190	58 BARWON HEADS ROAD BELMONT						0.365	1.14	Secondary School
191	30 SANDRINGHAM PARADE NEWTOWN						0.358	1.433	Brick Veneer Standard
192	2/10 BATMAN CLOSE BELMONT						0.347	1.121	
193	56-58 BARWON HEADS ROAD BELMONT						0.342	1.116	Secondary School
194	56-58 BARWON HEADS ROAD BELMONT						0.314	1.089	Secondary School
195	4A MAXWELL AVENUE BELMONT						0.308	1.047	
196	1 BALCOMBE ROAD NEWTOWN						0.301	1.378	Brick Veneer Standard
197	3 BRAEMAR COURT NEWTOWN						0.288	1.365	Brick Veneer Standard
198	4 GRAVEL PITS ROAD SOUTH GEELONG						0.268	1.011	Calco Trusses & Timber
199	50-54 BARWON HEADS ROAD BELMONT						0.241	1.013	
200	81 BARWON TERRACE SOUTH GEELONG						0.225	0.976	Tilt Slab Factory
201	66 BALCOMBE ROAD NEWTOWN						0.204	1.222	Brick Veneer Standard
202	33 BUCKINGHAM ROAD NEWTOWN						0.198	1.271	Brick Veneer Standard
203	221 SWANSTON STREET SOUTH GEELONG						0.196	0.934	Brick Factory
204	29 SANDRINGHAM PARADE NEWTOWN						0.194	1.271	Brick Veneer Standard
205	1/10 BATMAN CLOSE BELMONT						0.179	0.954	
206	4/70 BALCOMBE ROAD NEWTOWN						0.176	1.199	
207	17 FRANK STREET SOUTH GEELONG						0.162	0.91	Weatherboard
208	56-58 BARWON HEADS ROAD BELMONT						0.158	0.933	Secondary School
209	1/70 BALCOMBE ROAD NEWTOWN						0.155	1.177	
210	2 GRAVEL PITS ROAD SOUTH GEELONG						0.155	0.898	Calco Trusses & Timber
211	12 BALCOMBE ROAD NEWTOWN						0.141	1.226	Brick Veneer Standard
212	4/34 SANDRINGHAM PARADE NEWTOWN						0.138	1.211	Brick Veneer Unit
213	17 BALCOMBE ROAD NEWTOWN						0.136	1.16	Brick Veneer Standard
214	3/70 BALCOMBE ROAD NEWTOWN						0.135	1.158	
215	2/70 BALCOMBE ROAD NEWTOWN						0.135	1.158	
216	2B FRANCIS STREET BELMONT						0.131	0.893	Flats Southern Suburbs
217	3/34 SANDRINGHAM PARADE NEWTOWN						0.128	1.202	

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		5	10	20	50	100	200	500	
218	15 BALCOMBE ROAD NEWTOWN						0.126	1.173	Brick Veneer Standard
219	2/33 BUCKINGHAM ROAD NEWTOWN						0.125	1.2	Brick Veneer Standard
220	1-9 BARWON TERRACE SOUTH GEELONG						0.117	0.844	Tilt Slab Factory
221	56-58 BARWON HEADS ROAD BELMONT						0.104	0.879	Secondary School
222	57 WOOD STREET SOUTH GEELONG						0.101	0.852	Metal Factory
223	39 GAIRLOCH GROVE NEWTOWN						0.099	1.114	Brick Veneer Standard
224	40-70 WINDSOR ROAD NEWTOWN						0.092	1.139	Barwon Edge Boat House
225	13B/65 HIGH STREET BELMONT						0.084	0.859	Sushi & Dumpling House
226	57 WOOD STREET SOUTH GEELONG						0.071	0.821	
227	3/24 ALBERT TERRACE BELMONT						0.069	1.059	Brick Veneer Unit
228	99 BARWON TERRACE SOUTH GEELONG						0.062	0.806	Metal Factory
229	12 BRAEMAR COURT NEWTOWN						0.061	1.14	Brick Veneer Standard
230	56 BARWON HEADS ROAD BELMONT						0.058	0.833	Secondary School
231	33 SANDRINGHAM PARADE NEWTOWN						0.056	1.131	Brick Veneer Standard
232	31 SANDRINGHAM PARADE NEWTOWN						0.055	1.132	Brick Veneer Standard
233	47 BARRABOOL ROAD BELMONT						0.037	1.021	Brick Veneer Standard
234	78 BALCOMBE ROAD NEWTOWN						0.014	1.039	Weatherboard
235	2 MAXWELL AVENUE BELMONT						0.012	0.761	Weatherboard
236	313 BELLERINE STREET SOUTH GEELONG						0.008	0.743	Metal Factory
237	76 BALCOMBE ROAD NEWTOWN						0.001	1.027	Brick Veneer Standard
238	23 GAIRLOCH GROVE NEWTOWN							3.044	Brick Veneer Standard
239	6/10 BATMAN CLOSE BELMONT							2.009	Flats Southern Suburbs
240	11 BRAEMAR COURT NEWTOWN							1.068	Brick Veneer Standard
241	32 SANDRINGHAM PARADE NEWTOWN							1.065	Brick Veneer Standard
242	2/34 SANDRINGHAM PARADE NEWTOWN							1.031	
243	5 BRIDGE STREET NEWTOWN							1.022	Concrete Block Factory
244	1/34 SANDRINGHAM PARADE NEWTOWN							1.021	Brick Veneer Unit
245	6/70 BALCOMBE ROAD NEWTOWN							0.999	
246	19 BALCOMBE ROAD NEWTOWN							0.991	Brick Veneer Standard
247	5/70 BALCOMBE ROAD NEWTOWN							0.99	
248	12 GLAMIS STREET NEWTOWN							0.989	Brick Veneer Standard
249	72 BALCOMBE ROAD NEWTOWN							0.978	A/C Sheet / Fibro Cement Sheet
250	5 BRAEMAR COURT NEWTOWN							0.975	Brick Veneer Standard
251	17 GLAMIS STREET NEWTOWN							0.973	Weatherboard
252	20 ALBERT TERRACE BELMONT							0.947	Weatherboard
253	74 BALCOMBE ROAD NEWTOWN							0.938	Brick Veneer Standard
254	4/13-15 GLAMIS STREET NEWTOWN							0.916	Brick Veneer Unit
255	2/35 BUCKINGHAM ROAD NEWTOWN							0.889	
256	45 BARRABOOL ROAD BELMONT							0.854	Brick Veneer Standard
257	3/13-15 GLAMIS STREET NEWTOWN							0.852	Brick Veneer Unit
258	15 RIVERGLEN COURT BELMONT							0.847	Weatherboard
259	10 BRAEMAR COURT NEWTOWN							0.839	Brick Veneer Standard
260	2/13-15 GLAMIS STREET NEWTOWN							0.832	Brick Veneer Unit
261	117 CAMDEN ROAD NEWTOWN							0.828	Brick Veneer Standard
262	13 BRAEMAR COURT NEWTOWN							0.804	Brick Veneer Standard
263	36 SANDRINGHAM PARADE NEWTOWN							0.798	Brick Veneer Standard
264	35 SANDRINGHAM PARADE NEWTOWN							0.797	Brick Veneer Standard
265	1/13-15 GLAMIS STREET NEWTOWN							0.795	Brick Veneer Unit
266	41 GAIRLOCH GROVE NEWTOWN							0.79	Brick Veneer Standard
267	33 GAIRLOCH GROVE NEWTOWN							0.772	A/C Sheet / Fibro Cement Sheet
268	68 BALCOMBE ROAD NEWTOWN							0.766	Brick Veneer Standard

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		5	10	20	50	100	200	500	
269	37 GAIRLOCH GROVE NEWTOWN							0.758	Brick Veneer Standard
270	89 BARWON TERRACE SOUTH GEELONG							0.746	Metal Factory
271	14 GLAMIS STREET NEWTOWN							0.739	Brick Veneer Standard
272	5/13-15 GLAMIS STREET NEWTOWN							0.736	Brick Veneer Unit
273	100 BARWON TERRACE SOUTH GEELONG							0.733	Tilt Slab Factory
274	62-70 BARWON TERRACE SOUTH GEELONG							0.729	Metal Factory
275	11-13 GRAVEL PITS ROAD SOUTH GEELONG							0.729	Metal Factory
276	5/13-15 CROWN STREET SOUTH GEELONG							0.719	Tilt Slab Factory
277	35 GAIRLOCH GROVE NEWTOWN							0.717	Weatherboard
278	14 RIVERGLEN COURT BELMONT 3216							0.709	Brick Veneer Standard
279	11 GLAMIS STREET NEWTOWN							0.707	Weatherboard
280	7/100 BARWON TERRACE SOUTH GEELONG							0.688	Tilt Slab Factory
281	56-58 BARWON HEADS ROAD BELMONT							0.687	Secondary School
282	2/24 ALBERT TERRACE BELMONT							0.684	Brick Veneer Unit
283	18A CLYDE STREET BELMONT							0.681	Weatherboard
284	6/13-15 GLAMIS STREET NEWTOWN							0.677	Brick Veneer Unit
285	29 GAIRLOCH GROVE NEWTOWN							0.676	Brick Veneer Standard
286	17A CROWN STREET SOUTH GEELONG							0.674	Concrete Block Factory
287	82 BALCOMBE ROAD NEWTOWN							0.657	Brick Veneer Standard
288	75 SANDRINGHAM PARADE NEWTOWN							0.656	Brick Veneer Standard
289	105 BARWON TERRACE SOUTH GEELONG							0.639	Metal Factory
290	21-25 MITCHELL STREET BELMONT							0.634	Gymnasium - Single Storey
291	6/13-15 CROWN STREET SOUTH GEELONG							0.633	Tilt Slab Factory
292	75 BARWON TERRACE SOUTH GEELONG							0.627	Metal Factory
293	77 BARWON TERRACE SOUTH GEELONG							0.621	Metal Factory
294	12 CROWN STREET SOUTH GEELONG 3220							0.616	Metal Factory
295	10 GLAMIS STREET NEWTOWN							0.614	Brick Veneer Standard
296	75 BARWON TERRACE SOUTH GEELONG							0.606	
297	31 GAIRLOCH GROVE NEWTOWN							0.592	Weatherboard
298	80 BALCOMBE ROAD NEWTOWN							0.588	Weatherboard
299	2A FRANCIS STREET BELMONT							0.584	Brick Veneer Standard
300	5/100 BARWON TERRACE SOUTH GEELONG							0.579	
301	4/13-15 CROWN STREET SOUTH GEELONG							0.576	
302	73 SANDRINGHAM PARADE NEWTOWN							0.57	Weatherboard
303	1/100 BARWON TERRACE SOUTH GEELONG							0.568	Tilt Slab Factory
304	97 BARWON TERRACE SOUTH GEELONG							0.566	Metal Factory
305	2/100 BARWON TERRACE SOUTH GEELONG							0.564	
306	86-90 BARWON TERRACE SOUTH GEELONG							0.562	Metal Factory
307	6/100 BARWON TERRACE SOUTH GEELONG							0.561	Tilt Slab Factory
308	3A BARWON BOULEVARD HIGHTON							0.56	Brick Veneer Standard
309	92-96 BARWON TERRACE SOUTH GEELONG							0.547	Metal Factory
310	12 EWING BLYTH DRIVE BARWON HEADS							0.545	Brick Veneer Standard
311	52-60 WOOD STREET SOUTH GEELONG							0.536	Metal Factory
312	2/1 CURTIS STREET BELMONT							0.514	Tilt Slab Factory
313	3/13-15 CROWN STREET SOUTH GEELONG							0.507	
314	3/100 BARWON TERRACE SOUTH GEELONG							0.505	

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)							Building Type
		5	10	20	50	100	200	500	
315	18 ALBERT TERRACE BELMONT							0.491	Brick Veneer Standard
316	30 WOOD STREET SOUTH GEELONG							0.491	Metal Factory
317	4/100 BARWON TERRACE SOUTH GEELONG							0.486	
318	28 WOOD STREET SOUTH GEELONG							0.479	MG Campers and Caravans Geelong
319	16 CROWN STREET SOUTH GEELONG							0.47	Tilt Slab Factory
320	1 CURTIS STREET BELMONT							0.464	Tilt Slab Factory
321	38 LITTLE FYANS STREET SOUTH GEELONG							0.451	Barwon Health Renal Services
322	1/35 BUCKINGHAM ROAD NEWTOWN							0.451	
323	79 BARWON TERRACE SOUTH GEELONG							0.449	Metal Factory
324	17B CROWN STREET SOUTH GEELONG							0.44	Concrete Block Factory
325	12/65 HIGH STREET BELMONT							0.43	TAB
326	1/24 ALBERT TERRACE BELMONT							0.43	Brick Veneer Unit
327	28 WOOD STREET SOUTH GEELONG							0.375	Metal Factory
328	3/10 BATMAN CLOSE BELMONT							0.307	
329	97 BARRABOOL ROAD BELMONT							0.299	City Southside Caravan Park
330	46 BALCOMBE ROAD NEWTOWN							0.287	Brick Veneer Standard
331	22 WOOD STREET SOUTH GEELONG							0.284	Metal Factory
332	40 LITTLE FYANS STREET SOUTH GEELONG							0.283	Barwon Health Renal Services
333	1-3/83 BARWON TERRACE SOUTH GEELONG							0.227	Barry Medew Building Supplies
334	1-3/83 BARWON TERRACE SOUTH GEELONG							0.225	Barry Medew Building Supplies
335	2B FRANCIS STREET BELMONT							0.224	
336	4B/10 BATMAN CLOSE BELMONT							0.199	
337	4/10 BATMAN CLOSE BELMONT							0.182	
338	4-10 SOMMERS STREET BELMONT							0.173	Clubhouse - Standard
339	1A BARWON BOULEVARD HIGHTON							0.159	Brick Veneer Standard
340	27 GAIRLOCH GROVE NEWTOWN							0.105	Brick Veneer Standard
341	12/65 HIGH STREET BELMONT VIC							0.098	TAB
342	75-85 BARRABOOL ROAD BELMONT							0.094	
343	9 BARWON BOULEVARD HIGHTON							0.073	Brick Veneer Standard
344	4A MAXWELL AVENUE BELMONT							0.072	Metal Factory
345	5/10 BATMAN CLOSE BELMONT							0.068	Flats Southern Suburbs
346	5 RIVERGLEN COURT BELMONT							0.047	Brick Veneer Standard
347	13 BARWON BOULEVARD HIGHTON							0.003	Brick Veneer Standard

Table 28. Geelong (downstream of Breakwater Road) Property Inundation Table

Colours used in the table below are the same used in the Geelong flood risk maps above. Blue, buildings flooded above floor in a 1 in 2 year AEP. Yellow, buildings flooded above floor iin a 1 in 5 year AEP flood event,

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)								Building Type
		2	5	10	20	50	100	200	500	
1	493 WILSONS ROAD ST ALBANS PARK	0.19	0.52	0.75	0.97	1.23	1.42	1.61	2.00	Brick Geelong Water Ski Clubrooms
2	47 GUNDOG LANE BELMONT		0.39	0.87	1.30	1.94	2.49	3.06	3.84	Belmont Dog Obedience Club
3	26-76 GUNDOG LANE BELMONT			0.51	0.93	1.57	2.12	2.69	3.48	Barwon Valley Activity Centre
4	169 BARWON HEADS ROAD BELMONT			0.28	0.71	1.36	1.91	2.48	3.27	South Barwon Cricket Club
5	169 BARWON HEADS ROAD BELMONT			0.14	0.56	1.21	1.76	2.34	3.12	South Barwon Reserve oval shed
6	169 BARWON HEADS ROAD BELMONT				0.10	0.74	1.29	1.86	2.65	South Barwon Reserve toilets
7	169 BARWON HEADS ROAD BELMONT				0.07	0.72	1.27	1.85	2.64	South Barwon Reserve Toilets
8	169 BARWON HEADS ROAD BELMONT					0.35	0.89	1.47	2.25	South Barwon Cricket Club
9	169 BARWON HEADS ROAD BELMONT					0.23	0.78	1.36	2.14	South Barwon Cricket Club
10	243-259 BARWON HEADS ROAD MARSHALL					0.21	0.75	1.31	2.06	Brick Veneer
11	31-39 TANNERY ROAD CHARLEMONT					0.14	0.59	1.07	1.75	Brick Veneer
12	97 HARRIOTT ROAD CHARLEMONT					0.11	0.52	0.83	1.32	Brick Veneer
13	2 NORCOTT ROAD MARSHALL					0.02	0.45	0.91	1.59	Weatherboard
14	2 HIGH STREET BELMONT						0.54	1.11	1.90	Service Station
15	170 BARWON HEADS ROAD BELMONT						0.49	1.07	1.86	Shed
16	172 BARWON HEADS ROAD BELMONT						0.45	1.02	1.81	Shed
17	261-279 BARWON HEADS ROAD MARSHALL						0.46	1.02	1.76	Brick Veneer
18	154-178 BARWON HEADS ROAD BELMONT						0.39	0.96	1.75	
19	156-160 BARWON HEADS ROAD BELMONT						0.39	0.96	1.74	Belmont Mitre 10
20	25 BARWON TERRACE SOUTH GEELONG						0.41	0.88	1.56	
21	8 TEGWEN STREET BELMONT						0.29	0.87	1.65	Metal Factory
22	5 TEGWEN STREET BELMONT						0.25	0.81	1.59	Metal Factory
23	2 CURTIS STREET BELMONT						0.17	0.73	1.51	Metal Factory
24	1 PARK STREET BELMONT						0.15	0.72	1.50	Brick Veneer
25	2 FRANK STREET BELMONT						0.12	0.69	1.48	Metal Factory
26	4 TEGWEN STREET BELMONT						0.11	0.68	1.47	Metal Factory
27	573-593 LAKE ROAD CONNEWARRE						0.21	0.57	1.08	Shed
28	6 PARK STREET BELMONT							0.47	1.25	Brick Factory
29	2 TEGWEN STREET BELMONT							0.41	1.19	Concrete Block Factory
30	1/33 CROWS ROAD BELMONT							0.34	1.12	Mercedes Mechanic
31	1/33 CROWS ROAD BELMONT							0.31	1.09	Mercedes Mechanic
32	351 WILSONS ROAD ST ALBANS PARK							0.26	0.88	Brick Veneer
33	355-361 WILSONS ROAD ST ALBANS PARK							0.18	0.79	Japara Roccoco Nursing Home
34	2A TEGWEN STREET BELMONT							0.18	0.97	
35	347 WILSONS ROAD ST ALBANS PARK							0.16	0.79	Brick Veneer
36	2 OBERON DRIVE BELMONT							0.13	0.91	Metal Factory
37	353A WILSONS ROAD ST ALBANS PARK							0.13	0.75	Brick Veneer
38	135 HARRIOTT ROAD CHARLEMONT							0.12	0.61	Brick Veneer
39	345 WILSONS ROAD ST ALBANS PARK							0.12	0.75	Brick Veneer
40	349 WILSONS ROAD ST ALBANS PARK							0.10	0.73	Brick Veneer
41	343 WILSONS ROAD ST ALBANS PARK								0.63	Brick Veneer
42	341 WILSONS ROAD ST ALBANS PARK								0.61	Brick Veneer
43	239 BARWON HEADS ROAD BELMONT								0.59	Weatherboard
44	39 GRAYLING STREET BELMONT								0.55	
45	8 PARK STREET BELMONT								0.53	Metal Factory
46	1-2 SPERANZA COURT MARSHALL								0.46	Brick Veneer
47	3 TEGWEN STREET BELMONT								0.45	Office Industrial
48	8 SPERANZA COURT MARSHALL								0.42	Brick Veneer
49	21-29 TANNERY ROAD CHARLEMONT								0.40	

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)								Building Type
		2	5	10	20	50	100	200	500	
50	363-365 WILSONS ROAD ST ALBANS PARK								0.40	Brick Veneer
51	7 SPERANZA COURT MARSHALL								0.40	Brick Veneer
52	6 SPERANZA COURT MARSHALL								0.38	Brick Veneer
53	473-519 LAKE ROAD CONNEWARRE								0.36	Weatherboard
54	5 SPERANZA COURT MARSHALL								0.32	Brick Veneer
55	10 SPERANZA COURT MARSHALL								0.30	Brick Veneer
56	6 ALLEGRO COURT MARSHALL								0.26	Brick Veneer
57	282-284 BARWON HEADS ROAD MARSHALL								0.25	Brick Veneer
58	9 SPERANZA COURT MARSHALL								0.25	Brick Veneer
59	11-12 SPERANZA COURT MARSHALL								0.24	Brick Veneer
60	32 MACFARLANE STREET MARSHALL								0.24	Brick Veneer
61	6 LIAM LANE MARSHALL								0.24	Brick Veneer
62	5 LIAM LANE MARSHALL								0.20	Brick Veneer
63	18-20 STATION ROAD MARSHALL								0.18	Brick Veneer
64	3 SPERANZA COURT MARSHALL								0.18	Brick Veneer
65	573-593 LAKE ROAD CONNEWARRE								0.14	Brick Veneer
66	72 LEATHER STREET BREAKWATER								0.14	Metal Factory
67	22 STATION ROAD MARSHALL								0.12	Brick Veneer
68	281-319 BARWON HEADS ROAD CHARLEMONT								0.07	
69	337-339 WILSONS ROAD ST ALBANS PARK								0.02	

Appendix C4: Barwon Heads and Ocean Grove (Barwon River) Flood Emergency Plan

Barwon Heads and Ocean Grove has experienced frequent flooding from the lower Barwon River. The upper reach of Barwon River begins drains the Otway Ranges and flows through Fyansford, Geelong, Lake Connewarre Wetland Reserve, Barwon Heads and Ocean Grove. The catchment area of Barwon River upstream of Barwon Heads and Ocean Grove is approximately 3,844 km^2. Barwon Heads and Ocean Grove is located on the Barwon River Estuary, refer to the map below. The Barwon River receives inflows from the Leigh River and the Moorabool River, among other many other minor tributaries.

The Lake Connewarre Wetland Reserve is made up of a series of large shallow wetlands along the lower Barwon River, 7.5 km upstream of Barwon Heads and Ocean Grove. These Lakes have an approximate storage capacity of approximately 11,000 ML. When the initial water level of the Lake's is low these wetlands have the potential to provide significant flood mitigation downstream by attenuating flows upstream, significantly reducing the flood magnitude for Barwon Heads and Ocean Grove.

The Barwon Heads riverine flood risk is low as long as the Plummer Bank Levee does not fail. The 1952 flood event photos below clearly show the significant building damages that can occur if Plummer Bank Levee fails.

Minor shallow flooding starts to break out of the Barwon River during a 1 in 2 year AEP flood event, impacting the grounds of the Ocean Grove Golf Club. During small flood events (less than 1 in 20 year flood event), flooding is primarily contained within the Barwon River channel through Barwon Heads and Ocean Grove. Two buildings at the Riverview Family Caravan Park are flooded above floor during a 1 in 100 year AEP flood event. Minor and major roads are impacted by flooding within Barwon Heads and Ocean Grove, these include the Riverside Avenue, Whitton Street, Hurst Street, Beaver Street, Peers Crescent, Parker Street, Guthridge Street, Wallington Road, River Parade, Taits Road and Sheepwash Road.

Flooding in Barwon Heads and Ocean Grove along the Barwon River occurs slowly with several days of warning time available. There are four stream gauges along Barwon River, Leigh River and Moorabool River that provides flood warning for Barwon Heads and Ocean Grove, these include Batesford, Shelford, Pollocksford and McIntyre Bridge. Rises in streamflow at Barwon Heads and Ocean Grove can occur within 1 to1.5 days of the flood peak arriving in Geelong at the McIntyre Bridge.

Figure 89. Barwon Heads and Ocean Grove waterways.

Historic flood events

Stream records show that Barwon Heads and Ocean Grove has experienced frequent flood events since the early 1970's, refer to graph below. Significant flood events have occurred in 1952, 1970, 1971, 1973, 1974, 1975, 1976, 1977, 1978, 1983, 1984, 1986, 1992, 1995, 1996, 2001, 2007, 2011 and 2016. The 1952 flood event was the largest flood event on record.

The most recent flood event was in 2016.The Barwon River stream gauges at Geelong and Pollocksford were used to indicate when historic flood events that have occurred in Barwon Heads and Ocean Grove.

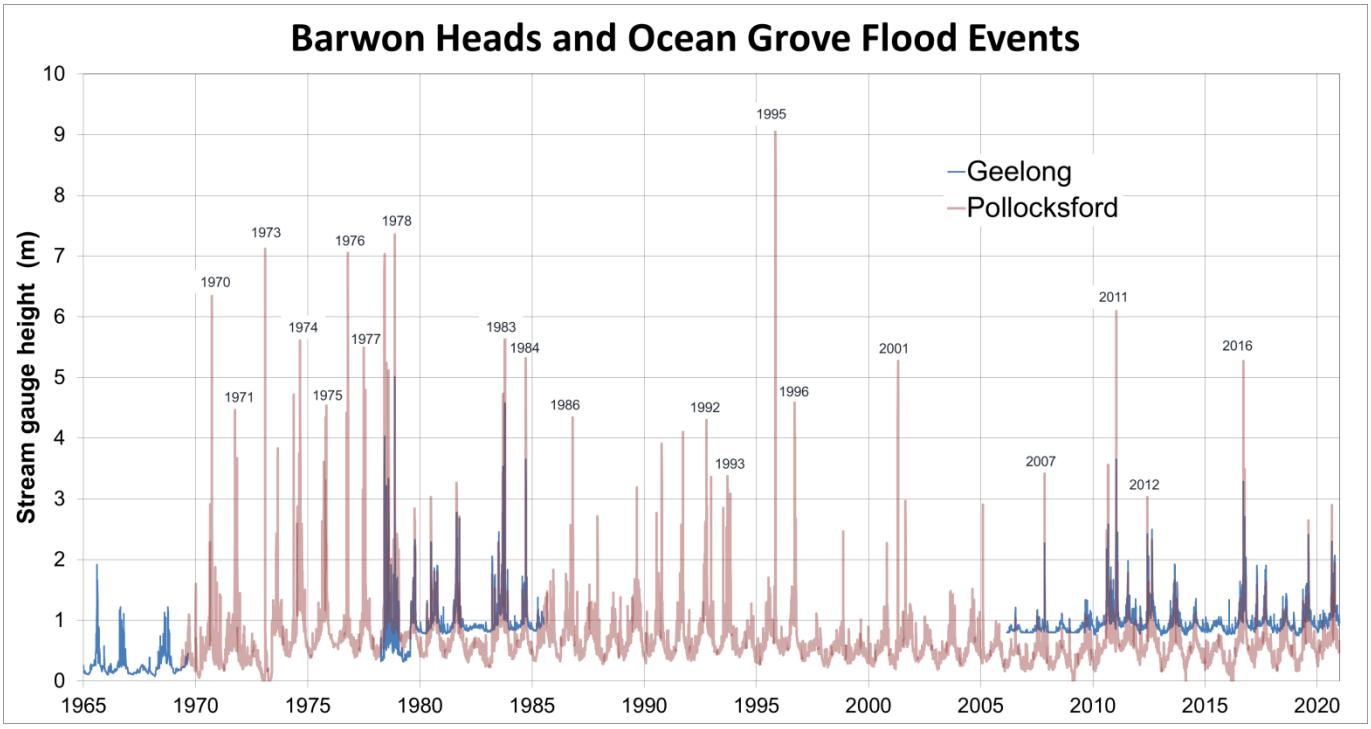


Figure 90. Barwon Heads and Ocean Grove historic flood events.

1952 flood event

The June 1952 flood event was the largest flood event on record, estimated to be between a 1 in 100 and 1 in 200 year AEP event (Water Technology 2018). Upper Barwon River catchment, Beach Forest rainfall gauge recorded 518 mm monthly rainfall in June, with 306 mm over 5 days and 132 mm on the 16th of June.

This flood was described as catastrophic event causing significant building and road damage in Barwon Heads and Ocean Grove, refer to the flood photos below. Hundreds of buildings were flooded in Ocean Grove and Barwon Heads to a depth of up to 1.5 m. This flood event occurred prior to the Plummer Bank Levee being constructed. For more details regarding flood impacts refer to the Barwon Heads and Ocean Grove Flood Intelligence Card below.

Figure 91. Flooding impacting Barwon Heads during the 1952 event (Barwon Heads Heritage Association).


Figure 92. Flooding impacting Hitchcock Avenue, Barwon Heads during the 1952 flood event (Barwon Heads Heritage Association).

Figure 93. Flooding impacting a shop in Barwon Heads during the 1952 event (Barwon Heads Heritage Association).

Figure 94. Flooding impacting Hitchcock Avenue, Barwon Heads during the 1952 flood event (Barwon Heads Heritage Association).

Figure 95. Flooding impacting a shop in Barwon Heads during the 1952 event (Barwon Heads Heritage Association).


Figure 96. Flooding impacting the Ocean Grove Boat Ramp during the 2004 event (COGG 2018).

Figure 97. Flooding impacting Guthridge Street, Ocean Grove during the 2004 event (COGG 2018).

Plummer Bank Levee

The Barwon Heads Plummer Bank Levee was construction after the 1952 flood event. The Plummer Bank Levee is an earthen levee, approximately 1.75 km long and provides significant flood protection to the north of Barwon Heads. Refer to the photo and map below. Flood photos of the 1952 flood event above clearly indicate the substantial damages that can result if the Barwon Heads Plummer Bank Levee fails. The Barwon River Flood Study (Water Technology 2018) indicates that the protection level of the Plummer Bank Levee is approximately greater than a 1 in 500 year AEP event. If the levee fails, flooding may start to impact buildings over floor during a 1 in 20 year flood event, as indicated in the flood extent map below.

During the 1995 flood, the peak flood level height at the Plummer Bank Levee was 2.33 m AHD. The approximate crest height of the Plummer Bank Levee is 4.25 m AHD (COGG 2018).

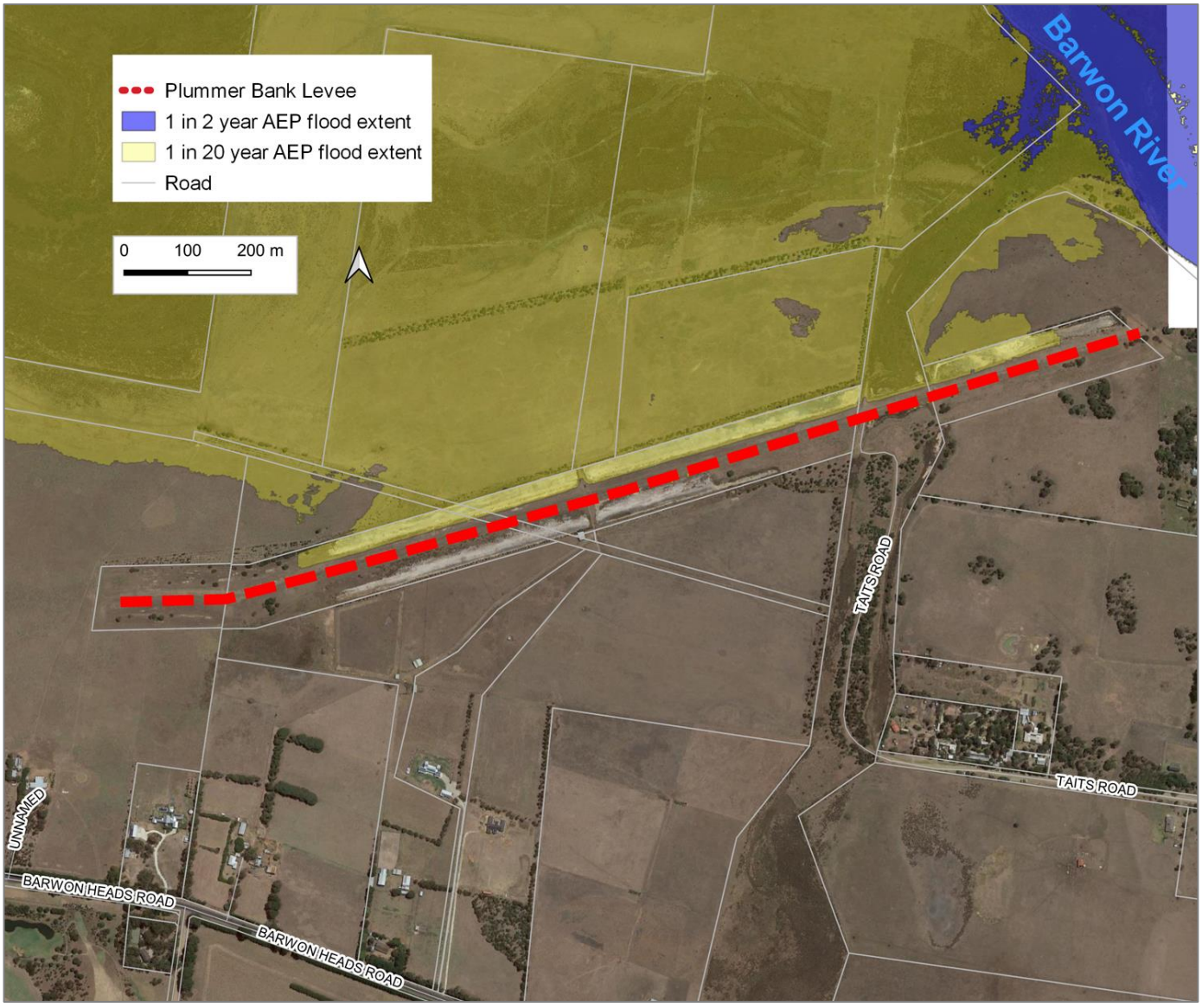


Figure 98. The Plummer Bank Levee, north of Barwon Heads.

Figure 99. The eastern end of the Plummer Bank Levee, north of Barwon Heads.

Stormwater flooding

Barwon Heads and Ocean Grove is particularly susceptible to stormwater flooding. The VICSES and City of Greater Geelong Council Request for Assistance Database records indicate that Barwon Heads and Ocean Grove has experienced frequent stormwater flood events. Building damages were recorded to have occurred during flood events in 2013, 2016, 2017, 2019, September 2020 and October 2020.

The risk of stormwater flooding is greatest when the capacity of the stormwater drainage network is exceeded and the excess water accumulates in the road network, which often then drains to low lying land. Stormwater flooding is often compounded in urban areas that have experienced rapid growth, as has been observed in both Ocean Grove and Barwon Heads. Flooding is compounded due to increased runoff from hard surfaces along ageing and often undersized infrastructure.

The Barwon Heads stormwater flood risk modelling undertaken by WBM (2005) developed a 1 in 100 year AEP flood depth map, refer to the map below. This flood modelling highlights areas that are prone to stormwater flooding, these include;

- Stormwater flooding occurs from the Sheepwash Road pumping station outfall, and may head north/east through residential properties.
- Streets impacted by stormwater include Taits Road, Sheepwash Road, Geelong Road, Ozone Road, Nobel Street, Thorn Street, Heron Crescent, Reid Street, Punt Road, Grove Road, Jasper Avenue and Hitchcock Avenue.
- More than 52 properties may be impacted by stormwater flooding during a 1 in 100 year AEP flood event.

Currently the City of Greater Geelong Council are undertaking a stormwater flood study for Ocean Grove. When this study is completed the results will be incorporated into this Plan.

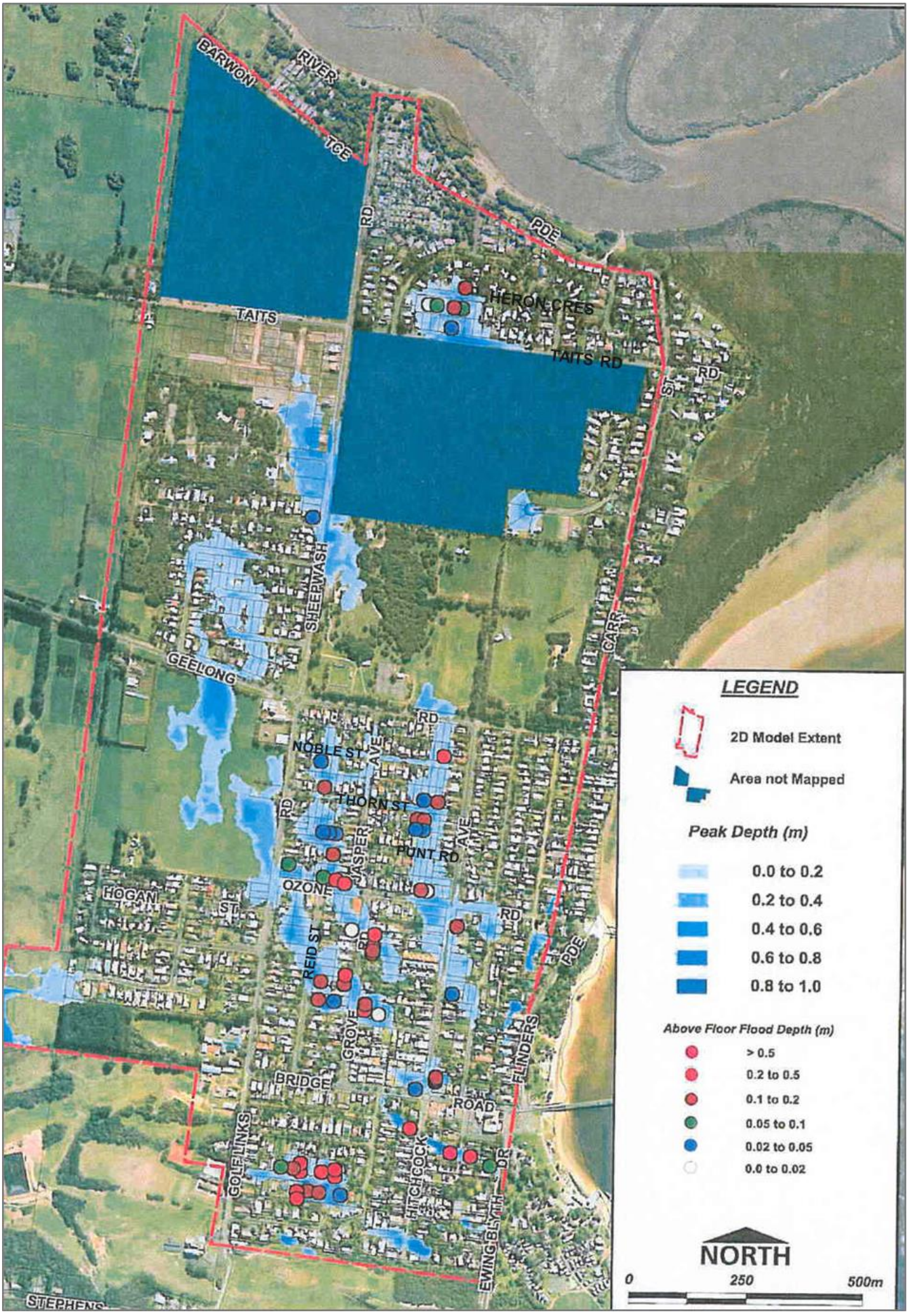


Figure 100. Stormwater flood depth map during a 1 in 100 year AEP event (WBM 2005).

The City of Greater Geelong Council have undertaking substantial stormwater flooding mitigation works in Barwon Heads. These works include installing seven stormwater pumping stations in Barwon Heads;

- Grandview Grove
- Clifford Parade
- Sheepwash Road
- Heron Crescent
- Hampden Close
- Cosham Court
- Sea Bank Estate

If these stormwater pumping stations fail or if their capacity is exceeded, this will cause stormwater flood levels to rise significantly. This occurred during the stormwater flood event on the 8th of February 2002, a power outage prevented six stormwater pumps from operating (COGG 2018).

Influence of Tides

The mouth of the Barwon River remains permanently open during flood events, discharging to Bass Strait. The variation in wave action within Barwon River Estuary is estimated to be up to 1.8m (Water Technology 2018). This was estimated using the Lorne monitoring station, in close proximity to Barwon Heads.

An analysis of the storm tide and storm surge wave height for a range of design events was estimated by Water Technology (2018) as part of the Barwon River flood study, refer to the table below. This analysis used temporal and spatial characteristics of storm tides, analysis of available storm surge and meteorological data at the Lorne monitoring station.

Table 29. Estimated Barwon Heads storm surge and storm tide levels (Water Technology 2018).

Annual Exceedance Probability (1 in year)	Storm Surge (m AHD)	Storm Tide (m AHD)
10	0.84	1.56
20	0.90	1.63
50	0.97	1.73
100	1.02	1.82
200	1.07	1.92

Minor wave action occurs on the Barwon River Estuary during flood events. River heights in the Estuary will vary with the normal tide cycle. The influence of the tide will decrease upstream of the estuary. The peak river height can vary +/- 0.5m upstream of Barwon Heads Bridge to +/- 0.1m at Sheepwash Road (Tony Jones Corangamite CMA).

The highest recorded tide level was 2.1m during the 1926 flood event at the Barwon Heads Bridge.

A high tide level during a storm surge flood event was also 2.1m during the 1978 flood event. Typically, king tides occur in Autumn and produce tide levels of around 1.7m. King tides can be caused by a high tide pushed up by a strong southerly or south westerly wind. The likely impact of a king tide is nuisance flooding along Peers Crescent in Ocean Grove and may also impact Ozone Road, Seaview Avenue, Riverside Terrace and Geelong Road in Barwon Heads.

Flood Warning

Anecdotal information suggests (VICSES Request of Assistance Database) several houses in Barwon Heads and Ocean Grove are impacted by stormwater flooding from localised rainfall. This localised overland flooding occurs quickly with very little warning available, can occur within 3 to 8 hours of rainfall. Monitoring local rainfall gauges will provide an indication of the likelihood of when stormwater flooding may occur.

The Geelong Flood Emergency Plan (COGG 2018) has outlined that the travel time between the McIntyre Bridge gauge and Barwon Heads and Ocean Grove is estimated to be between 1 to 1.5 days.

Table 30. Barwon River flood peak travel times (COGG 2018).

Geelong Flood Class Level	Flood Peak Travel time between Geelong and Barwon Heads
Minor Flood Level 2.5 m	36 hours (1.5 days)
Moderate Flood Level 3.10 m	30 hours (1.25 days)
Major Flood Level 4.3 m	24 hours (1 day)

The duration of flooding in Barwon Heads and Ocean Grove can last between 3 to 5 days. The flood duration was estimated using historic flood events measured in Geelong at the McIntyre Bridge stream gauge. Refer to the August 2018 flood event showing the flood duration was approximately 4 days. It's expected that the duration of larger flood events will be longer.

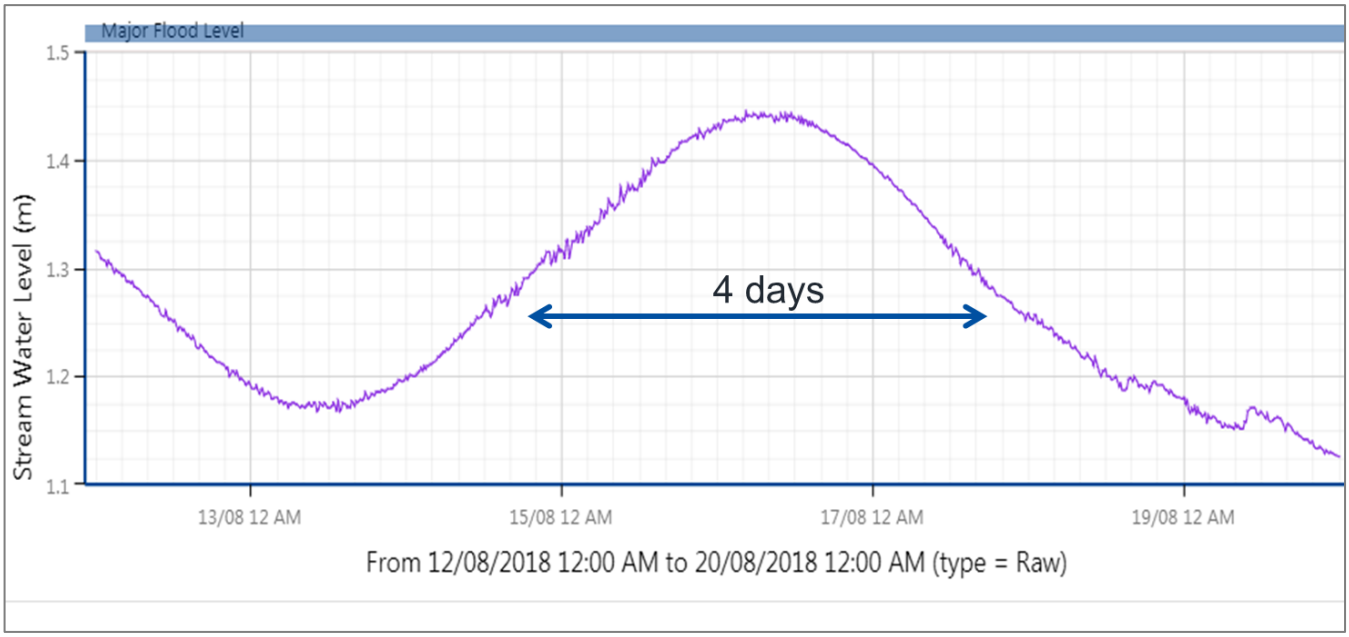


Figure 101. Barwon River flood duration at the Geelong McIntyre Bridge gauge, during the August 2018 flood event.

Barwon Heads and Ocean Grove Gauge Board Locations

Given the lower Barwon River is ungauged in Barwon Heads and Ocean Grove, stream gauge boards can be used to undertake flood observations during flood events. Regularly measuring the flood level at these gauge boards can be used to track the flood peak along the Baron River to determine the flood magnitude in Barwon Heads and Ocean Grove. There are several stream gauge boards that have been installed within Barwon Heads and Ocean Grove, these include;

- Sheepwash Road, Barwon Heads
- Guthridge Street, Ocean Grove

Refer to the map and photos of the stream gauge boards below.

Figure 102. Stream gauge board at the end of Sheepwash Road, Barwon Heads.

Figure 103. Stream gauge board at Guthridge Street, Ocean Grove.

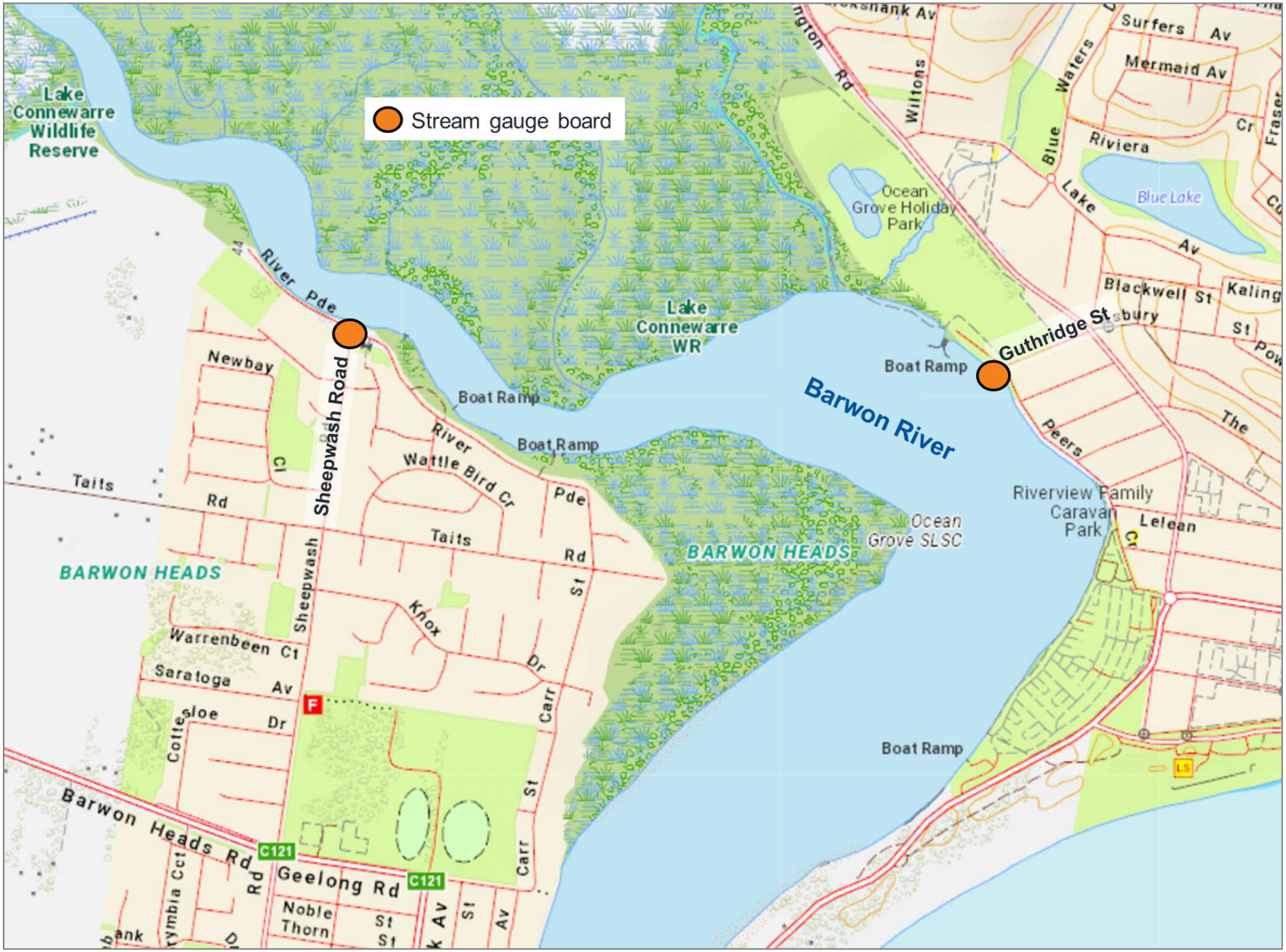


Figure 104. Barwon Heads and Ocean Grove gauge board locations.

Flood Impacts and Actions Required

Flood mapping from the Barwon River Flood Study (Water Technology 2019) was used to assess buildings, roads and other assets impacted by flooding.

There are several roads impacted by shallow flooding in Ocean Grove and Barwon Heads during a 20 year flood event, these include River Parade, Guthridge Street and Peers Crescent, flood depth greater than 0.14m.

During a 1 in 100 year flood event two buildings at the Riverview Family Caravan Park (Barwon Heads-Ocean Grove Road) are flooded above floor in Ocean Grove. Access is also cut to several Ocean Grove roads, these include Riverside Avenue, Whitton Street, Hurst Street, Beaver Street, Peers Crescent, Parker Street and Guthridge Street, flood depth greater than 0.3m.

Barwon Heads is impacted by minor flooding to roads and buildings during large flood events.

Key assets at risk of flooding in Barwon Heads and Ocean Grove are listed below.

Table 31. Key assets at risk of flooding.

Asset register				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
Ocean Grove Golf Club, 9 Guthridge Street.	2 year flood	Shallow floodwater starts to impact low lying areas of the Ocean Grove Golf Club grounds during a 1 in 2 year flood event.	Notify the managers of the Ocean Grove Golf Club.	VICSES
Peers Crescent and Guthridge Street, Ocean Grove.	20 year flood	Shallow floodwater overtops Peers Crescent and Guthridge Street in Ocean Grove during a 20 year flood event, depth greater than 0.12 m.	Deploy road closure signs as needed.	Council
River Parade, Barwon Heads.	50 year flood	Shallow floodwater overtops River Parade during a 50 year flood event, depth 0.14 m. Access may be cut during a 100 year flood event, depth 0.68 m.	Deploy road closure signs as needed.	Council
Riverside Avenue, Whitton Street, Hurst Street, Beaver Street, Peers Crescent, Parker Street and Guthridge Street, Ocean Grove.	100 year flood	Access is cut by deep flooding to Riverside Avenue, Whitton Street, Hurst Street, Beaver Street, Peers Crescent, Parker Street and Guthridge Street during a 100 year flood event. Flood depth is greater than 0.3 m	Deploy road closure signs as needed.	Council
Sheepwash Road and Taits Road, Barwon Heads.	100 year flood	Shallow floodwater overtops Sheepwash Road and Taits Road during a 100 year flood event, depth greater than 0.14 m. Access may be cut during a 200 year flood event, depth greater than 0.30 m.	Deploy road closure signs as needed.	Council
Two buildings at the Riverview Family Caravan Park, Barwon Heads-Ocean Grove Road, Ocean Grove.	100 year flood	Two buildings at the Riverview Family Caravan Park are flooded above floor during a 100 year flood event.	Sandbag buildings and evacuate the Caravan Park as needed.	Victoria Police VICSES
14 Riverside Terrace, Barwon Heads.	200 year flood	A house at 14 Riverside Terrace, Barwon Heads is flooded above floor during a 200 year flood event.	Sandbag and evacuate building as needed.	Victoria Police VICSES

For more detailed information regarding buildings and roads impacted refer to the Barwon Heads and Ocean Grove Flood Intelligence Card and flood impact maps below. Also refer to the Barwon Heads and Ocean Grove flood depth maps in **Appendix E** and community sandbag collection points in **Appendix H**.

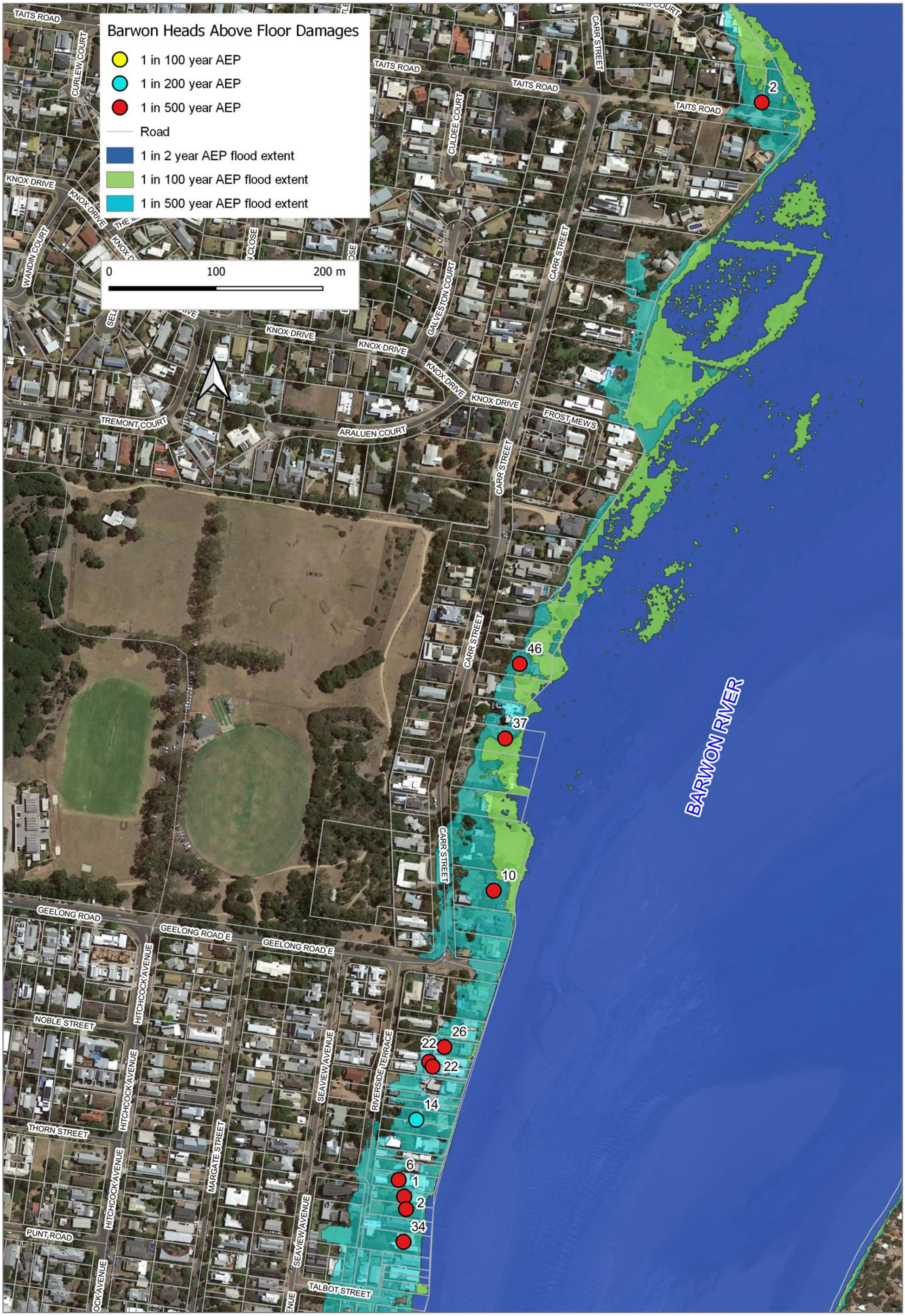


Figure 105. Barwon Heads buildings impacted by over floor flooding for a range of design flood events (Water Technology 2019).

Figure 106. Barwon Heads roads impacted by over floor flooding for a range of design flood events (Water Technology 2019).

Figure 107. Ocean Grove buildings impacted by over floor flooding for a range of design flood events (Water Technology 2019).

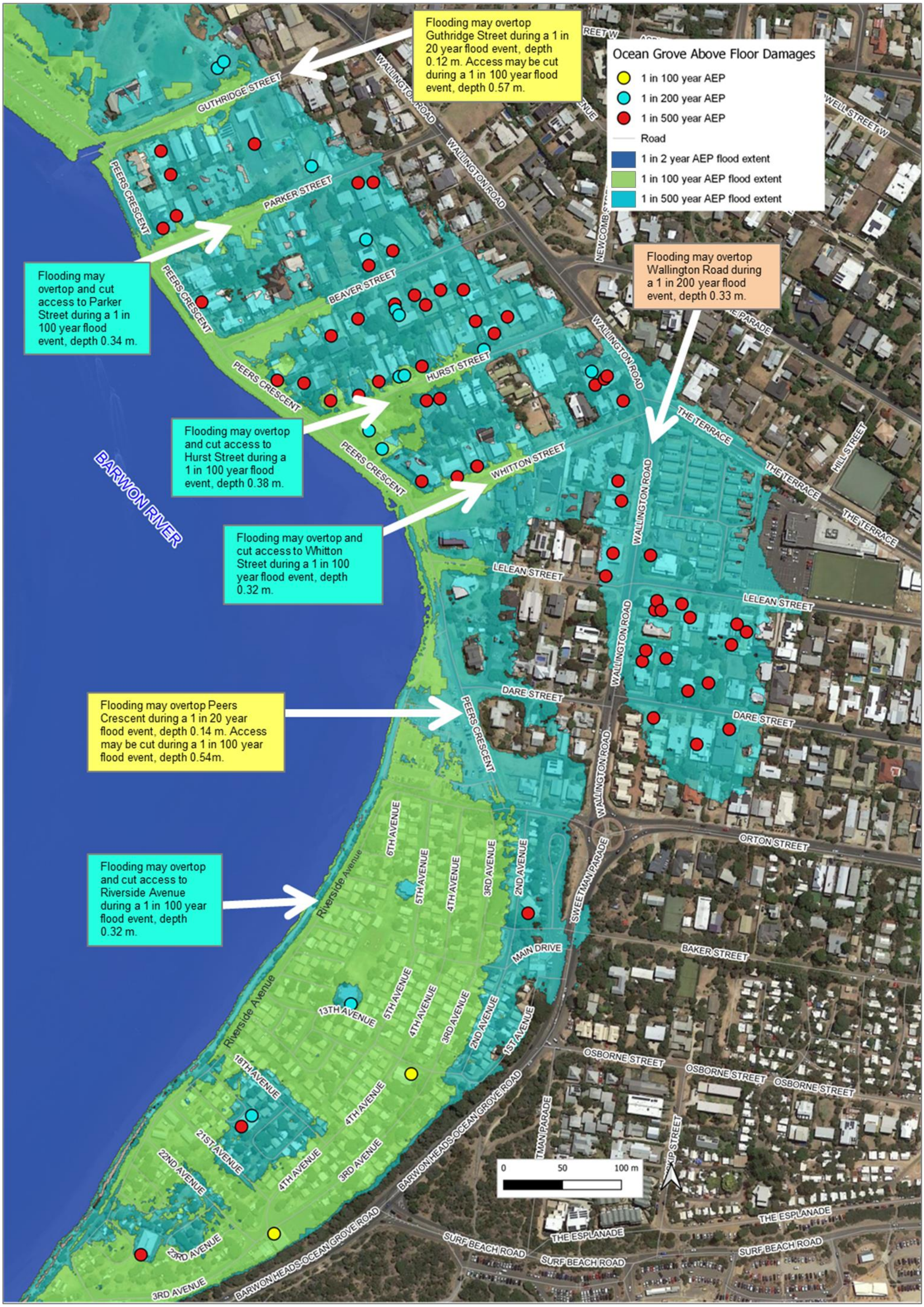


Figure 108. Ocean Grove roads impacted by over floor flooding for a range of design flood events (Water Technology 2019).

Table 32. Barwon Heads and Ocean Grove Flood Intelligence Card (Barwon River)

Flood travel time	Time of flood peak travel between Geelong and Barwon Heads / Ocean Grove during a minor flood event is 36 hours. Time of flood peak travel between Geelong and Barwon Heads / Ocean Grove during a major flood event is 24 hours. Riverine flooding duration: 3 to 6 days

Barwon River at Pollocksford gauge height 233200 (m)	Barwon River at McIntyre Bridge Geelong gauge height 233217 (m)	Barwon River at Sheepwash Road Barwon Heads gauge height (m)	Barwon River at Guthridge St Ocean Grove gauge height (m)	Barwon River at Geelong Design Flows (ML/d)	Annual Exceedance Probability (1 in year)	Barwon Heads and Ocean Grove damages total number properties flooded (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Road flood depth (m)	Action
3.50	2.30				Geelong minor flood level					
	2.51			9,999	2	0 (0)	Minor flood impacts to the Ocean Grove Golf Club Course (9 Guthridge Street). Overflow will fill Blue Lake if it's not already full.			
4.50	3.10				Geelong moderate flood level					
	3.52	0.95	0.75	25,983	5	0 (0)				
5.28	3.60				2001					
6.09	3.68				2011					
	3.80				1983					
	4.03	1.15	0.9	41,559	10	0 (0)				**Council** check stormwater pump stations and monitor the Plummer Bank Levee to ensure they are functioning to their full operating capacity.
6.50	4.30				Geelong major flood level					
	4.55				1978					
	4.52	1.40	1.15	60,343	20 year flood Proposed minor flood level for Barwon Heads and Ocean Grove	0 (0)	Shallow flooding starts to break out of the Barwon River in Barwon Heads and Ocean grove along Peers Crescent, Guthridge Street and River Parade. While the Plummer Bank Levee provides protection to a 1 in 500 year flood, ensure the structural integrity of the levee is checked. Failure of this Levee will substantially increase building damages in Barwon Heads during a 20 year flood event.		**Ocean Grove** Peers Cres depth 0.14m Guthridge Street depth 0.12m **Barwon Heads** River Parade depth 0.07m	In addition to actions listed above; **VICSES** publish a minor flood warning for Barwon Heads and Ocean Grove.
	5.32	1.85	1.6	90,367	50	0 (0)	**Ocean Grove** Deeper flooding may start to cut access to Guthridge Street.		**Ocean Grove** Peers Cres depth 0.14m Guthridge Street depth 0.22m **Barwon Heads** River Parade depth 0.14m	In addition to actions listed above; **Council** deploy road closure signs and undertake traffic management as needed.
9.05	5.23	1.84	1.58		1995					
	5.94	2.0	1.75	117,198	100 year flood Proposed moderate flood level for Barwon Heads and Ocean Grove	11 (2)	**Ocean Grove** Two buildings at the Riverview Caravan Park (Barwon Heads-Ocean Grove Road) may be inundated above floor. Flooding may cut access to Riverside Avenue, Whitton Street, Hurst Street, Beaver Street, Peers Cres and Parker Street. **Barwon Heads** Flooding may cut access to Sheepwash Road and River Parade. Shallow flooding overtops Bluestone School Road, west of Barwon Heads.	2 buildings are impacted by above floor flooding; **Ocean Grove;** two buildings at Riverview Caravan Park (Barwon Heads-Ocean Grove Road.	**Ocean Grove** Riverside Avenue depth 0.38m Whitton Street depth 0.32m Hurst Street depth 0.38m Beaver Street depth 0.31m Peers Cres depth 0.54m Parker Street depth 0.34m Guthridge Street depth 0.57m **Barwon Heads** River Parade depth 0.68m Taits Road depth 0.05m Sheepwash Road depth 0.20m Bluestone School Road depth 0.09m	In addition to actions listed above; **VICSES** sandbag buildings as needed. **Victoria Police** evacuate the Riverview Caravan Park as needed. **Council** deploy road closure signs and undertake traffic management as needed. **VICSES** publish a moderate flood warning for Barwon Heads and Ocean Grove.
	5.82				1952		Significant flooding in Barwon Heads to a depth of 1 to 1.5m before the Plummer Bank Levee was constructed.			
	6.61			147,736	200 year flood Proposed major flood level for Barwon Heads	95 (16)	**Ocean Grove** 13 additional buildings may be impacted by flooding above floor in Hurst Street, Beaver Street, Peers Crescent, Barwon Heads-Ocean Grove Road, Wallington Road and Guthridge Street. Flooding impacts Whitton Street, Hurst Street, Beaver Street, Lelean Street, Dave Street and Guthridge Street. Flooding from Blue Lake spills out only adjacent properties.	14 additional buildings are impacted by above floor flooding; **Ocean Grove;** x4 HURST STREET (1/7, 2/7, 15, 2/15), x2 BEAVER STREET (14, 2/15), x2 PEERS CRESCENT (27, 29), x2 RIVERVIEW FAMILY CARAVAN PARK (Barwon Heads-Ocean Grove Road), 101 BARWON HEADS-OCEAN GROVE ROAD, 3/25 WALLINGTON ROAD, 9	**Ocean Grove** Riverside Avenue depth 0.66m Whitton Street depth 0.59m Hurst Street depth 0.65m Beaver Street depth 0.58m Peers Cres depth 0.81m Parker Street depth 0.61m Guthridge Street depth 0.85m Wallington Road depth 0.33m **Barwon Heads**	In addition to actions listed above; **VICSES** sandbag buildings and assist with raising assets within houses as needed. **Regional Roads** and **Council** deploy road closure signs and undertake traffic management as needed.

					and Ocean Grove		**Barwon Heads** An additional building may be impacted by flooding above floor in Riverside Terrace. Flooding cuts access to Taits Road.	GUTHRIDGE STREET (Ocean Grove Golf Club), 46 BARWON HEADS ROAD. **Barwon Heads;** 14 RIVERSIDE TERRACE	River Parade depth 0.99m Taits Road depth 0.31m Sheepwash Road depth 0.52m Bluestone School Road depth 0.13m	**VICSES** publish a major flood warning for Barwon Heads and Ocean Grove.
	7.48			194,022	500	179 (88)	72 additional buildings may be impacted by flooding above floor. **Barwon Heads** Flooding may cut access to Sheepwash Road, Riverside Terrace, River Parade and Bluestone School Road.	72 additional buildings are impacted by above floor flooding.	**Ocean Grove** Riverside Avenue depth 1.03m Whitton Street depth 0.97m Hurst Street depth 1.03m Beaver Street depth 0.95m Peers Cres depth 1.19m Parker Street depth 0.98m Guthridge Street depth 1.22m Wallington Road depth 0.72m **Barwon Heads** River Parade depth 1.40m Taits Road depth 0.66m Sheepwash Road depth 0.93m Carr Street depth 0.18m Riverside Tce 0.66m Bluestone School Road depth 0.38m	Refer to actions listed above.

Table 33. Barwon Heads and Ocean Grove Property Inundation Table

Colours used in the table below are the dame used in the Barwon Heads and Ocean Grove flood risk maps above. Yellow, buildings flooded above floor in a 1 in 100 year AEP. Blue, buildings flooded above floor iin a 1 in 200 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)			Building Type
		100	200	500	
1	3rd Avenue, Riverview Family Caravan Park, Ocean Grove	0.293	0.554	0.921	Building at Riverview Family Caravan Park
2	19 PARKER STREET OCEAN GROVE	0.125	0.394	0.768	A/C Sheet / Fibro Cement Sheet
3	4th Avenue, Riverview Family Caravan Park, Ocean Grove		0.448	0.82	Building at Riverview Family Caravan Park
4	2/15 HURST STREET OCEAN GROVE		0.195	0.57	Weatherboard
5	2/15 BEAVER STREET OCEAN GROVE		0.186	0.561	Brick Veneer Standard
6	27 PEERS CRESCENT OCEAN GROVE		0.17	0.544	Brick Veneer Standard
7	13th Avenue, Riverview Family Caravan Park, Ocean Grove		0.152	0.527	Building at Riverview Family Caravan Park
8	101 BARWON HEADS-OCEAN GROVE ROAD OCEAN GROVE		0.134	0.503	Caravan Park - Medium
9	14 RIVERSIDE TERRACE BARWON HEADS		0.12	0.468	Brick Veneer Standard
10	3/25 WALLINGTON ROAD OCEAN GROVE		0.077	0.457	Brick Veneer Unit
11	29 PEERS CRESCENT OCEAN GROVE		0.065	0.439	Weatherboard
12	14 Beaver Street, Ocean Grove		0.037	0.405	
13	2/7 HURST STREET OCEAN GROVE		0.036	0.41	Weatherboard
14	1/7 HURST STREET OCEAN GROVE		0.035	0.409	Weatherboard
15	9 Guthridge Street, Ocean Grove Golf Club		0.006	0.381	
16	15 Hurst Street, Ocean Grove		0.003	0.373	
17	2/14 BEAVER STREET OCEAN GROVE			0.455	Brick Veneer Unit
18	9 Guthridge Street, Ocean Grove Golf Club			0.386	
19	4 WALLINGTON ROAD OCEAN GROVE			0.371	A/C Sheet / Fibro Cement Sheet
20	18 BEAVER STREET OCEAN GROVE			0.353	
21	2/25 WALLINGTON ROAD OCEAN GROVE			0.34	Asbestos Cement / Fibro Cement U
22	17 BEAVER STREET OCEAN GROVE			0.323	A/C Sheet / Fibro Cement Sheet
23	17 DARE STREET OCEAN GROVE			0.323	Weatherboard
24	1/25 WALLINGTON ROAD OCEAN GROVE			0.315	Asbestos Cement / Fibro Cement U
25	12 WALLINGTON ROAD OCEAN GROVE			0.314	Weatherboard
26	8 BEAVER STREET OCEAN GROVE			0.308	
27	1/15 BEAVER STREET OCEAN GROVE			0.294	A/C Sheet / Fibro Cement Sheet
28	32 CARR STREET BARWON HEADS			0.289	Weatherboard
29	3 HURST STREET OCEAN GROVE			0.283	Weatherboard
30	10-14 CARR STREET BARWON HEADS			0.278	Brick Veneer Standard
31	2-4 TAITS ROAD BARWON HEADS 3227			0.275	Brick Veneer Standard
32	19 PEERS CRESCENT OCEAN GROVE			0.275	Brick Veneer Standard
33	1/12-14 DARE STREET OCEAN GROVE			0.259	Weatherboard Unit
34	3 WHITTON STREET OCEAN GROVE			0.256	Weatherboard

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)			Building Type
		100	200	500	
35	1/24 LELEAN STREET OCEAN GROVE			0.253	Brick Veneer Unit
36	3/24 LELEAN STREET OCEAN GROVE			0.252	Brick Veneer Unit
37	4/25 WALLINGTON ROAD OCEAN GROVE			0.244	Asbestos Cement / Fibro Cement U
38	2/24 LELEAN STREET OCEAN GROVE			0.244	Brick Veneer Unit
39	23 WALLINGTON ROAD OCEAN GROVE			0.243	A/C Sheet / Fibro Cement Sheet
40	46-48 CARR STREET BARWON HEADS			0.24	Brick Veneer Standard
41	6 RIVERSIDE TERRACE BARWON HEADS			0.239	Weatherboard
42	21 PEERS CRESCENT OCEAN GROVE			0.229	Brick Veneer Standard
43	6 HURST STREET OCEAN GROVE			0.228	Brick Veneer Standard
44	16 LELEAN STREET OCEAN GROVE			0.223	
45	23RD AVENUE, RIVERVIEW FAMILY CARAVAN PARK, OCEAN GROVE			0.219	
46	1/8 GUTHRIDGE STREET OCEAN GROVE			0.218	Brick Veneer Unit
47	9 HURST STREET OCEAN GROVE 3226			0.217	Brick Veneer Standard
48	10 BEAVER STREET OCEAN GROVE 3226			0.214	Brick Veneer Standard
49	3/8 GUTHRIDGE STREET OCEAN GROVE			0.21	Brick Veneer Unit
50	7 PARKER STREET OCEAN GROVE			0.199	Brick Veneer Standard
51	20 PARKER STREET OCEAN GROVE			0.186	Brick Veneer Standard
52	5 HURST STREET OCEAN GROVE			0.186	Brick Veneer Standard
53	4 RIVERSIDE LANE BARWON HEADS			0.173	
54	8 HURST STREET OCEAN GROVE			0.173	Brick Veneer Standard
55	6 WALLINGTON ROAD OCEAN GROVE			0.172	Weatherboard
56	15 LELEAN STREET OCEAN GROVE			0.17	Service Station
57	26-28 RIVERSIDE TERRACE BARWON HEADS			0.164	Brick Veneer Standard
58	6 WALLINGTON ROAD OCEAN GROVE			0.162	Asbestos Cement / Fibro Cement U
59	20B DARE STREET OCEAN GROVE			0.154	
60	2/20 PARKER STREET OCEAN GROVE			0.149	Brick Veneer Standard
61	16 LELEAN STREET OCEAN GROVE			0.148	
62	16 LELEAN STREET OCEAN GROVE			0.137	
63	4 WALLINGTON ROAD OCEAN GROVE			0.125	Asbestos Cement / Fibro Cement U
64	1/14 BEAVER STREET OCEAN GROVE			0.107	Brick Veneer Unit
65	2/13 PEERS CRESCENT OCEAN GROVE			0.102	Brick Veneer Standard
66	17 HURST STREET OCEAN GROVE			0.096	Brick Veneer Standard
67	6-8 CARR STREET BARWON HEADS			0.091	Weatherboard
68	2/5 WHITTON STREET OCEAN GROVE			0.081	Brick Veneer Standard
69	1 RIVERSIDE LANE BARWON HEADS			0.08	Weatherboard
70	16-18 LELEAN STREET OCEAN GROVE			0.077	Flats Bellarine Peninsula
71	18 DARE STREET OCEAN GROVE			0.077	
72	1/16 BEAVER STREET OCEAN GROVE			0.076	Brick Veneer Unit
73	2/16 BEAVER STREET OCEAN GROVE			0.067	Brick Veneer Unit

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)			Building Type
		100	200	500	
74	2/22-24 RIVERSIDE TERRACE BARWON HEADS			0.063	Weatherboard Unit
75	20 LELEAN STREET OCEAN GROVE			0.058	Weatherboard
76	5 PARKER STREET OCEAN GROVE			0.053	Weatherboard
77	17 WALLINGTON ROAD OCEAN GROVE			0.052	Weatherboard
78	2/20 BEAVER STREET OCEAN GROVE			0.052	Flats Bellarine Peninsula
79	2 RIVERSIDE LANE BARWON HEADS			0.044	Brick Veneer Standard
80	19 DARE STREET OCEAN GROVE			0.044	Weatherboard
81	1/5 WHITTON STREET OCEAN GROVE			0.023	Brick Veneer Standard
82	4 RIVERSIDE LANE BARWON HEADS			0.02	Weatherboard
83	101 BARWON HEADS-OCEAN GROVE ROAD, OCEAN GROVE			0.016	
84	4/22-24 RIVERSIDE TERRACE BARWON HEADS			0.015	Weatherboard Unit
85	15 HURST STREET OCEAN GROVE			0.012	Weatherboard Unit
86	14 GUTHRIDGE STREET, BOAT RAMP MOTEL, OCEAN GROVE			0.008	
87	9/19-21 WALLINGTON ROAD OCEAN GROVE			0.001	Asbestos Cement / Fibro Cement U

Appendix C5: Waurn Ponds Flood Emergency Plan

Waurn Ponds has experienced frequent riverine flooding from the Waurn Ponds Creek. The upper reaches of the Waurn Ponds Creek drains the eastern side of Mount Moriac and flows through suburbs of Geelong, including Waurn Ponds, Belmont, Marshall, Grovedale and Highton. The catchment area of Waurn Ponds Creek is small, approximately 42 km^2. Waurn Ponds Creek is a tributary of the Barwon River, joins the Barwon River south of Breakwater Road, refer to the waterway map below. The contribution of flows from Waurn Ponds Creek to the Barwon River during flood events is small, estimated to be between 0.5 to 1% for design flood events (Water Technology 2018).

During small flood events (less than 1 in 20 year AEP event), flooding is primarily contained within that Waurn Ponds Creek channel through Waurn Ponds, Belmont, Marshall, Grovedale and Highton. Flood modelling indicates there are no buildings subject to above floor flooding, a building is impacted by below floor flooding in Waurn Ponds Drive. Shallow flooding starts to overtop Rossack Drive during a 1 in 20 year flood.

During a 1 in 50 year event shallow flooding overtops Torquay Road (depth 0.17m) and access is cut to Rossack Drive.

During large flood events (greater than a 1 in 100 year event) a significant number of properties are impacted by flooding including a house in Waurn Ponds Drive is flooded above floor. 12 buildings are flooded below floor in Francis Street, Glenbrae Court, Eldridge Place, Jacaranda Place and Torquay Road, including the Sherwood Village Caravan Park (70 Bailey Street Belmont). Deep flooding cuts access to many minor and major roads including Rossack Drive, Torquay Road, Bailey Street, Francis Street, Eldridge Place and Glenbrae Court.

In addition to riverine flood impacts, there may be buildings and roads subject to stormwater flooding.

There are no stream or rainfall gauges within the Waurn Ponds Creek catchment to provide flood warning. Currently, there are no stream gauge boards within the Waurn Ponds Creek catchment. Rises in streamflow at Waurn Ponds may occur between 3 to 6 hours after heavy rainfall in the upper Waurn Ponds Creek catchment.

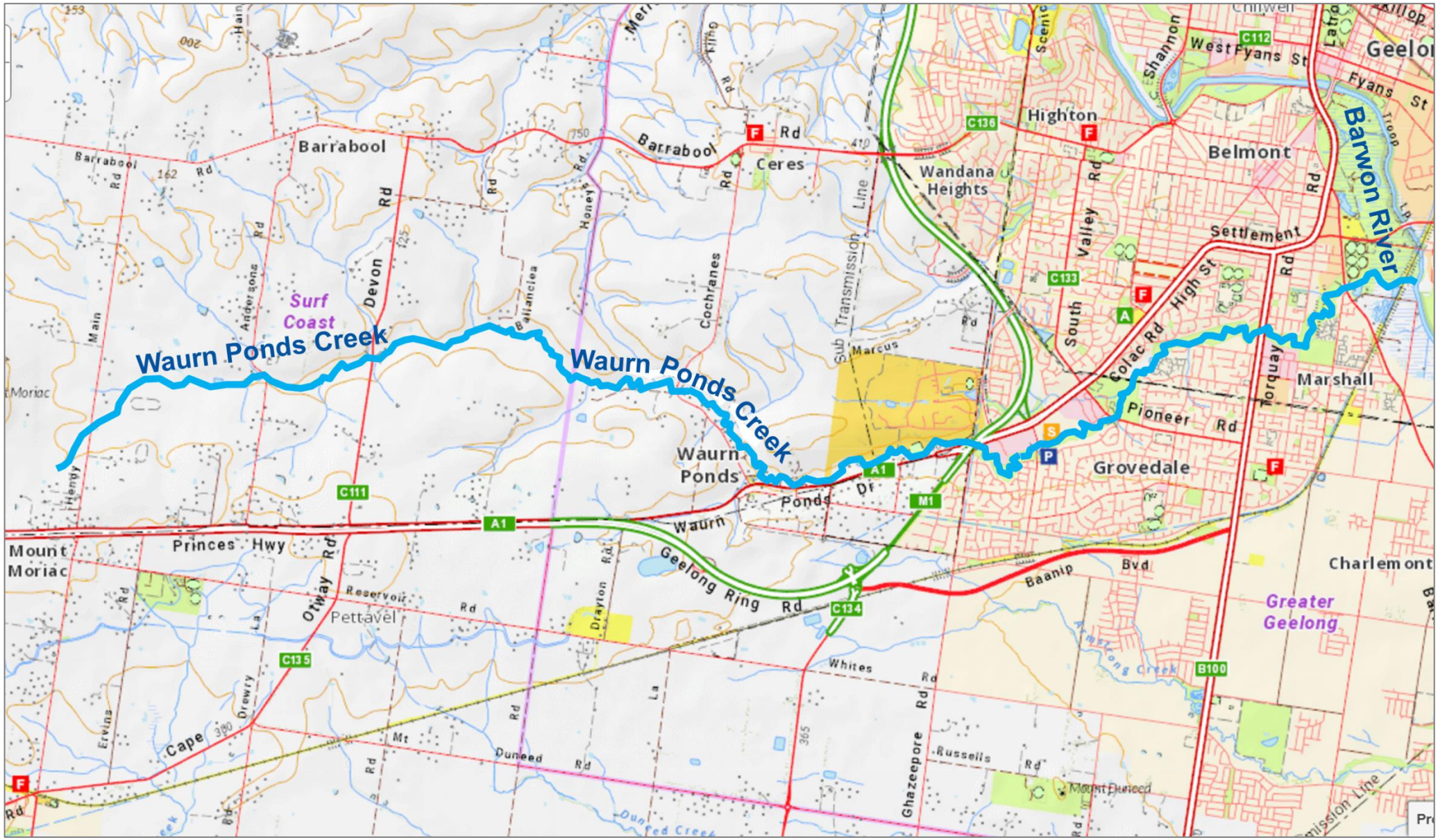


Figure 109. Waurn Ponds waterways.

Historic flood events

Given there is no rainfall monitoring within the Waurn Ponds Creek catchment, the Avalon Airport rainfall gauge was used to indicated when historic flood events have occurred in Waurn Ponds Creek. Given the distance between Avalon and Waurn Ponds Creek is 23 km, this rainfall record should be used as a guide only. Refer to the graph below.

Rainfall records show that Waurn Ponds Creek has experienced frequent flood events since the early 1970's, refer to graph below. Significant flood events have occurred in 1973, 1974, 1978, 1980, 1983, 2005, 2011, 2016, 2017 and 2020.

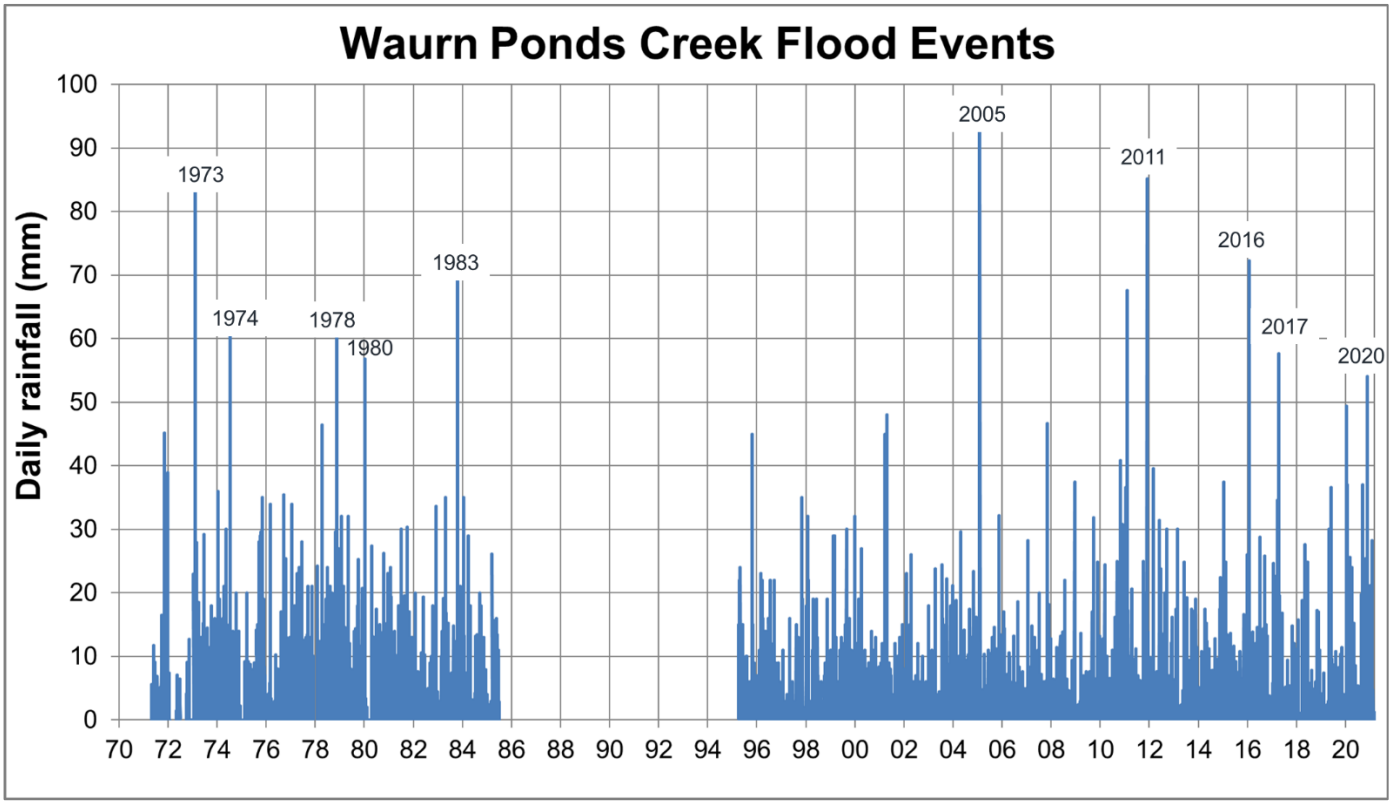


Figure 110. Waurn Ponds Creek historic flood events.

January 2016 flood event

The BoM estimated the January 2016 flood event to be between a 1 in 50 and 1 in 100 year AEP flood event. The Highton rainfall gauge recorded 214 mm over 4 days. During this event Waurn Ponds Creek experienced a high intensity, short duration rainfall event. The Avalon rainfall gauge recorded 72 mm, with 54 mm falling in 30 minutes.

Very little information is available regarding the Waurn Ponds Creek flood impacts during this flood event. The VICSES and City of Greater Geelong Council request for assistance records and flood risk mapping was used to indicate the Waurn Ponds Creek flood impacts. Deep flooding impacted more than 17 buildings above floor (VICSES and COGG Request for Assistance Database). Many minor and major roads were impacted by shallow flooding within and surrounding Waurn Ponds Creek. Anecdotal information indicates that deep flooding cut access to Rossack Rive and shallow flooding overtopped Torquay Road.

There are no flood photos available for the Waurn Ponds Creek catchment.

For further flood risk information refer to the building and road impact maps and the Waurn Ponds Creek Flood Intelligence Card below.

Flood Behaviour and Warning Time

Rapid rises in floodwater in the Waurn Ponds Creek can occur within 3 to 6 hours from rainfall. The floodwater peak may occur within 6 to 12 hours from rainfall.

It is important to note that the time it takes rainfall associated with severe thunderstorm activity to develop into runoff is highly dependent on antecedent conditions, the saturation of the catchment. A flood on a ‘dry’ waterway travels more slowly that a flood on a ‘wet’ waterway. Large floods tend to travel faster than small floods. Hence, the size of the flood, recent flood history, soil moisture and forecast weather conditions all need to be considered when using the following information to direct flood response activities.

There are no upstream gauges that provide flood warning for Waurn Ponds.

Proposed Gauge Board Locations

Given there are no stream gauges within the Waurn Ponds Creek catchment, the use of local flood observers sharing flood intelligence information via Snap Send Solve will be important to gain situational awareness of flooding in the Waurn Ponds Creek catchment. It will also be a priority to install temporary Portable Automated Logging System (PALS) stream gauges and gauge boards at main intersections along Waurn Ponds Creek to assist with gaining flood intelligence and situational awareness during flood events.

Flood Impacts and Actions Required

Flood mapping undertaken as part of the Barwon River Flood Study (Water Technology 2020) was used to develop the flood risk summary, flood building damages map, road impact map and Flood Intelligence Card below. Given that no stream monitoring or historic flood impact data was used to the calibration or the Waurn Ponds Creek flood model, this flood risk mapping is of moderate accuracy due to the limited calibration data available. Therefore, this flood mapping should be used as a guide only.

Key assets at risk of flooding in Waurn Ponds are listed below.

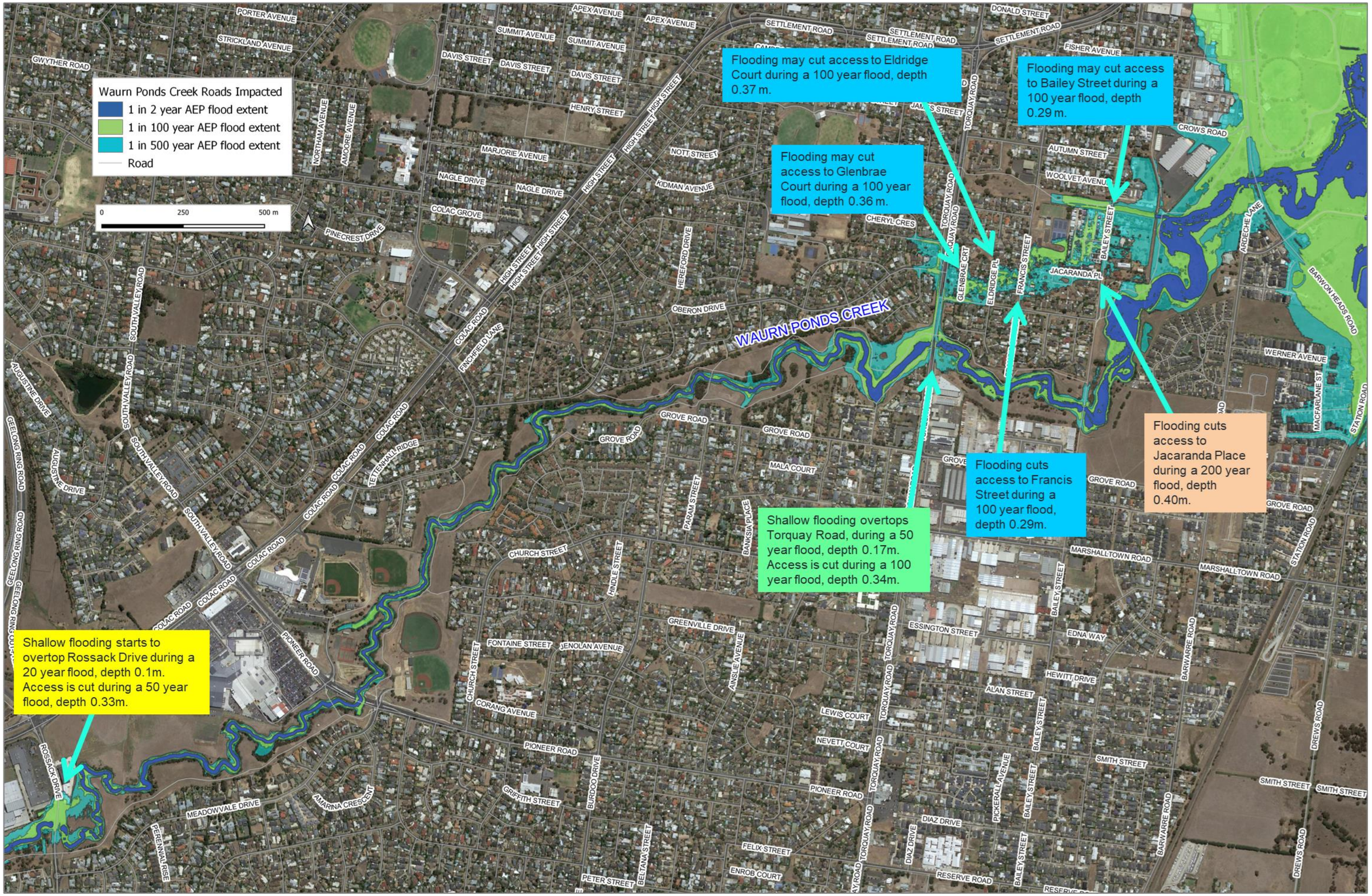
Table 34. Key assets at risk of flooding.

Asset register				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
250 Waurn Ponds Drive, Waurn Ponds.	20 year flood	A house at 250 Waurn Ponds Drive may be impacted by flooding below floor during a 20 year flood.	Evacuate building as needed.	Victoria Police
Rossack Drive, Grovedale.	20 year flood	Flooding starts to overtop Rossack Drive during a 20 year flood, depth 0.1m.	Deploy road closure signs as needed.	Council
Torquay Road, Waurn Ponds.	50 year flood	Flooding starts to overtop Torquay Road during a 50 year flood, depth 0.17m.	Deploy road closure signs as needed.	Council
Rossack Drive, Grovedale.	50 year flood	Deep flooding cuts access to Rossack Drive during a 50 year flood event, depth 0.33m.	Ensure road closure signs are deployed along Rossack Drive	Council
Sherwood Village Caravan Park (70 Bailey Street, Belmont).	100 year flood	Deep flooding starts to impact the Sherwood Village Caravan Park (70 Bailey Street, Belmont) during a 100 year flood, depth up to 0.25m.	Evacuate the buildings at the Sherwood Village Caravan Park as needed.	Victoria Police
250 Waurn Ponds Drive, Waurn Ponds.	100 year flood	A house at 250 Waurn Ponds Drive may be impacted by flooding above floor during a 100 year flood.	Sandbag and evacuate building as needed.	VICSES Victoria Police
Torquay Road, Glenbrae Court, Eldridge Place, Francis Street and Bailey Street, Waurn Ponds.	100 year flood	Deep flooding cuts access to Torquay Road, Glenbrae Court, Eldridge Place, Francis Street and Bailey Street during a 100 year flood event, depth greater than 0.3m.	Deploy road closure signs as needed.	Council Vic Roads
375 Cochranes Road Waurn Ponds, 38 Cheryl Crescent in Belmont.	500 year flood	Two additional houses may be impacted by above floor flooding during a 500 year flood.	Sandbag and evacuate building as needed.	VICSES Victoria Police

For more detailed information regarding buildings and roads impacted refer to the Waurn Ponds Flood Intelligence Card and flood impact maps below. Also refer to the Waurn Ponds flood depth maps in **Appendix E**.

4.51

Figure 111. Waurn Ponds Creek catchment buildings impacted by flooding for a range of design flood events (Water Technology 2019).



4.52 **Figure 112. Waurn Ponds Creek catchment roads impacted by flooding for a range of design flood events, with the 1 in 200 year AEP flood depth map (Water Technology 2019).**

Table 35. Waurn Ponds Flood Intelligence Card (Waurn Ponds Creek)

Flood travel time	Time from start of rain to steep rise in floodwater at Waurn Ponds, 3-6 hours Time from start of rainfall to flood peak in Waurn Ponds 6-12 hours Riverine flooding duration: 6 to 32 hours

Rainfall Intensity Trigger (BOM)	Waurn Ponds Creek at Rossack Drive gauge board (m)	Waurn Ponds Creek Design Flow (ML/d)	Waurn Ponds Annual Exceedance Probability (1 in year)	Waurn Ponds damages total number properties flooded (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Road flood depth (m)	Action
~28.2 mm in 6 hours to ~50.4 mm in 24 hours		1,037	2	0 (0)	Flooding is confined to a narrow floodplain along the Waurn Ponds Creek for most of the catchment. A large flood extent is located downstream of Torquay Road and close to the confluence with Barwon River impacting low lying parkland.			
~34.1 mm in 6 hours to ~61.5 mm in 24 hours		1,642	5	0 (0)				
~40.3 mm in 6 hours to ~72.9 mm in 24 hours		2,332	10	0 (0)				**VICSES** activate ground observers to take photos and record flood levels at key crossings.
~46.7 mm in 6 hours to ~84.6 mm in 24 hours		3,197	20	1 (0)	Rossack Drive is overtopped on the left bank, flood depth is 0.1m. This will activate the flood gates at Rossack Drive, Grovedale. A residential building is flooded below floor at 250 Waurn Ponds Drive.	A building is flooded below floor at 250 Waurn Ponds Drive.	Jacaranda Place depth 0m Glenbrae Court depth 0m Eldridge Place depth 0m Francis Street depth 0m Bailey Street depth 0m Torquay Road depth 0m Rossack Drive depth 0.1m	In addition to actions listed above; **Council** staff to ensure Rossack Drive flood gates are closed in Grovedale. **Victoria Police** evacuate house at 250 Waurn Ponds Drive as needed.
~55.7 mm in 6 hours to ~102 mm in 24 hours		4,925	50	1 (0)	Rossack Drive is flooded on both sides of the waterway, maximum depth around 0.98 m. Torquay Road is overtopped, depths on the road reach 0.17 m.		Jacaranda Place depth 0m Glenbrae Court depth 0m Eldridge Place depth 0m Francis Street depth 0m Bailey Street depth 0m Torquay Road depth 0.17m Rossack Drive depth 0.33m	In addition to actions listed above; **Vic Roads** deploy road closure signs as needed along Torquay Road.
~63 mm in 6 hours to ~116 mm in 24 hours		6,653	100	12 (1)	One building is flooded above floor at 250 Waurn Ponds Drive. Torquay Road is overtopped, depths on the road reach 0.25m. Breakout to the north along Torquay Road. Floodwater then flows north east along Bailey Street, flood depth up to 0.25m. 12 buildings are flooded below floor, including the Sherwood Village Caravan Park (70 Bailey Street, Belmont).	One building is flooded above floor; 250 Waurn Ponds Drive. 12 buildings are flooded below floor; **BELMONT**: x3 FRANCIS STREET (177, 206, 208), x2 GLENBRAE COURT (15, 16), x2 ELDRIDGE PLACE (2, 14), 13 JACARANDA PLACE, 85 TORQUAY ROAD. **WAURN PONDS**: 200 WAURN PONDS DRIVE, 11 CABERNET COURT.	Jacaranda Place depth 0m Glenbrae Court depth 0.36m Eldridge Place depth 0.37m Francis Street depth 0.29m Bailey Street depth 0.29m Torquay Road depth 0.34m Rossack Drive depth 1.03m	In addition to actions listed above; **Victoria Police** evacuate the Sherwood Village Caravan Park (70 Bailey Street, Belmont). as needed. **Council** deploy road closure signs as needed along Glenbrae Court, Eldridge Place, Francis Street and Bailey Street.
~73.4 mm in 6 hours to ~134 mm in 24 hours		7,258	200	24 (1)	Flooding from the Torquay Road overland flowpath impacts 9, 10, 13 and 18 Jacaranda Place. Flooding at the Sherwood Village Caravan Park is more extensive.		Jacaranda Place depth 0.40m Glenbrae Court depth 0.45m Eldridge Place depth 0.42m Francis Street depth 0.34m Bailey Street depth 0.35m Torquay Road depth 0.47m Rossack Drive depth 1.15m	In addition to actions listed above; **Council** deploy road closure signs as needed along Jacaranda Place.
~86.3 mm in 6 hours to ~157 mm in 24 hours		11,491	500	40 (3)	Two additional buildings are flooded above floor; 375 Cochranes Road Waurn Ponds, 38 Cheryl Crescent in Belmont. Waurn Ponds Drive. Flooding impacts properties on Bailey Street in Belmont opposite the Sherwood Forest Caravan Park.	Two additional buildings are flooded above floor; 375 Cochranes Road Waurn Ponds, 38 Cheryl Crescent in Belmont. Waurn Ponds Drive.	Jacaranda Place depth 0.49m Glenbrae Court depth 0.54m Eldridge Place depth 0.53m Francis Street depth 0.42m Bailey Street depth 0.57m Torquay Road depth 0.66m Rossack Drive depth 1.42m	In addition to actions listed above; **VICSES** and **Victoria Police** sandbag or evacuate houses at risk of above floor flooding as needed.

Table 36. Waurn Ponds Creek Flood Property Inundation Table

Colours used in the table below are the same used in the Waurn Ponds Creek catchment flood risk maps above. Blue, building flooded above floor in a 1 in 100 year AEP. Red, buildings flooded above floor in a 1 in 500 year AEP flood event, etc.

No	Address	Depth of building over floor flooding for each AEP (1 in year) event (m)			Building Type
		100	200	500	
1	250 WAURN PONDS DRIVE, WAURN PONDS	0.098	0.207	0.423	
2	375 COCHRANES ROAD, WAURN PONDS			0.198	
3	38 CHERYL CRESCENT BELMONT			0.015	Brick Veneer Standard

Appendix C6: Armstrong Creek Flood Emergency Plan

Armstrong Creek is located west of the Lake Connewarre Wildlife Reserve and has experienced frequent riverine flooding from the Armstrong Creek. The upper reaches of the Armstrong Creek drains the southern section of the Geelong Ring Road and northern section of Mount Duneed. Armstrong Creek flows through suburbs of Geelong, including the southern section of Waurn Ponds, Mount Duneed and Armstrong Creek. The catchment area of Armstrong Creek is small, approximately 27 km^2. Armstrong Creek discharges to the western reaches of the Lake Connewarre wetlands, refer to the waterway map below. During flood events Armstrong Creek contributes flood flow to the Barwon River, when connected to the Lake Connewarre wetland system.

The January 2016 rainfall event is estimated to be between a 1 in 50 and 1 in 100 year AEP flood event (BoM 2016). This flood event caused significant impact to buildings, roads, and other infrastructure. Deep flooding impacted more than 10 buildings above floor (VICSES and COGG Request for Assistance Database). Minor and major roads were impacted by shallow flooding within and surrounding Armstrong Creek. Anecdotal information indicates that Anglesea Road, Ghazeepore Road, Sovereign Drive, Torquay Road and Horseshoe Bend Road were impacted by shallow flooding.

Flooding throughout the Armstrong Creek catchment is generally widespread and shallow, with deeper flooding through several wetland areas. Flooding also backs up behind roadways which act as hydraulic controls running perpendicular to the main flow path of waterways within the Armstrong Creek catchment. Flooding is conveyed via an underground pipe from Lake Road to Barwon Heads Road. When the capacity of the underground pipe is exceeded flooding surcharges upstream of the pipe impacting adjacent properties and roads. During high intensity, short duration rainfall events the small capacity of Armstrong Creek quickly overflows onto adjacent property impacting a widespread area. During significant flood events, high floodwater velocities present significant risk to life of pedestrians and motorists.

There are no stream or rainfall gauges within the Armstrong Creek catchment to provide flood warning. Currently, there are no stream gauge boards within the Armstrong Creek catchment. Rises in streamflow at Armstrong Creek may occur between 3 to 6 hours after heavy rainfall in the upper Armstrong Creek catchment.

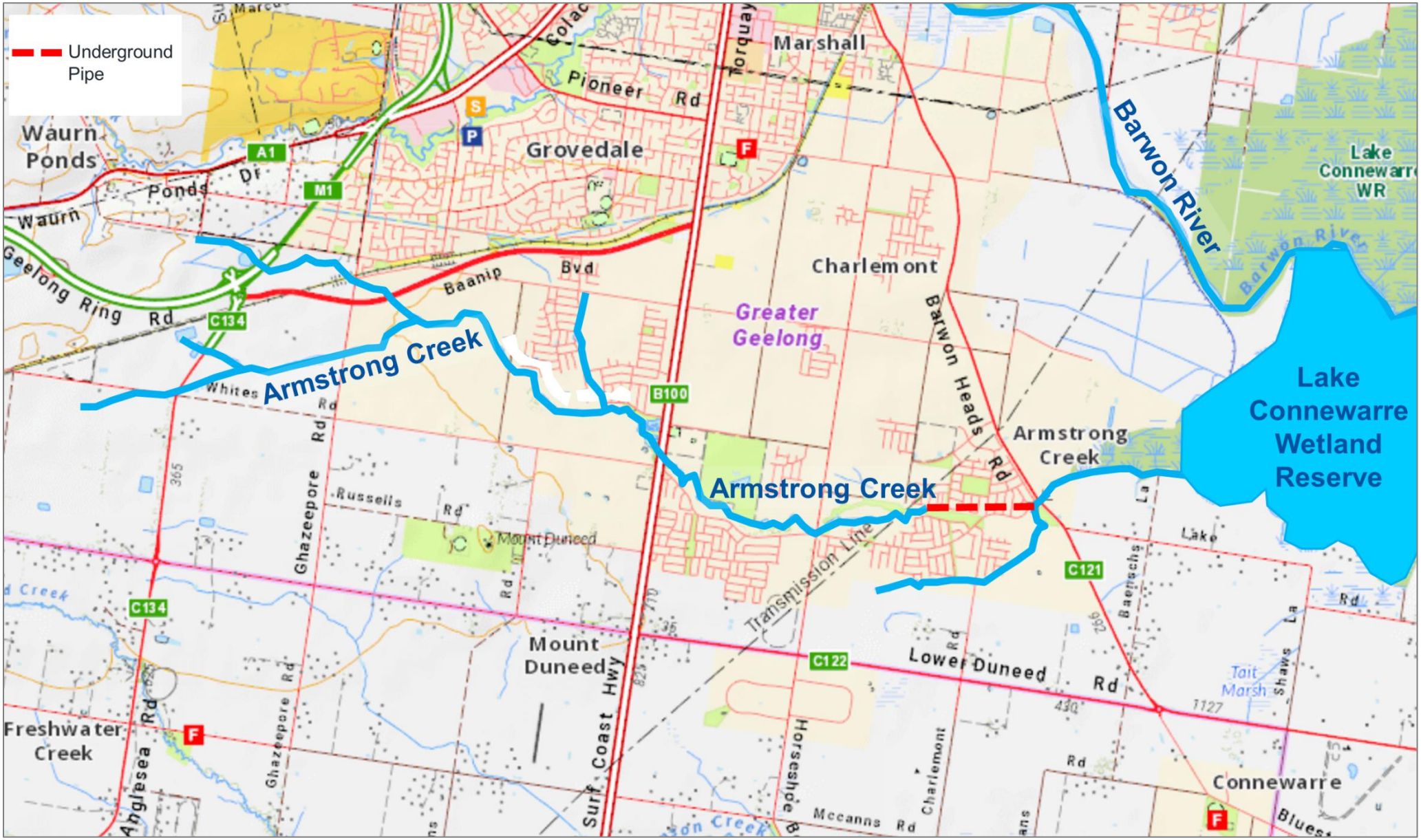


Figure 113. Armstrong Creek catchment waterways.

Historic Flood Events

Given there is no rainfall monitoring within the Armstrong Creek catchment, the Avalon Airport rainfall gauge was used to indicated when historic flood events have occurred in Armstrong Creek. Given the distance between Avalon and Armstong Creek is 30 km, this rainfall record should be used as a guide only. Refer to the graph below.

Rainfall records show that Armstrong Creek has experienced frequent flood events since the early 1970's, refer to graph below. Significant flood events have occurred in 1973, 1974, 1978, 1980, 1983, 2005, 2011, 2016, 2017 and 2020.

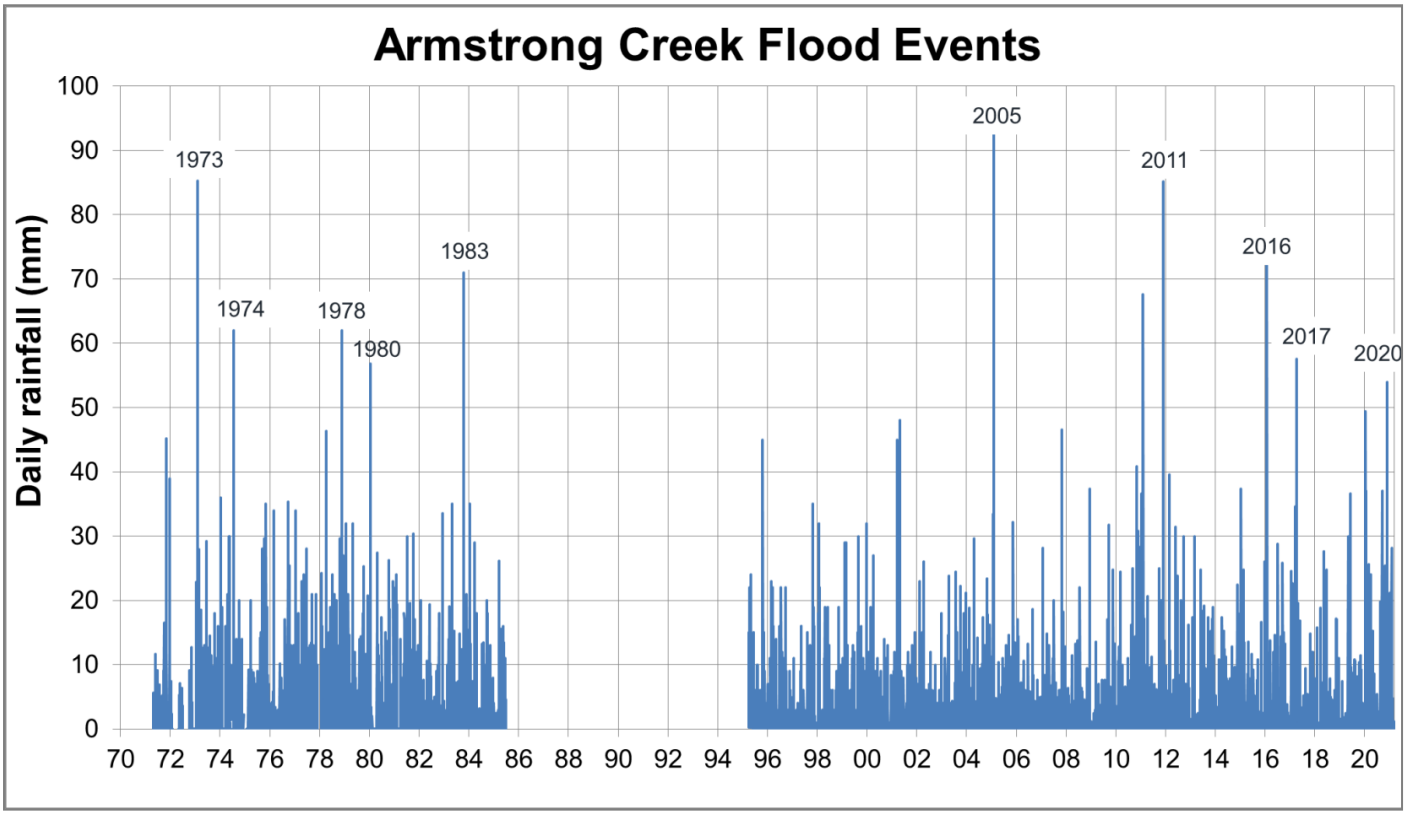


Figure 114. Armstrong Creek historic flood events.

January 2016 flood event

The BoM estimated the January 2016 flood event to be between a 1 in 50 and 1 in 100 year AEP flood event. The Highton rainfall gauge recorded 214 mm over 4 days. During this event Armstrong Creek experienced a high intensity, short duration rainfall event. The Avalon rainfall gauge recorded 72 mm, with 54 mm falling in 30 minutes.

Very little information is available regarding the Armstrong Creek flood impacts during this flood event. The VICSES and City of Greater Geelong Council request for assistance records and City of Greater Geelong Council flood risk mapping was used to indicate the Armstrong Creek flood impacts. Flooding impacted more than 10 buildings above floor (VICSES and COGG Request for Assistance Database). Minor and major roads were impacted by shallow flooding within and surrounding Armstrong Creek. Anecdotal information indicates that Anglesea Road, Ghazeepore Road, Sovereign Drive, Airport Road, Torquay Road and Horseshoe Bend Road may have been impacted by shallow flooding.

There are no flood photos available for Armstrong Creek.

For further flood risk information refer to the 1 in 100 year AEP flood extent map and the Armstrong Creek Flood Intelligence Card below.

Flood Warning Time

Rapid rises in floodwater in local waterways and the Armstrong Creek can occur within 3 to 6 hours from rainfall. The floodwater peak may occur within 6 to 12 hours from rainfall.

It is important to note that the time it takes rainfall associated with severe thunderstorm activity to develop into runoff is highly dependent on antecedent conditions, the saturation of the catchment. A flood on a ‘dry’ waterway travels more slowly that a flood on a ‘wet’ waterway. Large floods tend to travel faster than small floods. Hence, the size of the flood, recent flood history, soil moisture and forecast weather conditions all need to be considered when using the following information to direct flood response activities.

There are no upstream gauges that provide flood warning for Armstrong Creek.

Proposed Gauge Board Locations

Given there are no stream gauges within Armstrong Creek catchment, the use of local flood observers sharing flood intelligence information via Snap Send Solve will be important to gain situational awareness of flooding in the Armstrong Creek catchment. It will also be a priority to install temporary Portable Automated Logging System (PALS) stream gauges and gauge boards at main intersections along Armstrong Creek to assist with gaining flood intelligence and situational awareness during flood events.

Armstrong Creek Flood Impacts and Required Actions

Anecdotal information collected during historic flood events (VICSES and COGG Request for Assistance Database) was used to estimate assets, buildings and roads impacted by flooding. It is important to note that the building damage information below only indicates buildings that may be at risk of above floor flooding and should be used as a guide only.

The 1 in 100 year AEP flood extent developed as part of the Geelong flood mapping (COGG 2021) is provided below. The current Armstrong Creek flood risk mapping is of low accuracy given there was limited data and calibration undertaken as part of the flood mapping development. Therefore, this flood mapping should be used as a guide only.

The January 2016 flood event caused damages to buildings, roads, bridges and other infrastructure. Deep flooding impacted more than 10 buildings above floor (VICSES and COGG Request for Assistance Database). Anecdotal information indicates that Anglesea Road, Ghazeepore Road, Sovereign Drive, Torquay Road and Horseshoe Bend Road may have been impacted by shallow flooding.

Key assets at risk of flooding in Armstrong Creek are listed below. For additional flood risk information refer to the Armstrong Creek Flood Intelligence Card, table and map below.

Table 37. Armstrong Creek key assets at risk of flooding.

Asset register - Flooding Hotspots				
Asset Name and location	**Annual Exceedance Probability (1 in year)**	**Consequence / Impact**	**Mitigation/ Action**	**Lead Agency**
10 buildings within Armstrong Creek catchment, including Bickford Road, Sovereign Drive and Chandon Court.	50 year flood	Flooding impacted 10 buildings above floor during the January 2016 flood event in Bickford Road, Sovereign Drive and Chandon Court. This event was estimated to be above a 1 in 50 year flood event.	Sandbag and evacuate buildings as needed.	VICSES Victoria Police
Anglesea Road, Ghazeepore Road, Sovereign Drive, Airport Road, Torquay Road and Horseshoe Bend Road, where they intersect Armstrong Creek.	100 year flood	Flooding may impact Anglesea Road, Ghazeepore Road, Sovereign Drive, Torquay Road, Airport Road and Horseshoe Bend Road, where they intersect Armstrong Creek during a 1 in 100 year flood event.	Deploy road closure signs and undertake traffic management as needed.	Council Vic Roads

For more detailed information regarding buildings and roads impacted refer to the Armstrong Creek Flood Intelligence Card and flood impact map below.

Figure 115. Buildings within the Armstrong Creek catchment impacted by flooding during a range of flood events with the 1 in 100 year AEP flood extent (COGG 2021).

Table 38. Armstrong Creek Flood Intelligence Card

Flood travel time	Time from start of rain to steep rise in floodwater at Armstrong Creek, 3 - 6 hours Time from start of rainfall to flood peak in Armstrong Creek 6 -12 hours Riverine flooding duration: 6 to 32 hours

Observed rainfall (mm)	Annual Exceedance Probability (1 in year)	Armstrong Creek damages total number buildings flooded below floor (above floor)	Consequence / Impact	Houses/ buildings flooded / isolated	Roads Impacted	Action
~28.2 mm in 6 hours to ~50.4 mm in 24 hours	2	0 (0)				
~34.1 mm in 6 hours to ~61.5 mm in 24 hours	5	0 (0)				
~40.3 mm in 6 hours to ~72.9 mm in 24 hours	10	3 (0)	Localised minor flooding along Armstrong Creek may impact low lying rural land, parkland, wetlands and minor road crossings.			**VICSES** activate ground observers to take photos and record flood levels at key crossings as needed. **Council** monitor culverts and drains to check for debris build up, clear debris from waterway crossings, culverts and drains as needed.
~46.7 mm in 6 hours to ~84.6 mm in 24 hours	20	8 (5)*				In addition to actions listed above; **Council** deploy road closure signs as needed. **VICSES** assist to sandbagging or raise furniture and other assets as needed.
~55.7 mm in 6 hours to ~102 mm in 24 hours	50	11 (10)*	More than ten buildings were impacted by flooding above floor during the January 2016 flood event were located in Bickford Road, Sovereign Drive and Chandon Court.	Buildings impacted by flooding (VICSES and COGG Request for Assistance Database) were located in Bickford Road, Sovereign Drive and Chandon Court.		Refer to actions listed above.
~63 mm in 6 hours to ~116 mm in 24 hours	100	15 (13)*	Three additional houses may be impacted by flooding. Shallow flooding may impact Anglesea Road, Ghazeepore Road, Sovereign Drive, Torquay Road and Horseshoe Bend Road.		Shallow flooding may impact; Anglesea Road, Ghazeepore Road, Sovereign Drive, Torquay Road, Airport Road and Horseshoe Bend Road.	Refer to actions listed above.
~73.4 mm in 6 hours to ~134 mm in 24 hours	200	22 (23)*				Refer to actions listed above.
~86.3 mm in 6 hours to ~157 mm in 24 hours	500	42 (35)*				Refer to actions listed above.

*Buildings and properties impacted by flooding, estimated using the VICSES and COGG Request for Assistance Database.

Appendix C7: City of Greater Geelong Council Stormwater Flood Emergency Plan

The City of Greater Geelong Council area contains a vast network of drainage infrastructure, including underground pipes, stormwater pumping stations, flood control structures (e.g. levees and retarding basins) and open channels. Elements of the expansive stormwater network includes;

- 1,900 km of pipes
- Over 64,000 stormwater pits
- Over 300 retarding basins and 20 pump stations
- Over 150 km of open stormwater drains
- Over 5 km of levees
- Over 150 water sensitive urban design assets, including wetlands and swale drains.

The City of Greater Geelong council area is particularly susceptible to stormwater flooding. Heavily urbanised sections of Geelong have created impervious areas, increasing runoff and exacerbate localised flooding. The risk of stormwater flooding is greatest when aging and capacity constrained drainage networks are exceeded. This causes excess floodwater to accumulate in the road network which often drains to low lying land flooding buildings, as observed in the 1 in 100 year AEP flood extent mapping provided by the City of Greater Geelong Council. Refer to the flood map below. Stormwater flooding is often compounded in urban areas that have experienced rapid growth, observed in many areas within the City of Greater Geelong Council area.

Most of the City of Greater Geelong Council area is prone to frequent stormwater flooding and localised flooding, these areas include Lara, Ocean Grove, Barwon Heads, Geelong CBD, Highton, Newtown, Belmont, Corio, Norlane, Bell Park, Waurn Ponds Grovedale, Newcomb, Moolap, Drysdale, Clifton Springs, Portarlington, St Leonards, Point Lonsdale and Leopold.

Specifically, within the Geelong CBD the catchment covers a diverse mix of land uses including high-density residential, commercial and industrial development. The majority of the catchment has a relatively steep slope grading towards Corio Bay. Given the relatively high percentage of impervious surfaces within the study area and adjoining catchment, an extensive drainage network has been constructed in order to service the stormwater runoff requirements within the catchment. Rainfall runoff generated within the catchment is drained to Corio Bay via the existing drainage network of pits and via overland flow predominantly directed along the city's roadways. Significant drainage infrastructure within the study areas includes the Western Gully Main Drain and Outfall (at Cunningham Pier) and Johnstone Park Retarding Basin.

Recent short duration, high intensity rainfall events have led to significant property damage in Geelong during several 2016 and 2017 flood events, refer to the map below. The damage to infrastructure caused by a recent stormwater flood events has been estimated to cost more than $569,000, refer to the table below. Stormwater flood damages recorded in the VICSES and City of Geelong Council Request of Assistance Database clearly shows that City of Greater Geelong Council has significant stormwater flood risk. This building damage information only indicates buildings that may be at risk of above floor flooding. It's important to note this information has a low level of accuracy and should be used as a guide only. Refer to the map below showing buildings impacted by stormwater flooding.

Table 39.Cost of Geelong stormwater flood event damages (COGG 2018).

Flood event	Cost of damage to infrastructure
27th January 2016	$409,000
20th March 2017	$111,000
9th April 2017	$281,000
24th April 2017	$569,000

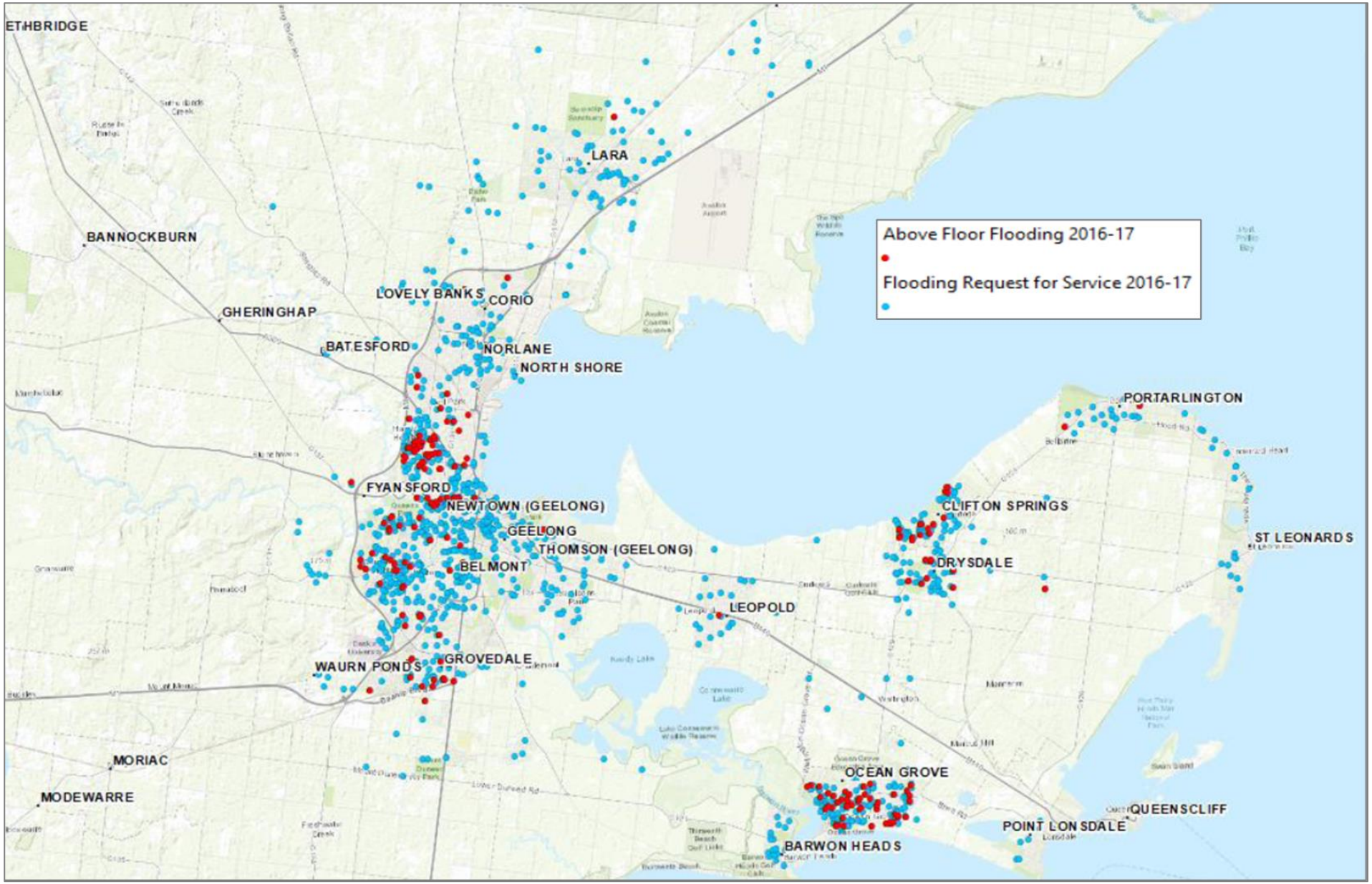


Figure 116. 2016-2017 City of Greater Geelong Council Requests for assistance.

Figure 117. The City of Greater Geelong Council areas impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

Figure 118. The Geelong CBD area impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

Figure 119. The Highton area in Geelong impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

Figure 120. The Bell Park area in Geelong impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

Figure 121. The Norlane area in Geelong impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

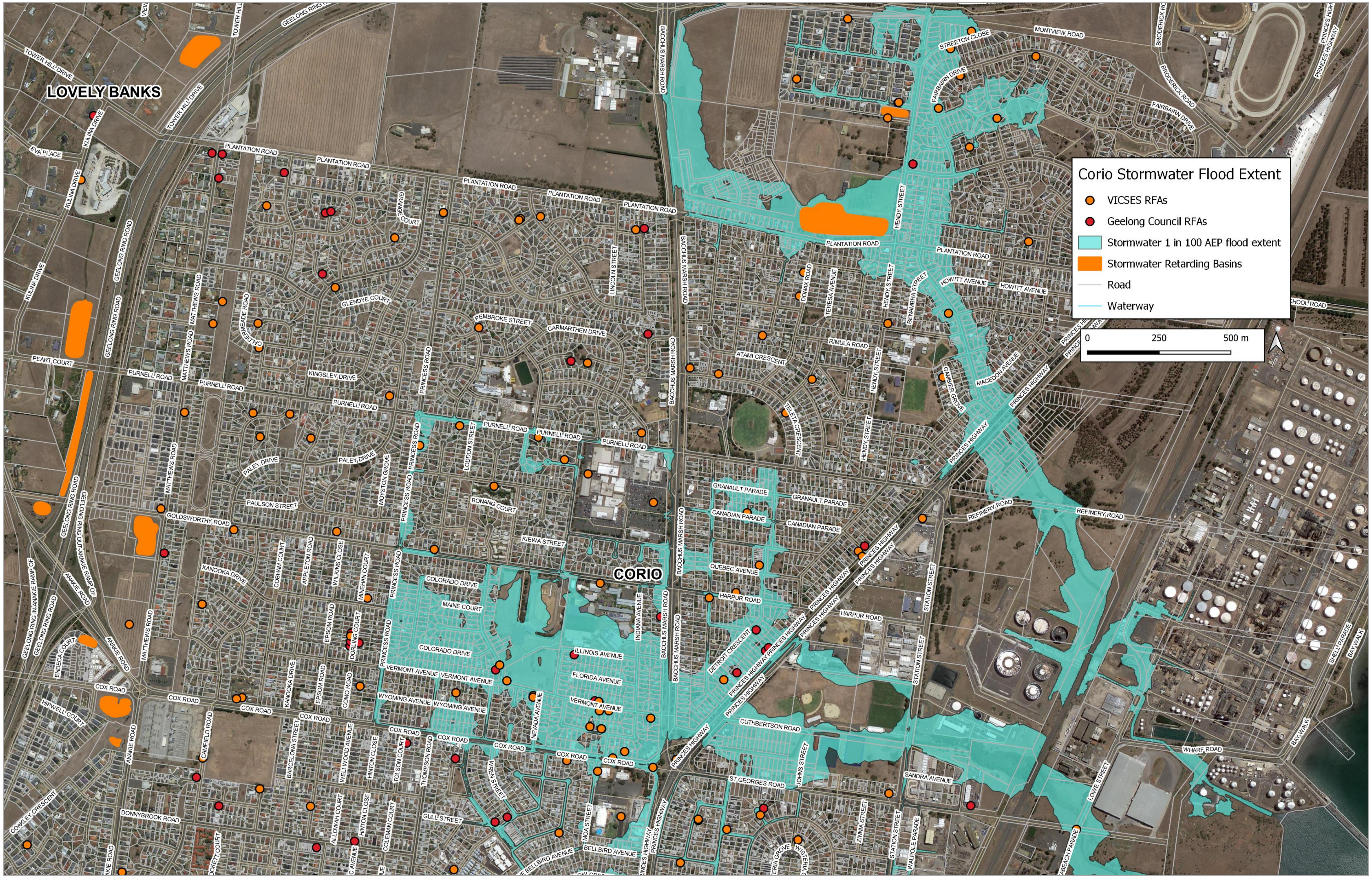


Figure 122. The Norlane area in Geelong impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

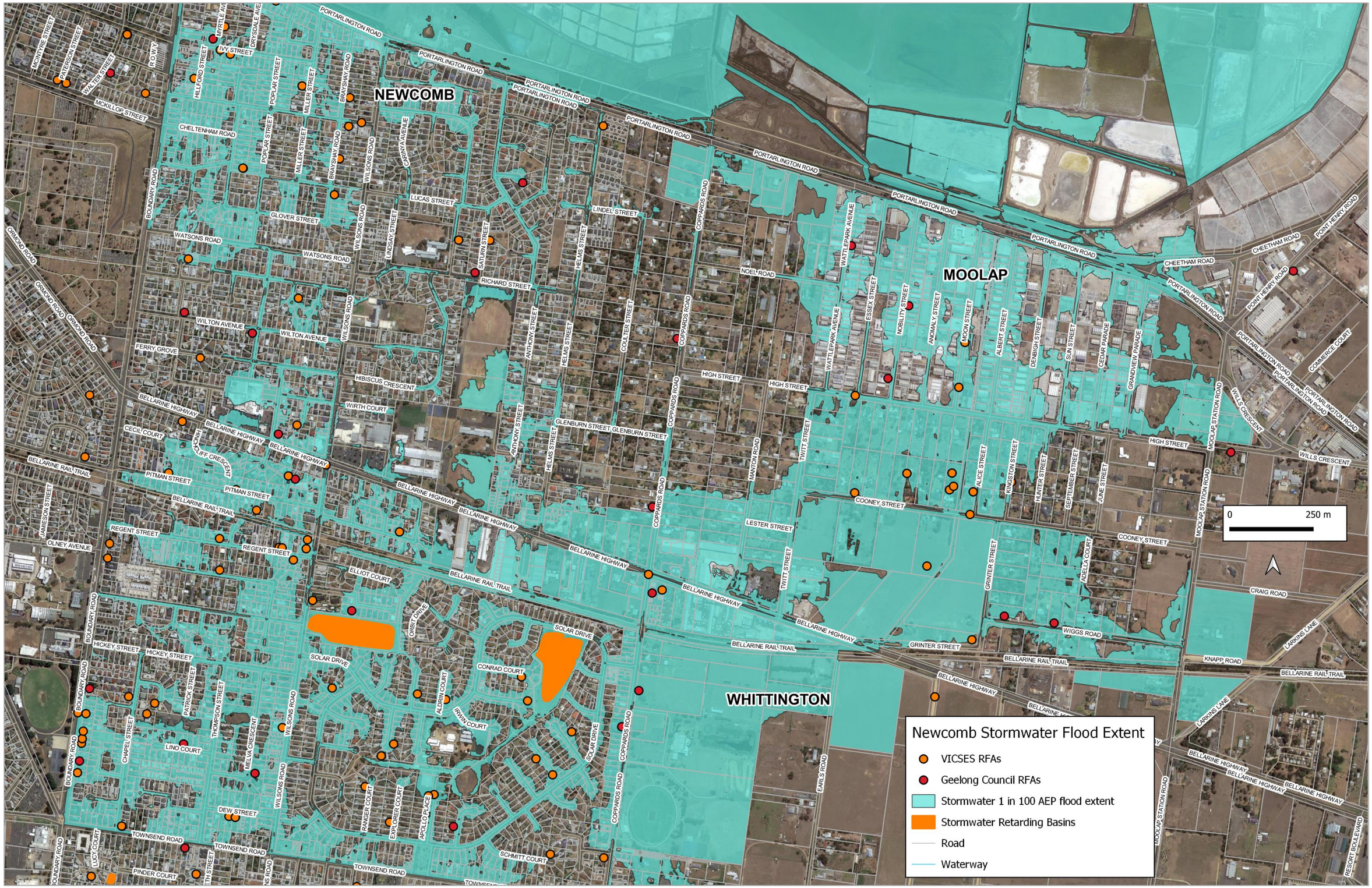


Figure 123. The Newcomb and Moolap area in Geelong impacted by stormwater flooding, 1 in 100 year AEP flood extent (COGG 2021).

Historic Stormwater Flood Events

Rainfall records indicate that Geelong has experienced frequent stormwater flood events since early 1970's, refer to the graph below. The largest recent stormwater flood event was in 1973, 1974, 1978, 1980, 1983, 2005, 2011, 2016, 2017, 2020, refer to the photos below. Significant flood events have occurred in 2016 and 2017. The 2016 flood event was the largest recent flood event on record, with 53.34 mm falling in greater than 1.5 hours on the 27th of January.

The Avalon Airport rainfall gauge was used to indicate when historic flood events have occurred in Geelong, however there is a distinct lack of long-term rainfall monitoring surrounding Geelong. Several rainfall gauges have recently been installed, however only have more than a few years of record.

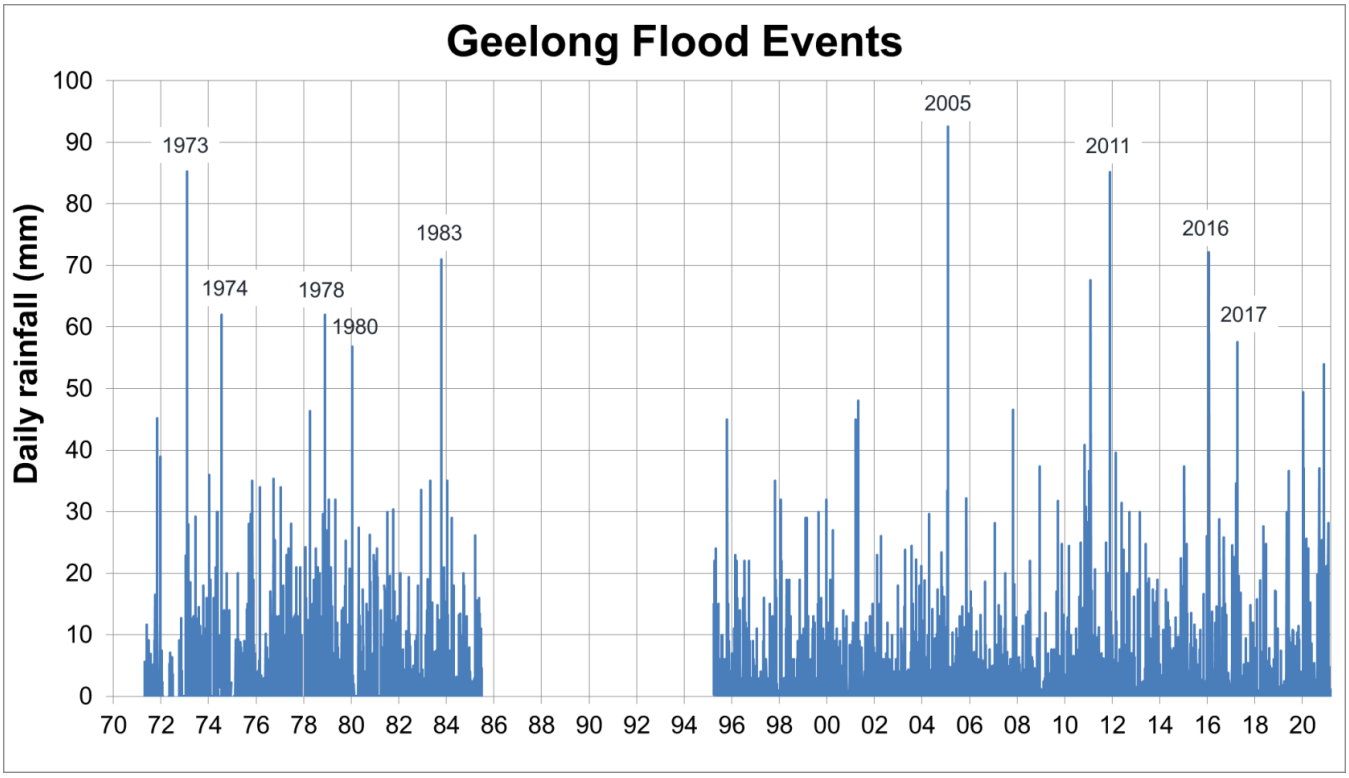


Figure 124. Geelong historic stormwater flood events.

January 2016 flood event

The January 2016 flood event was Geelong's largest recent event on record, estimated to be between a 1 in 50 and 1 in 100 year AEP event. Highton rainfall gauge recorded 214 mm over 4 days. The BoM estimated that Geelong and Avalon got more than a month's worth of rain in the downpour. Geelong recorded 42.4mm in that severe thunderstorm, equivalent to a 1 in 50 year AEP event, and almost double it's January average rainfall in about an hour. Avalon rainfall topped that, as the storm moved through there, they're up to 72mm, 54mm of that in 30 minutes, a staggering rainfall event there, 1 in 100 year AEP event.

On the 27th of January significant flooding occurred in the Geelong CBD, Highton, Belmont, Armstrong Creek, Waurn Ponds Creek, Lara, Corio, Bell Park, Newtown, Grovedale, Whittington, Newcomb, Moolap, Clifton Springs, Drysdale, Lovely Banks, Norlane, Portarlington, Leopold, St Leonards, Port Lonsdale, Barwon Heads and Ocean Grove.

Cars were submerged, 18 people were rescued and hundreds of buildings were damaged during the stormwater flash flood event in Geelong after a severe storm unleashed a huge downpour. VICSES and the City of Greater Geelong Council responded to more than 600 calls for assistance, mainly from people in Geelong. Of these calls188 of these requests related to cars stuck in water, flooding through homes, and roofs leaking. The most concerning were 18 calls to rescue people out of floodwaters. Unfortunately, there were many cases of people caught in car parks in fast-flowing water, causing risk to life. The Geelong Hospital, local roads and the Geelong railway line were affected by the storm.

There were several underground toilets and underground car parks (part of the Westfield and Bay City Shopping Centres) in Brougham Street and Moorabool Street. Basements of buildings were fully submerged including the National Wool Museum along Brougham Street and Moorabool Street. Deep flooding impacted cars in the carpark on the corner of Corio Street and Mercer Street. Deep flooding greater than 1 m depth was observed at the corner of Gordon Ave and Fenwick Street, and was described as an overland flowpath. The EPA reported an oil sheen in Geelong's Corio Bay and shoreline near the Viva refinery. The EPA investigated the leak and urged people to avoid swimming in the area until further notice.

Heavy localised rainfall caused significant flooding to the Johnston Park Retarding Basin, caused flooding to overflow into adjacent properties and roads, refer to flood photos below. A Department of Transport spokesman said several cars had to be fished out of floodwaters on Ballarat Road in North Geelong due to people driving when they shouldn't. Most minor and major roads were impacted by flooding, cutting access to Rossack Drive. Extensive flooding along Gordon Avenue, to a depth of 1.2 m caused cars parked in the area to be fully submerged.

Figure 125. Cars cross a flooded Geelong street during the January 2016 flood event.

Figure 126. Cars submerged along Gordon Avenue during the January 2016 flood event (COGG).

Figure 127. Johnstone Park impacted by flooding during the January 2016 flood event (COGG 2018).

Figure 128. Cars submerged in water outside the Traffic Accident Commission in Geelong during the January 2016 flood event.

Figure 129. Flooding in Geelong west during the January 2016 flood event (COGG 2020).

Figure 130. Rain causes flooding on the corner of Ryrie and Moorabool Streets in Geelong during the January 2016 flood event.

Figure 131. Underground drains overflowing, filling the Johnston Park during the January 2016 flood event. The arrow indicates a partial collapse of the main drain (COGG 2018).

Figure 132. Johnston Park impacted by flooding during the January 2016 flood event (COGG 2018).

Flood Warning Time

Stormwater flooding can develop quickly as a result of heavy rainfall. Heavy rainfall can cause rapid rise of floodwater. The warning time available from rainfall to stormwater flood impacts occurring can range between 2 to 3 hours depending on the rainfall intensity.

Flood Mitigation Works

The City of Greater Geelong Council regularly undertakes stormwater flood studies that are used to target problem areas to prioritise strategic drainage network upgrades. The City of Greater Geelong Council are currently undertaking stormwater flood studies for Cowies Creek, Ocean Grove, Clifton Springs, Drysdale and Armstrong Creek. For detail regarding stormwater ponding areas refer to the stormwater flood maps below. Significant flood mitigation works have been undertaken by the City of Greater Geelong Council to reduce stormwater flooding over the last 5 years. These have involved the construction of retarding basins, upgrading drainage systems and the construction of levees and other works have substantially reduced flood risk within the City of Greater Geelong Council area.

Following the completion of the Central Geelong flood study in 2016 (Water Technology 2016) and significant stormwater flooding that has impacted the Geelong CBD and West Geelong areas over the past 10 years, the City of Greater Geelong Council recognised that extensive investment was required to reduce floor risk. Refer to the 1 in 100 AEP flood map and January 2016 event photo of the Geelong CBD below. The City of Greater Geelong Council have recently constructed a new stormwater drain along Gheringhap Street, from near Johnstone Park to Corio Bay, significantly reducing the frequency and severity of flooding with the Geelong CBD following major storm events and benefitting local businesses, residencies, visitors and developers by reducing insurance claims. The construction of the new 450 m Gheringhap Street Drain was completed in December 2019 and will ensure the Convention Centre and other future buildings are protection from flooding around the Geelong CBD waterfront.

City of Greater Geelong Council are currently undertaking flood study for the Armstrong Creek, Cowies Creek, Clifton Springs and Drysdale area, focused on identifying future feasible stormwater flood mitigation options. Proposed priority stormwater drainage upgrade projects include upgrading drainage in Lara along Kyema Drive.

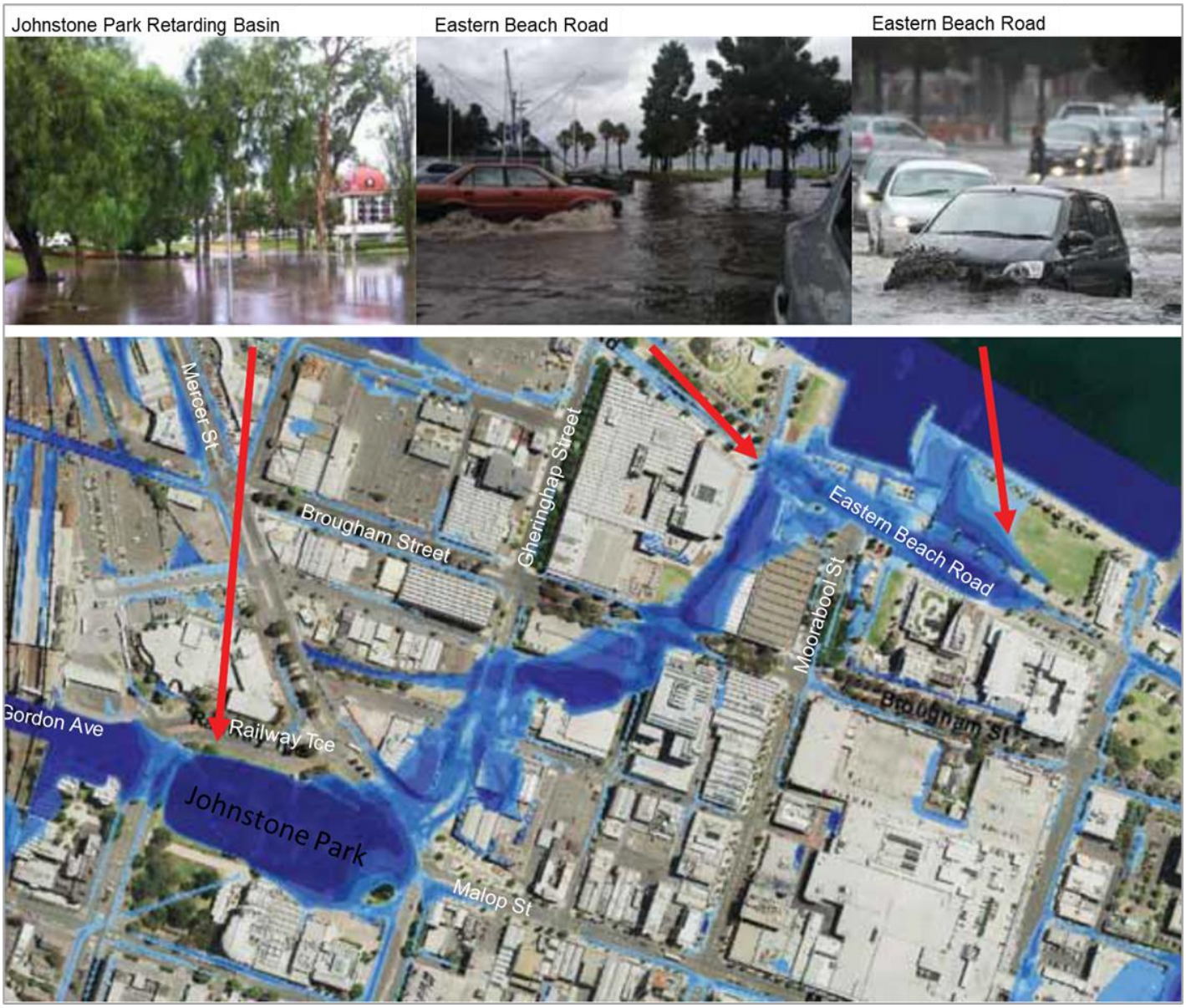


Figure 133. Johnstone Park Retarding Basin and Gheringhap Street 1 in 100 AEP year flood depth map (Water Technology 2016).

Retarding Basins

Retarding basins within the City of Greater Geelong Council area play an important role in temporarily storing stormwater runoff and reducing downstream flow rates. Retarding basins are designed to reduce floor risk in surrounding properties and roads. While there are more than 128 stormwater retarding basins located within the City of Greater Geelong Council, there are 12 key retarding basins, these include;

- 1. Prestige Park Basin, 44 Prestige Ave, Bell Park.
- 2. Parkland (Pepperdine Way) Basin, Peppertree Way, Highton.
- 3. Knollbrook Close Basin, Knollbrook Close, Highton.
- 4. Sunderland (Grosverner Drive) Basin, 50 Sunderland Road, Wandana Heights.
- 5. Scenic Road/Barrabool Road Detention Basin, Wandana Heights.
- 6. 8 Shetland Close, Highton
- 7. Highton – Augustine Lake Reserve, South Valley Road, Highton.
- 8. Barrabool Road and Thoroughbred Way
- 9. McDonald Reserve, 77 Reynolds Road, Belmont.
- 10. Dunsmore Road Basin, Shoubra Reserve, Highton.
- 11. Kingston Estate, Ocean Grove.
- 12. McLeods Water Hole, Wyndham Street, Drysdale.

Refer to the map below for the locations of these key City of Greater Geelong Council retarding basins (numbers in the table above are the same retarding basins in the map below).

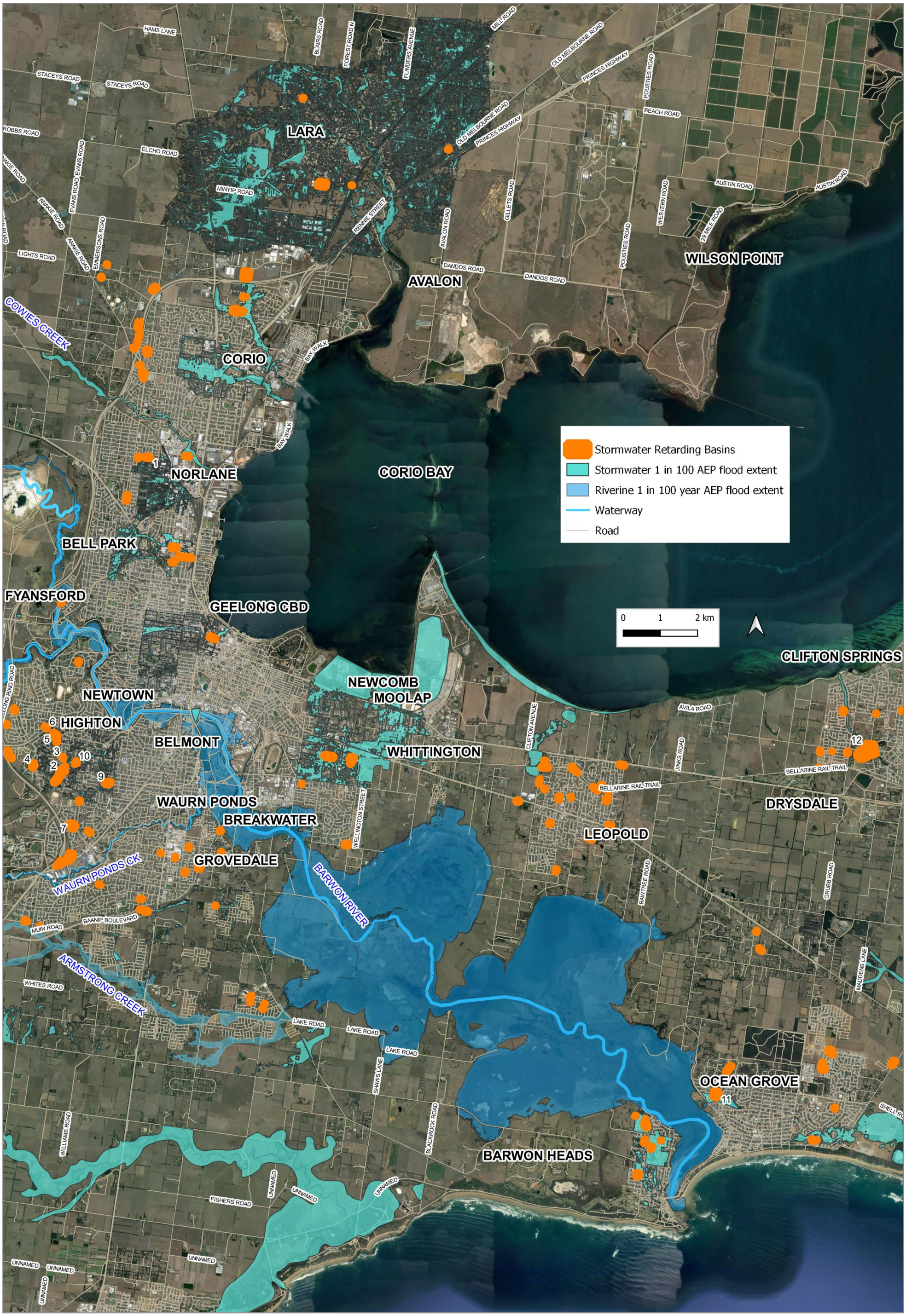


Figure 134. City of Greater Geelong Council key retarding basins (number in the table above) with 1 in 100 year flood extent maps (COGG 2021).

Appendix D: Flood evacuation arrangements

Phase 1 - Decision to Evacuate

The decision to evacuate is to be made in consultation with the MEMO, MERC, DFFH, Health Commander and other key agencies and expert advice (CMA's and Flood Intelligence specialists).

The Incident Controller may make the decision to evacuate an at-risk community under the following circumstances:

- Properties are likely to become inundated;
- Properties are likely to become isolated and occupants are not suitable for isolated conditions;
- Public health is at threat as a consequence of flooding and evacuation is considered the most effective risk treatment. This is the role of the Health Commander of the incident to assess and manage. Refer to the State Health Emergency Response Plan (SHERP) for details);
- Essential services have been damaged and are not available to a community and evacuation is considered the most effective risk treatment.

The following should be considered when planning for evacuation:

- Anticipated flood consequences and their timing and reliability of predictions;
- Size and location of the community to be evacuated;
- Likely duration of evacuation;
- Forecast weather;
- Flood Models;
- Predicted timing of flood consequences;
- Time required and available to conduct the evacuation;
- Evacuation priorities and evacuation planning arrangements;
- Access and egress routes available and their potential flood liability;
- Current and likely future status of essential infrastructure;
- Is cross border assistance required or evacuation to another municipality relief centre?;
- Resources required and available to conduct the evacuation;
- Shelter including Emergency Relief Centres, Assembly Areas etc.;
- Vulnerable people and facilities;
- Transportation;
- Registration
- People of CALD background and transient populations;
- Safety of emergency service personnel;
- Different stages of an evacuation process.

Phase 2 – Warning

Warnings may include a warning to ‘prepare to evacuate’ and a warning to ‘evacuate now’. Once the decision to evacuate has been made, the at-risk community will be warned to evacuate. Evacuation warnings should be disseminated via methods listed in section 3.6 of this plan.

Phase 3 – Withdrawal

VICPOL is the responsible agency for evacuation. VICSES will provide advice regarding most appropriate evacuation routes and locations for at-risk communities to evacuate to.

VICSES, CFA, AV and Local Government will provide resources where available to support VICPOL/ REGIONAL ROADS with route control and may assist VICPOL in arranging evacuation transportation.

VICPOL will control security of evacuated areas.

Evacuees will be encouraged to move using their own transport where possible. Transport for those without vehicles or other means will be arranged.

Air support operations will be conducted under the control of the IC

The IC may request aircraft support through the State Air Desk located at the SCC will establish priorities.

Suitable airbase facilities are located at:

- Avalon Airport, Beach Road, Lara.
- Barwon Heads Airport, Barwon Heads Road, Connewarre

Special needs groups will be/are identified in Council’s ‘vulnerable persons register’. This can be done through community network organisations.

Phase 4 – Shelter

Relief Centres and/or assembly areas which cater for people’s basic needs for floods may be established to meet the immediate needs of people affected by flooding

VICPOL in consultation with VICSES will liaise with Local Government and DFFH (where regional coordination is required) via the relevant control centre to plan for the opening and operation of relief centres. This can best be achieved through the Emergency Management Team (EMT).

Animal Shelter

Animal shelter compounds will be established for domestic pets and companion animals of evacuees.

Phase 5 – Return

The Incident Controller in consultation with VICPOL will determine when it is safe for evacuees to return to their properties and will arrange for the notification of the community.

VICPOL will manage the return of evacuated people with the assistance of other agencies as required.

Considerations for deciding whether to evacuate include:

- Current flood situation;
- Status of flood mitigation systems;
- Size and location of the community;
- Access and egress routes available and their status;
- Resources required to coordinate the return;
- Special needs groups;
- Forecast weather;
- Transportation particularly for people without access to transport

Disruption to Services

Disruption to a range of services can occur in the event of a flood. This may include road closures affecting school bus routes, truck routes, water treatment plant affecting potable water supplies etc.

Public Information and Warnings

VICSES uses EM-COP Public Publishing to distribute riverine and flash flood warnings in Victoria. The platform enables automatic publishing to the VicEmergency app, website and hotline (1800 226 226). Communities can also access this information through VICSES social media channels (Victoria State Emergency Service on Facebook and VICSES News on Twitter) and emergency broadcasters, such as Sky News TV and various radio stations (current list available via the EMV website).

VICSES Regions (or ICCs where established) lead the issuing of warnings for riverine flood events when pre-determined triggers are met (issuing of a BOM Flood Watch or Warning), and share locally tailored information via the standard VICSES communication channels (social media, traditional media, web and face to face). These activities are coordinated by the VICSES RDO and approved by the VICSES RAC, or the PIO and IC respectively (when an ICC is active).

If verified reports are received of flash flooding posing, or resulting in, a significant threat to life or property, VICSES Regions (or ICCs) will issue a flash flood warning product via EM-COP.

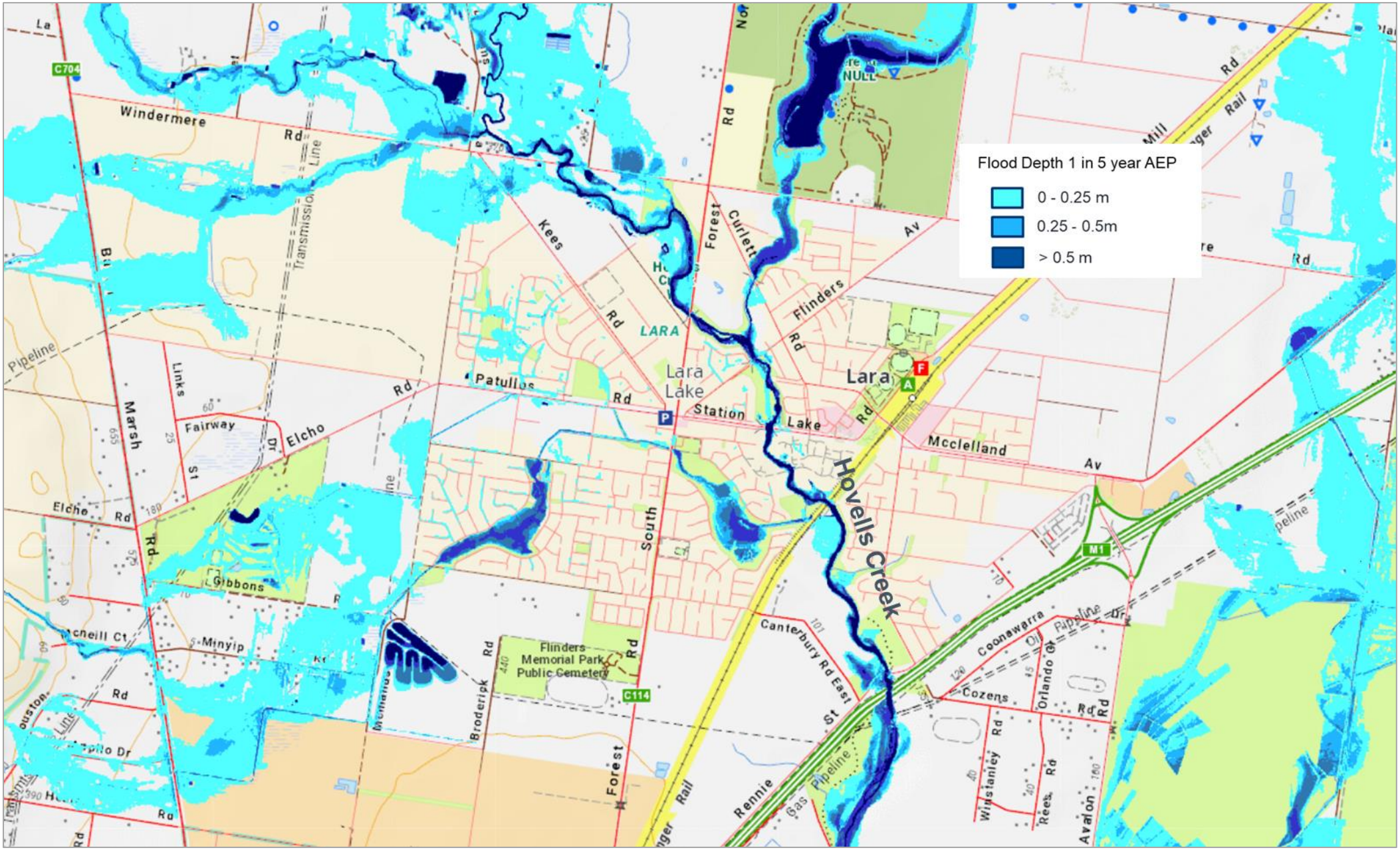
VICSES at the state tier (or SCC Public Information Section) plays an important role in sharing riverine and flash flood information via state-based standard communication channels.

During some emergencies, VICSES may alert communities by sounding a local siren, or by using the Emergency Alert (EA) platform to send an SMS to mobile phones or a voice message to landlines. The use of sirens for higher-end warnings has been pre-determined, and mapped to relevant warning templates in EM-COP.

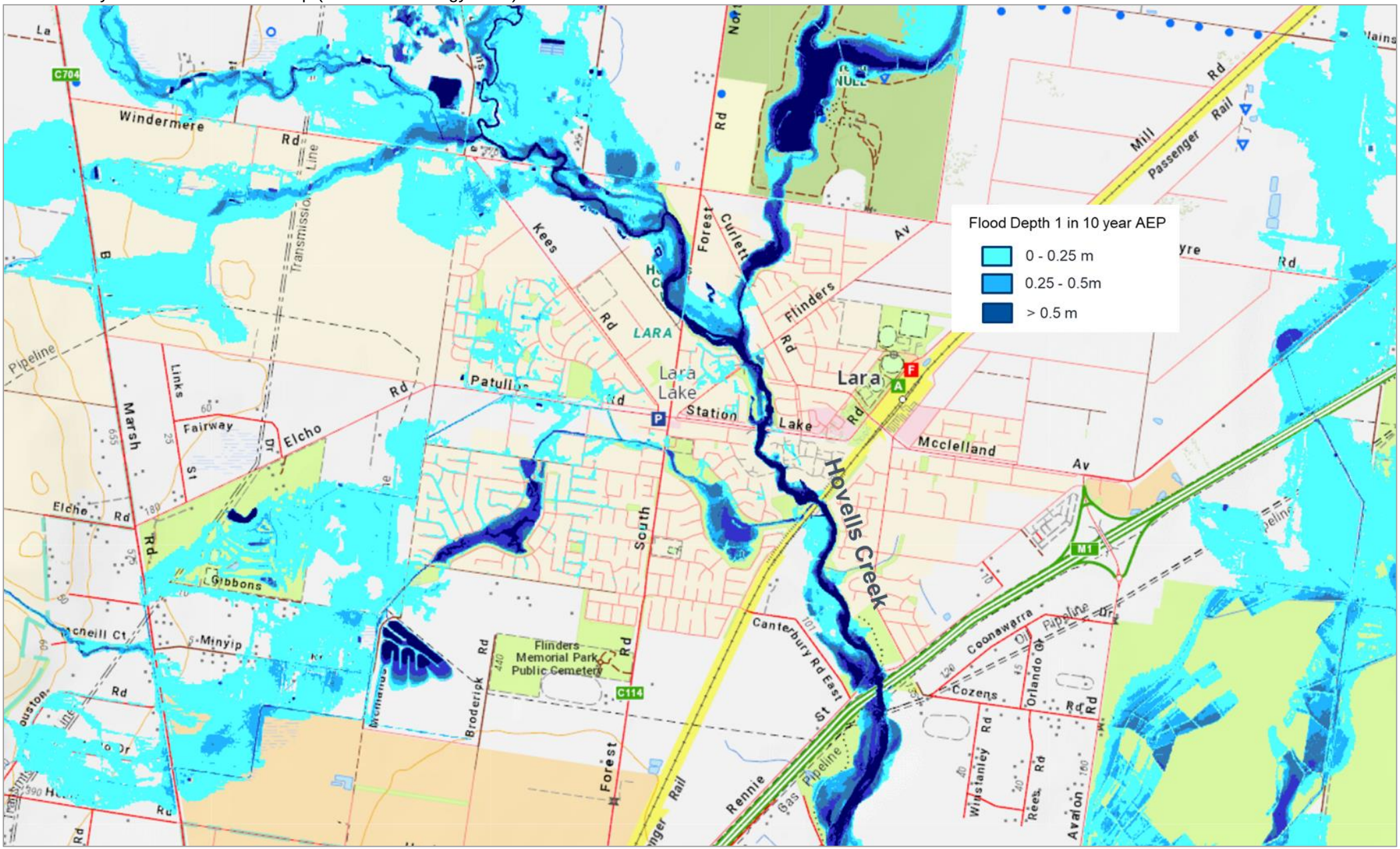
EM-COP Public Publishing Business Rules for Riverine and Flash Flood are available in the **Public Information tab of the IMT Toolbox,** providing further guidance on specific triggers, roles and responsibilities. VICSES SOP057 and JSOP 04.01 provide further guidance.

Appendix E: Flood Maps

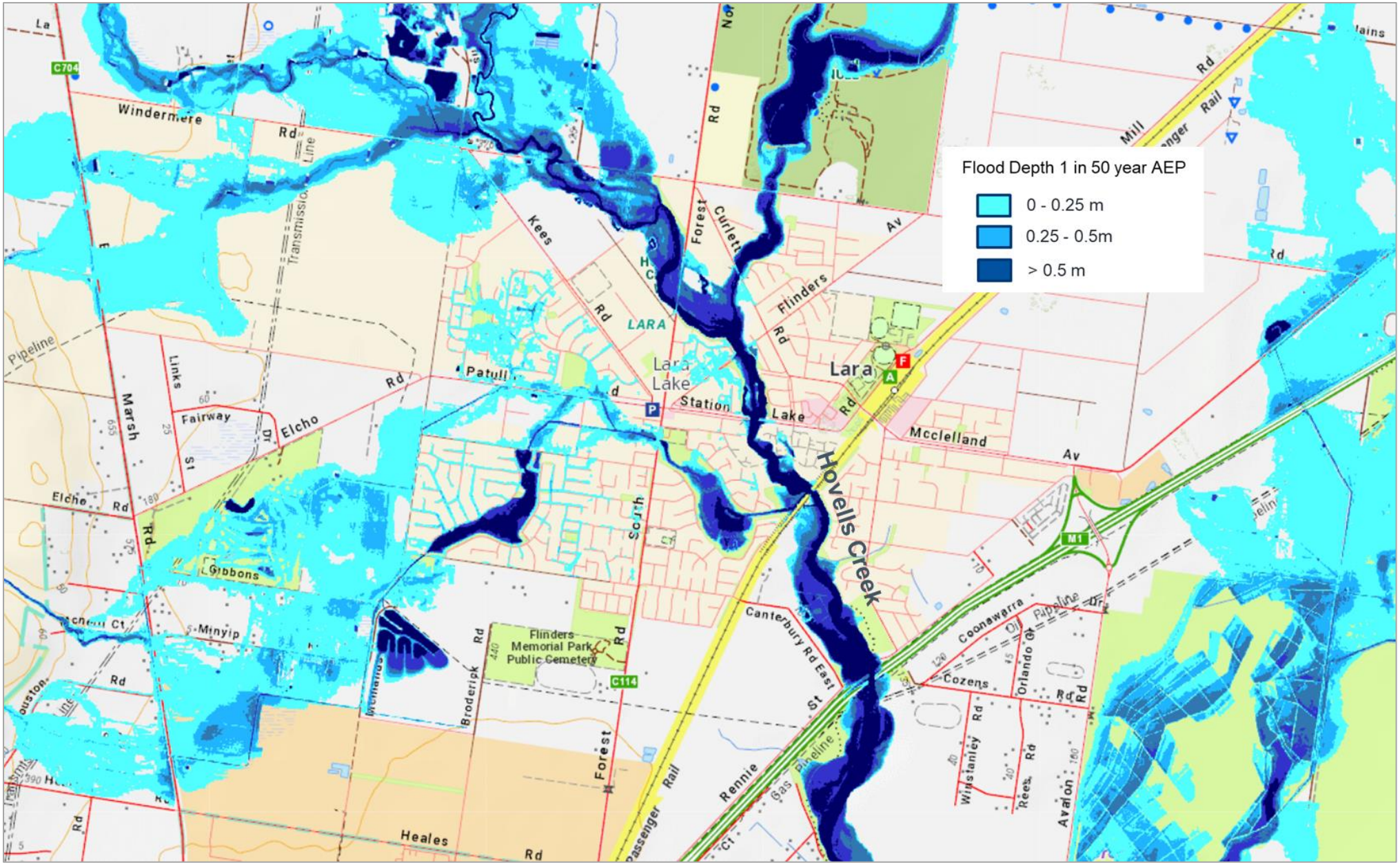
Lara 1 in 5 year AEP flood extent map (Water Technology 2020).



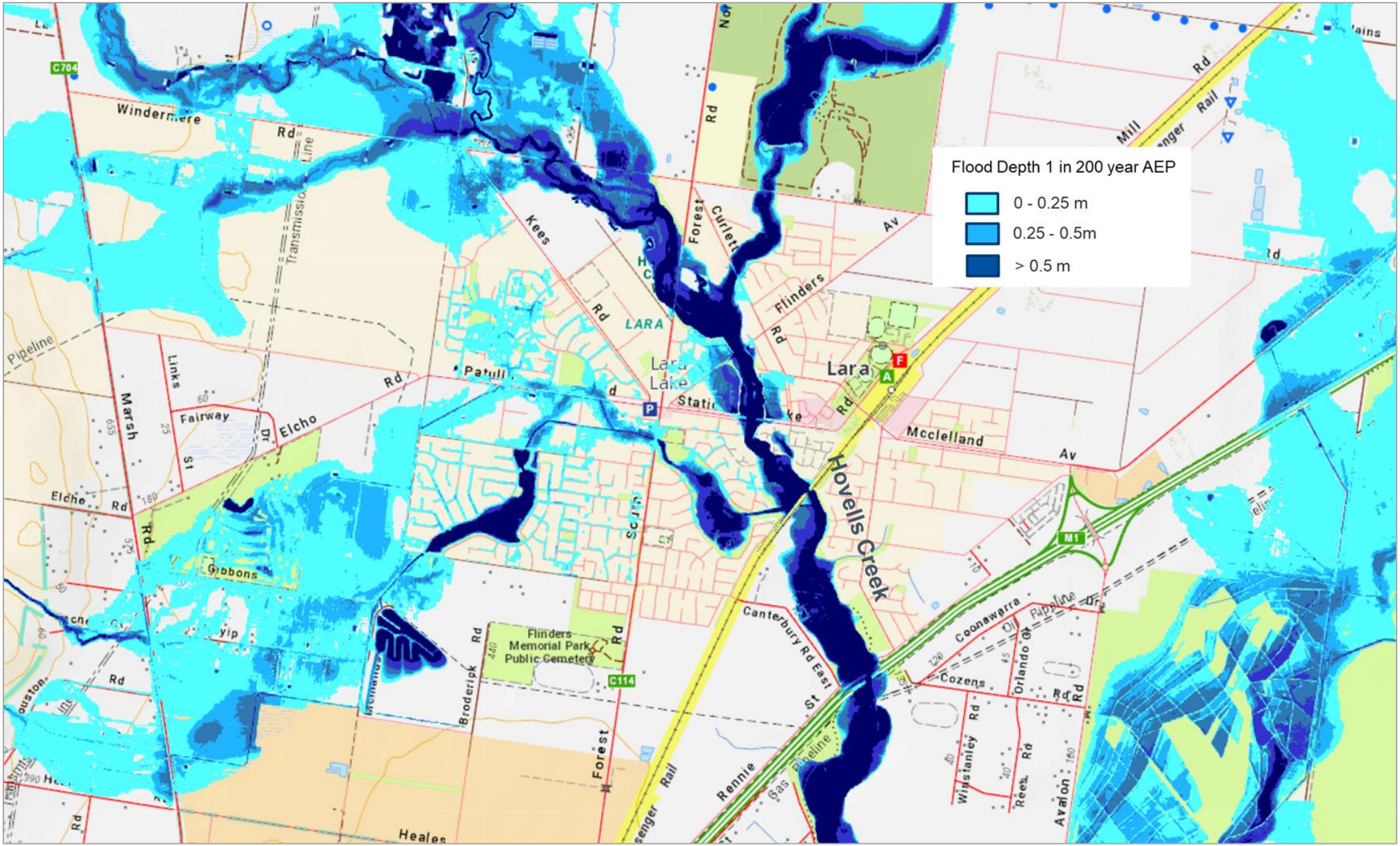
Lara 1 in 10 year AEP flood extent map (Water Technology 2020).



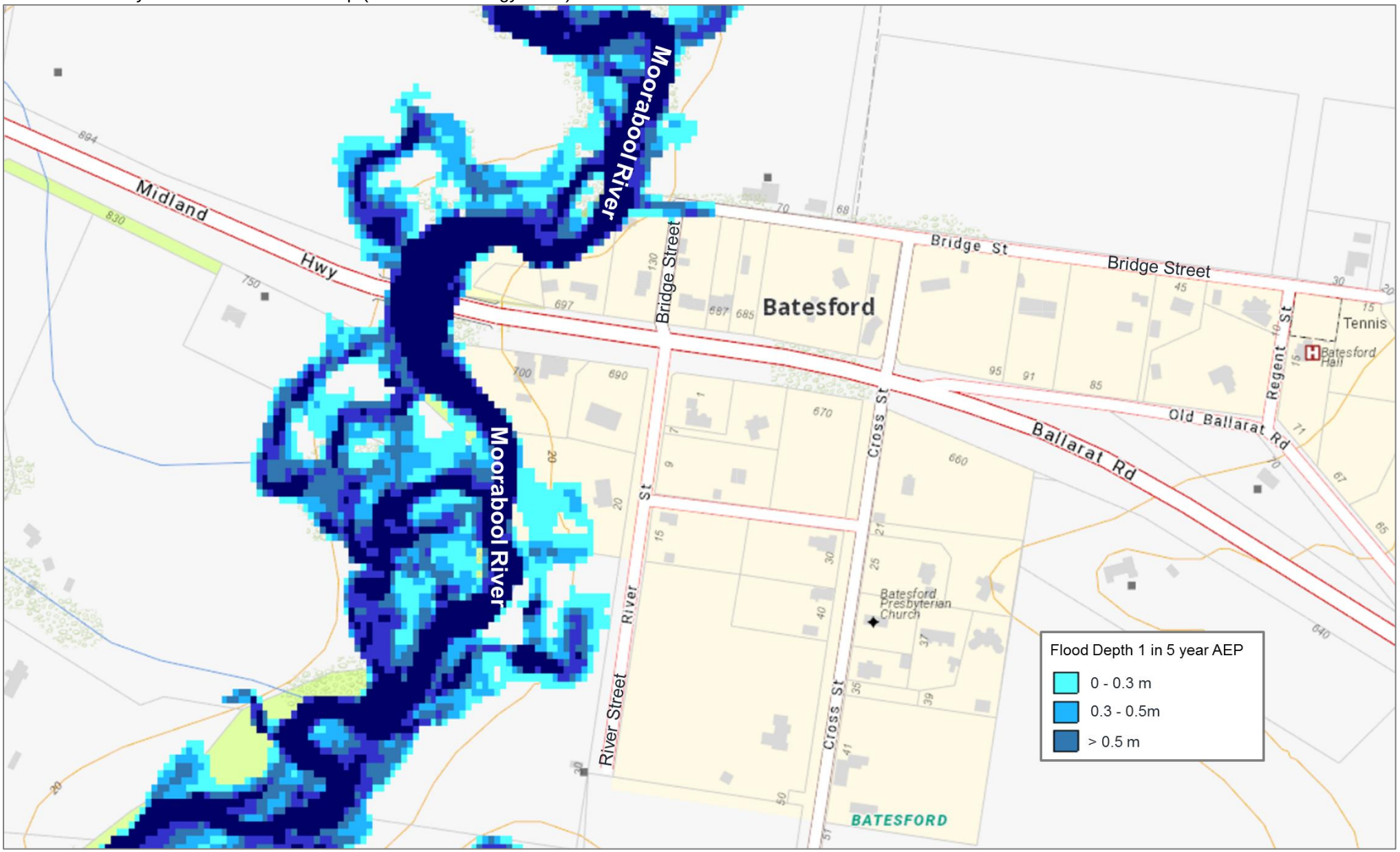
Lara 1 in 50 year AEP flood extent map (Water Technology 2020).



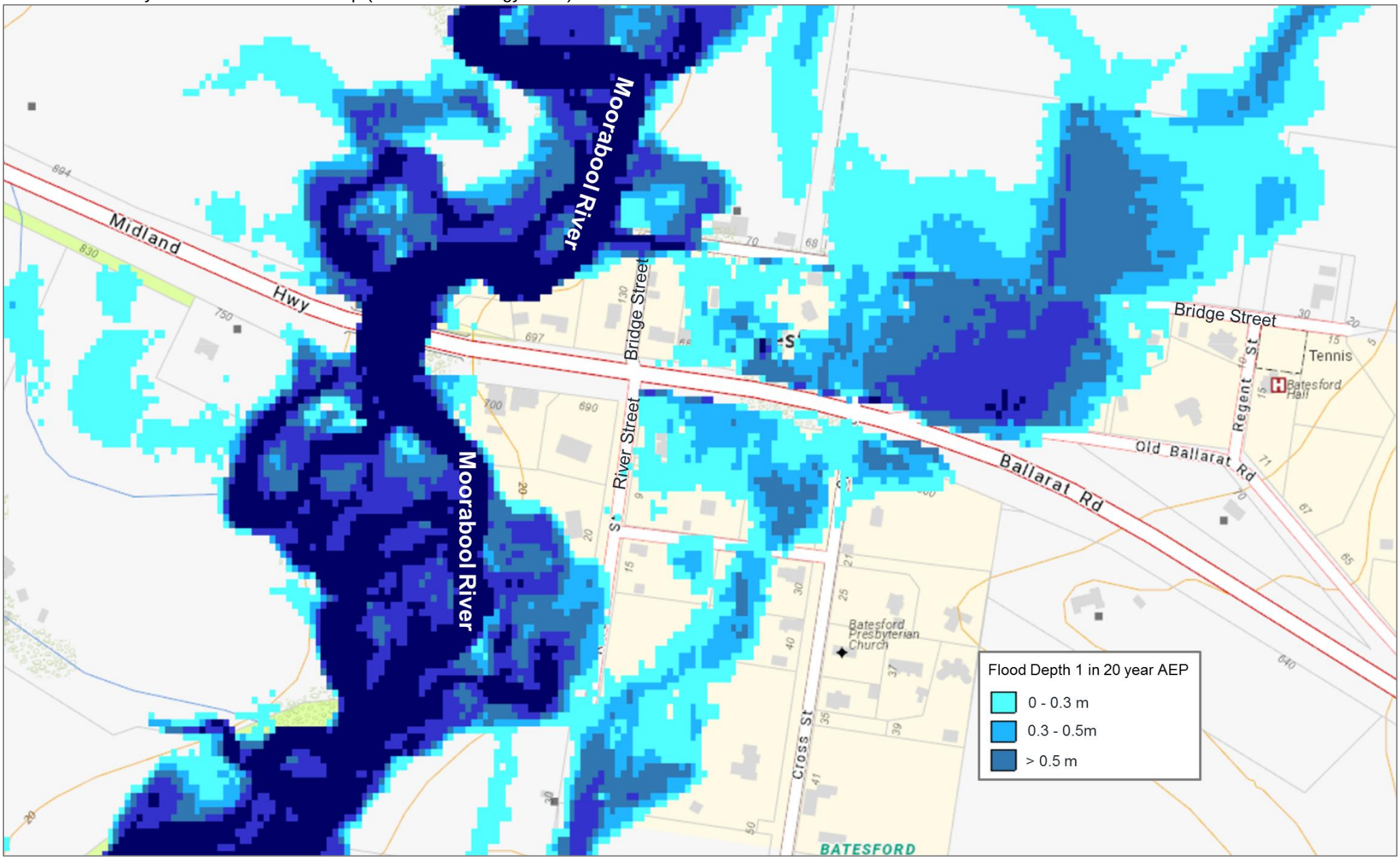
Lara 1 in 200 year AEP flood extent map (Water Technology 2020).



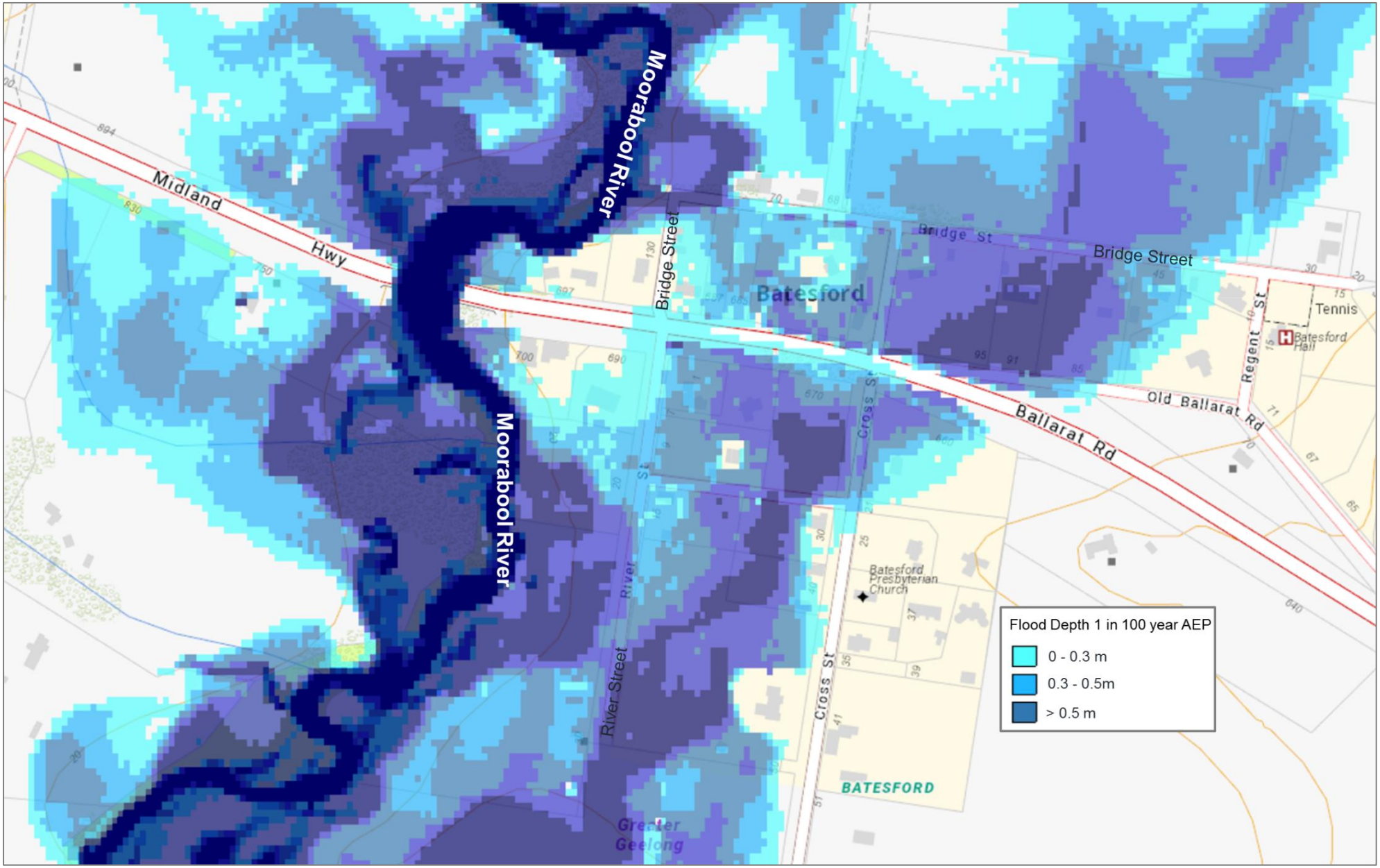
Batesford 1 in 5 year AEP flood extent map (Water Technology 2019).



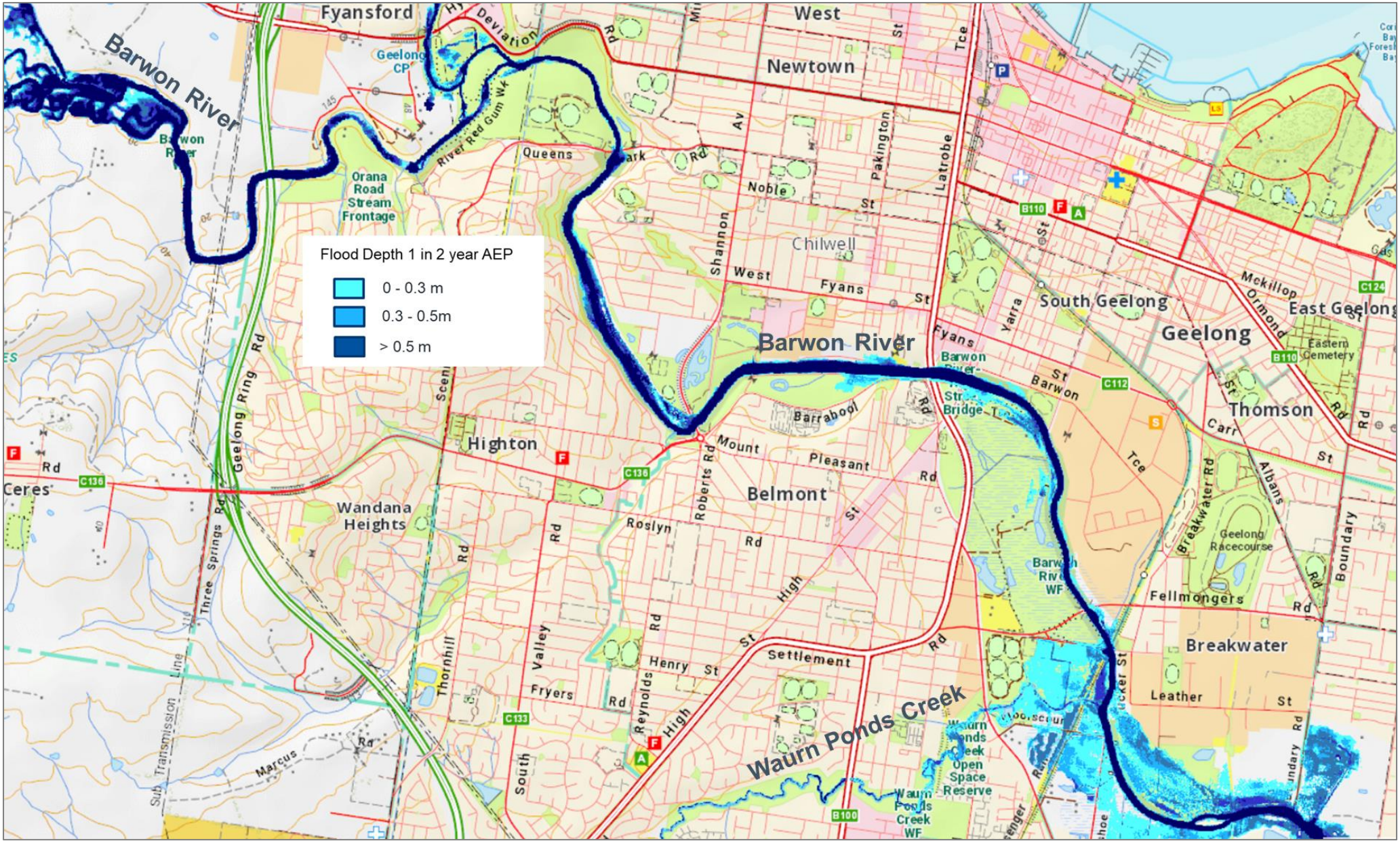
Batesford 1 in 20 year AEP flood extent map (Water Technology 2019)



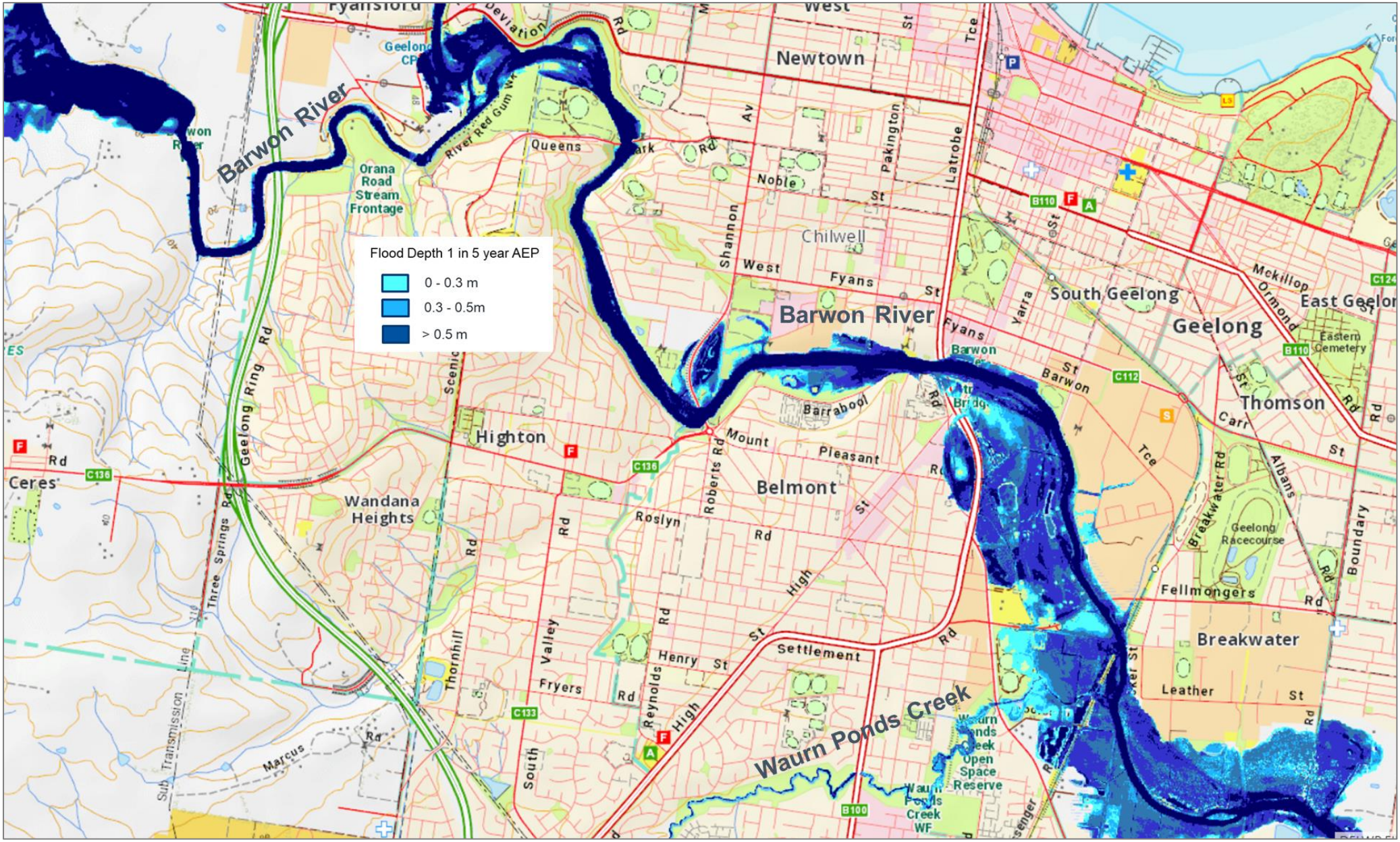
Batesford 1 in 100 year AEP flood extent map (Water Technology 2019).



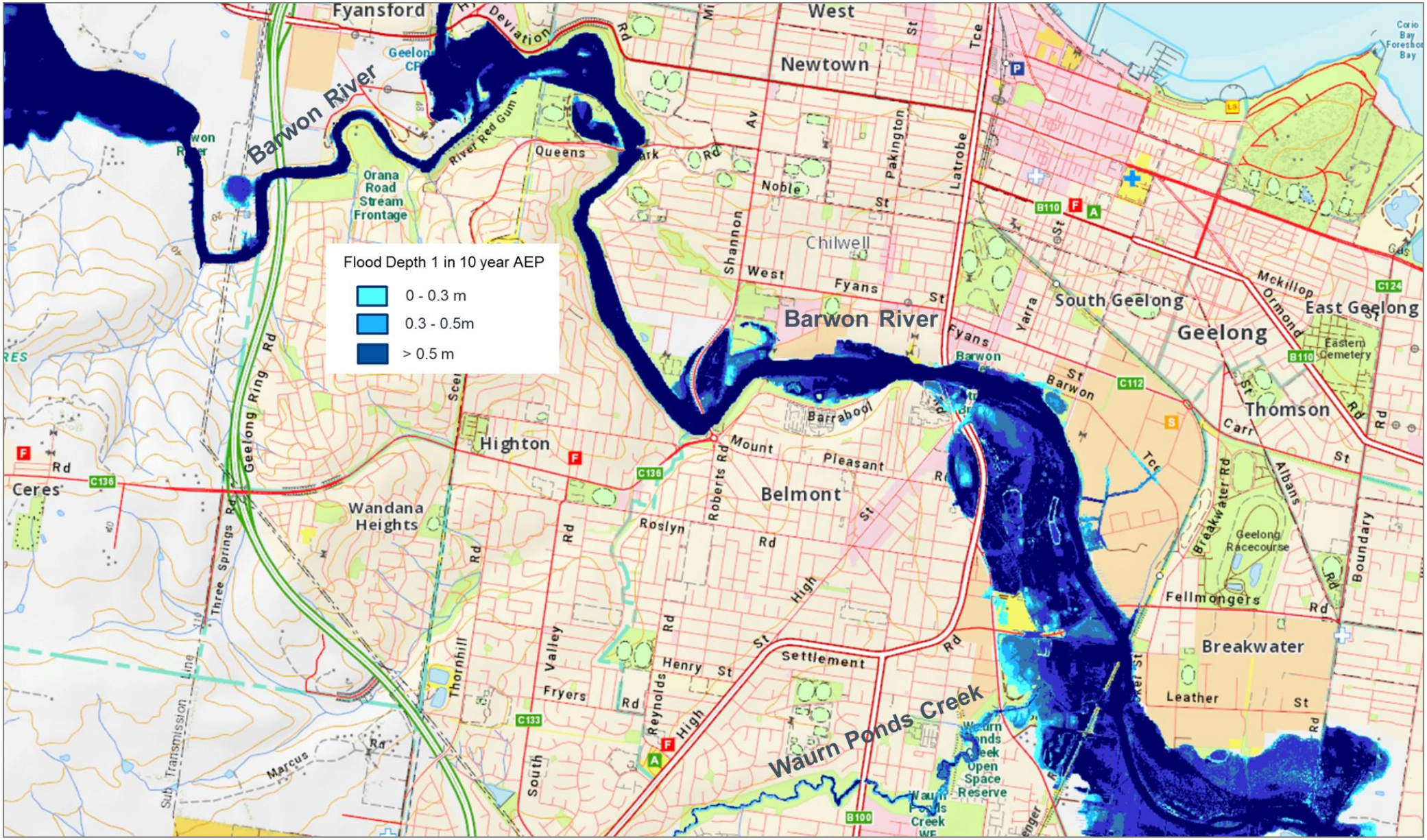
Geelong 1 in 2 year AEP flood extent map (Water Technology 2019).



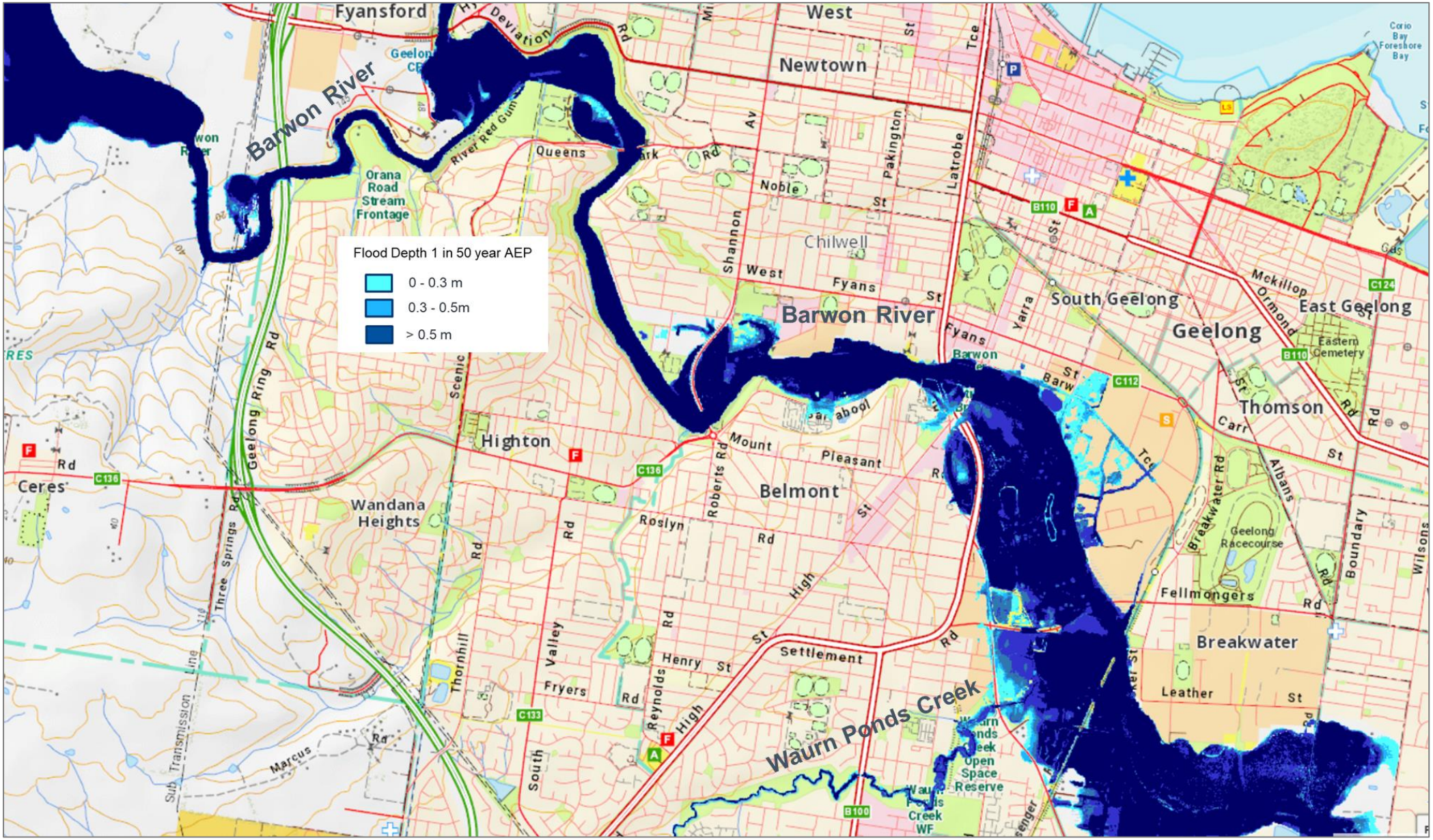
Geelong 1 in 5 year AEP flood extent map (Water Technology 2019).



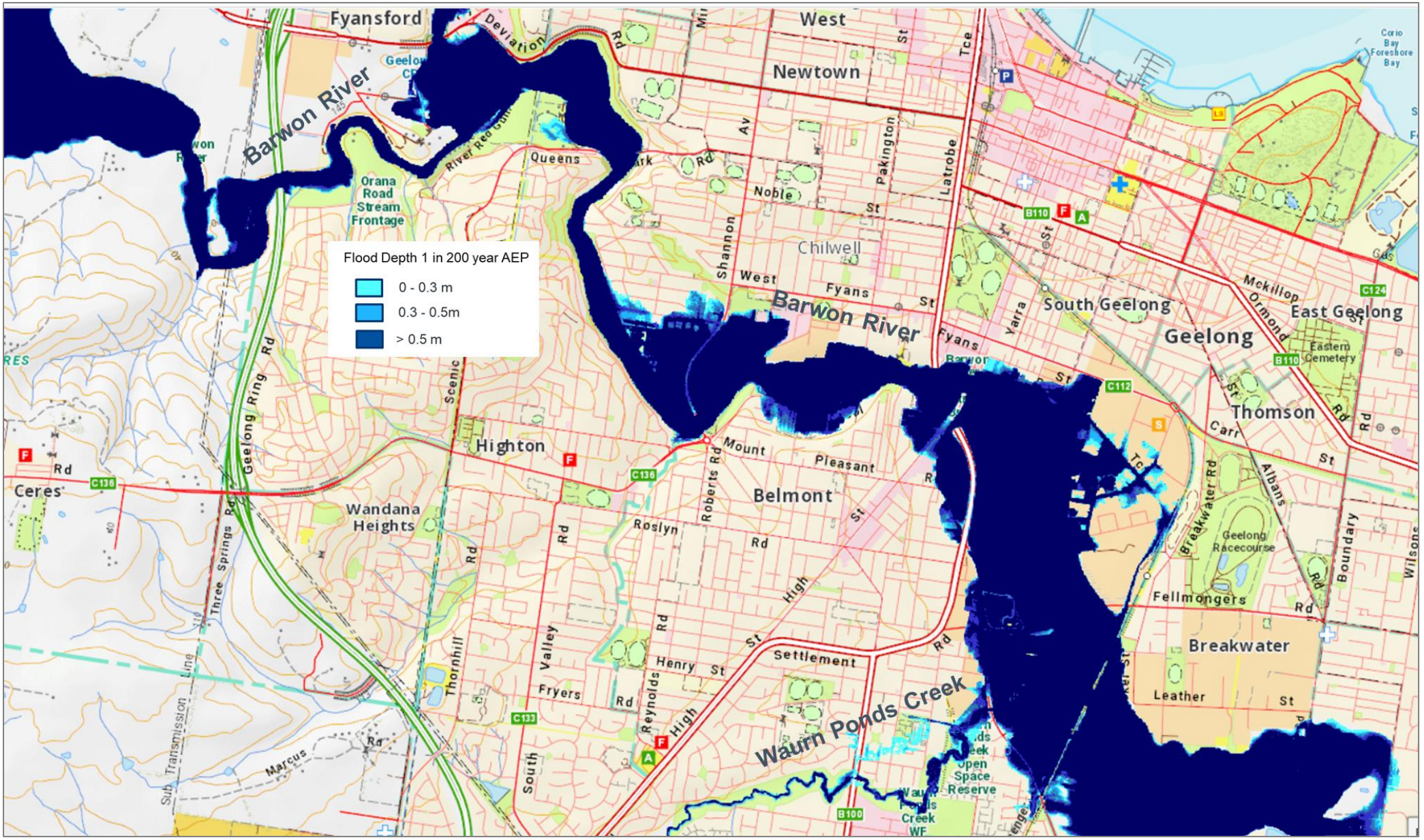
Geelong 1 in 10 year AEP flood extent map (Water Technology 2019).



Geelong 1 in 50 year AEP flood extent map (Water Technology 2019).



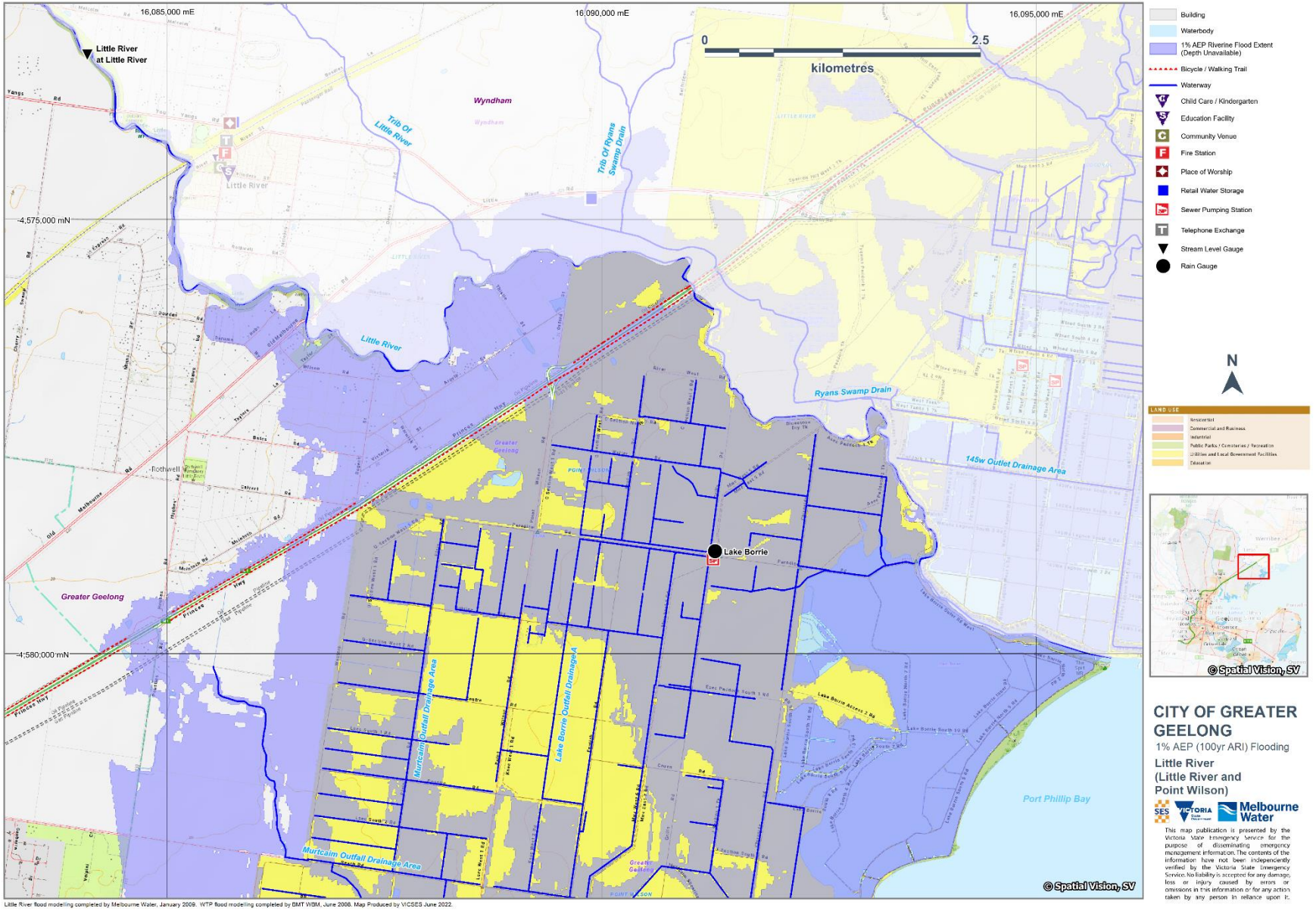
Geelong 1 in 200 year AEP flood extent map (Water Technology 2019).



Barwon Heads and Ocean Grove 1 in 10 year AEP flood depth map (Water Technology 2019).

Barwon Heads and Ocean Grove 1 in 20 year AEP flood depth map (Water Technology 2019).

Barwon Heads and Ocean Grove 1 in 200 year AEP flood depth map (Water Technology 2019).



Little River 1 in 100-year AEP flood extent map (Melbourne Water, January 2009).

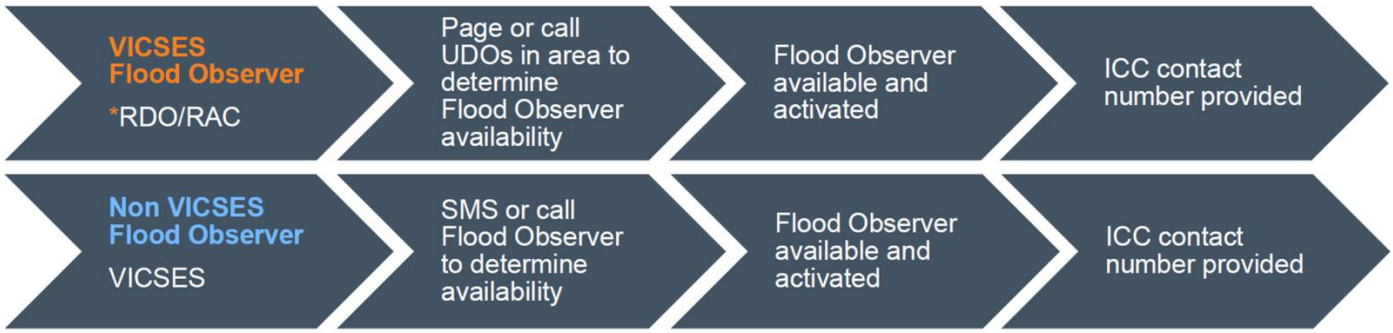
Appendix F: Local knowledge arrangements

As control agency for flood in Victoria, VICSES is committed to ensuring the incorporation of local knowledge in decision making before, during and after incidents.

Information from community sources including but not limited to observations, historical information and information about current and possible consequences of an incident may be utilised to help inform the process of incorporating local knowledge into decision making during an incident. Community observers and agency staff will help support this process.

Flood Observers

When a VICSES Incident Control Centre is activated with knowledge of a potential flooding event, Flood Observers should be contacted to determine their availability to assist. The process for activating flood observers is as flows:



*VICSES Flood Observers – The Intelligence Cell in consultation with the RDO/RAC will contact the Unit Duty Officer (UDO) of Units with Flood Observers in the area where observations are required. The UDO will contact Flood Observers to determine their availability. Available Flood Observers names and contact details will be provided to the intelligence cell from the UDO so they can be contacted and activated under normal resourcing arrangements.

In no-notice flash flooding events, the full list of observers will be provided by the RDO or RAC to the Incident Controller, for use by the Intelligence Cell once activated.

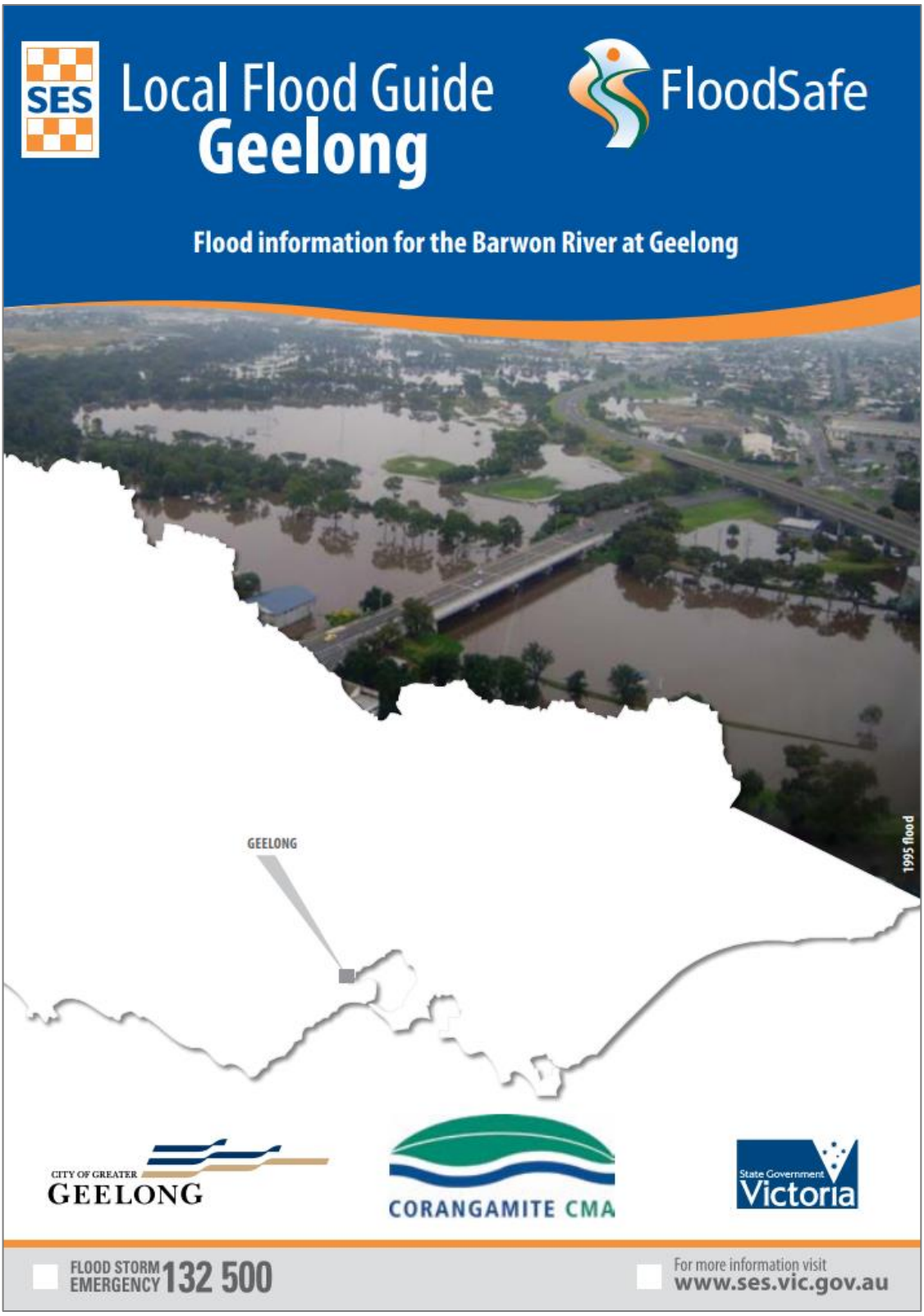
If non VICSES Flood Observers witness an unexpected significant flood event, they will notify VICSES via the 132 500 phone number and share flood photos via the Snap Send Solve app.

Targeted Flood Observer training will be undertaken by VICSES on an as needs basis for high flood risk towns where limited stream gauge monitoring is available.

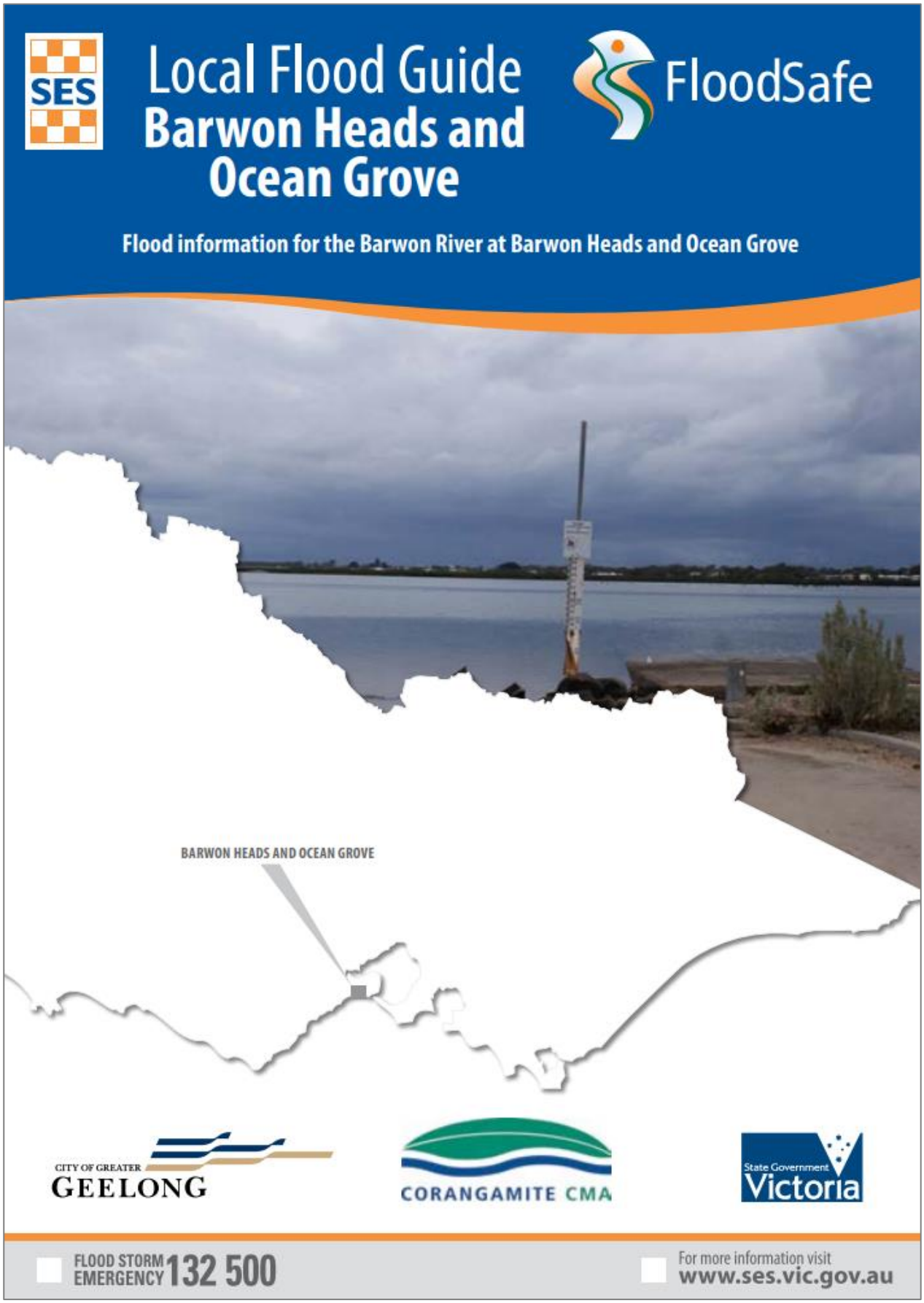
Appendix G: Local flood information

There have been four Local Flood Guides developed for the City of Greater Geelong Council Region;

- Refer to the link below for the City of Greater Geelong Council Local Flood Guide
  https://www.ses.vic.gov.au/plan-and-stay-safe/flood-guides/city-of-greater-geelong-council



- Refer to the link below for the Barwon Heads and Ocean Grove Local Flood Guide
  https://www.ses.vic.gov.au/plan-and-stay-safe/flood-guides/city-of-greater-geelong-council



- Refer to the link below for the Lara Local Flood Guide
  https://www.ses.vic.gov.au/plan-and-stay-safe/flood-guides/city-of-greater-geelong-council

Lara

SES

Local Flood Guide

Riverine flood information for Hovells Creek at Lara

For flood emergency assistance call VICSES on 132 500

CITY OF GREATER GEELONG

CORANGAMITE CMA

VICTORIA

The Victoria State Emergency Service respectfully acknowledges Aboriginal and Torres Strait Islander people as the Traditional owners of the land throughout Victoria and acknowledges their ancestors and elders, past, present and emerging.

Reviewed: 1 September 2021 1

- Refer to the link below for the Batesford Local Flood Guide
  https://www.ses.vic.gov.au/plan-and-stay-safe/flood-guides/city-of-greater-geelong-council

Appendix H: Geelong Community Sandbag Collection Points

Triggers to start prefilling sandbags and setting up community sandbag collection points;

- BOM flood watch has been issued for the town / catchment area
- Significant rainfall is predicted for the town/catchment area (greater than 50mm)
- BOM has high certainty the rainfall event will impact a town/catchment area listed below.
- Flooding is immanent

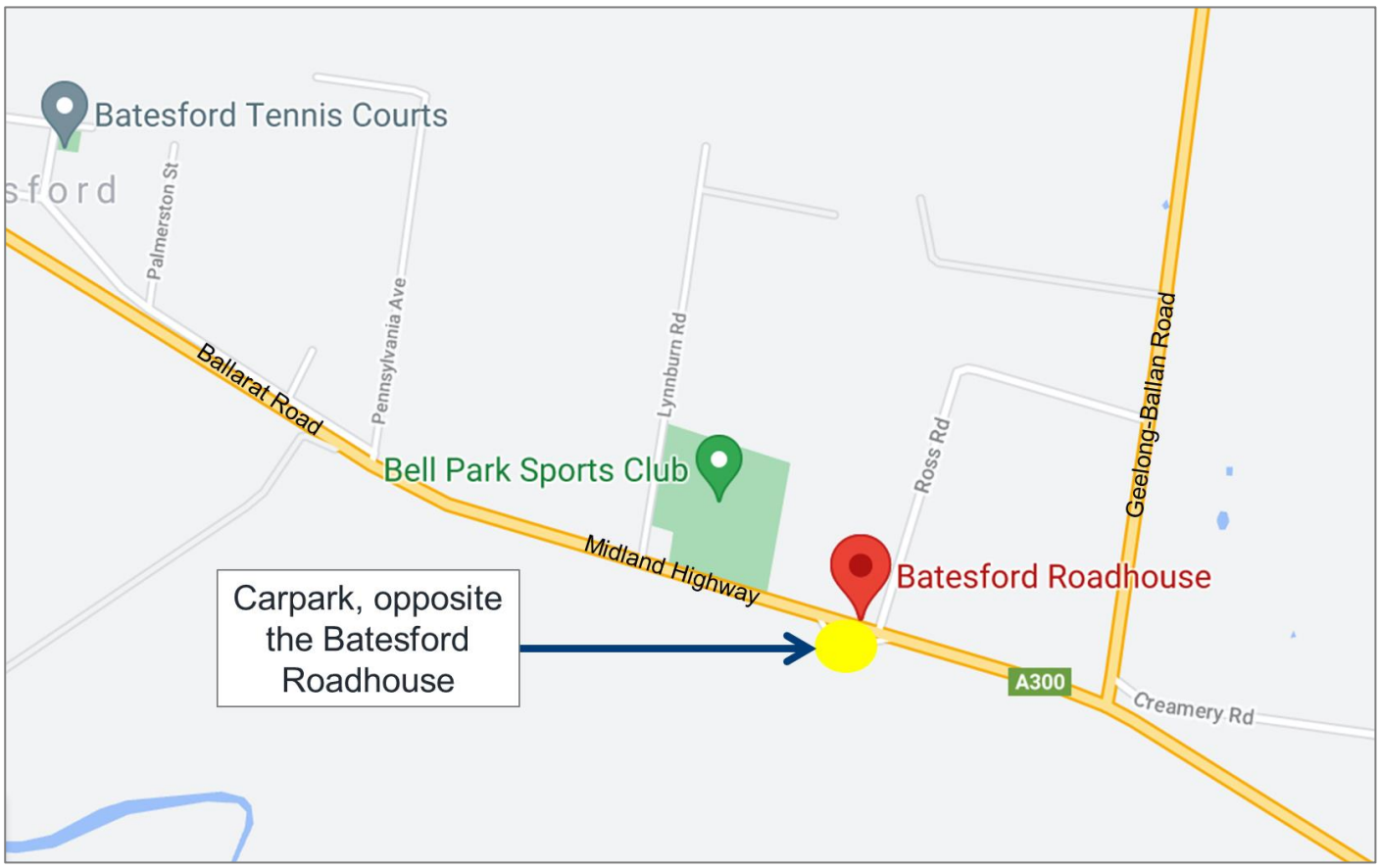
When needed community sandbag collection points will be set up at;

1. Batesford: Carpark opposite the Batesford Roadhouse at 495 Midland Highway, Batesford.
2. Barwon Heads: Barwon Heads Boat ramp Carpark, River Parade. If this site is impacted by flooding, change to the corner of Sheepwash Road and River Parade.
3. Drysdale: Sports Oval carpark, Belchers Road, Drysdale.
4. Fyansford: Geelong West CFA Station, 67A McCurdy Road, Herne Hill.
5. Geelong: Geelong Show Grounds, 77 Breakwater Road, Thompson.
6. Lara East: Lara Recreation Reserve, 2 Mill Road, Lara.
7. Lara West: Elcho Park Reserve, 185 Elcho Road, Lara.
8. Ocean Grove: Open Parkland at 86 Tuckfield Street, Ocean Grove.

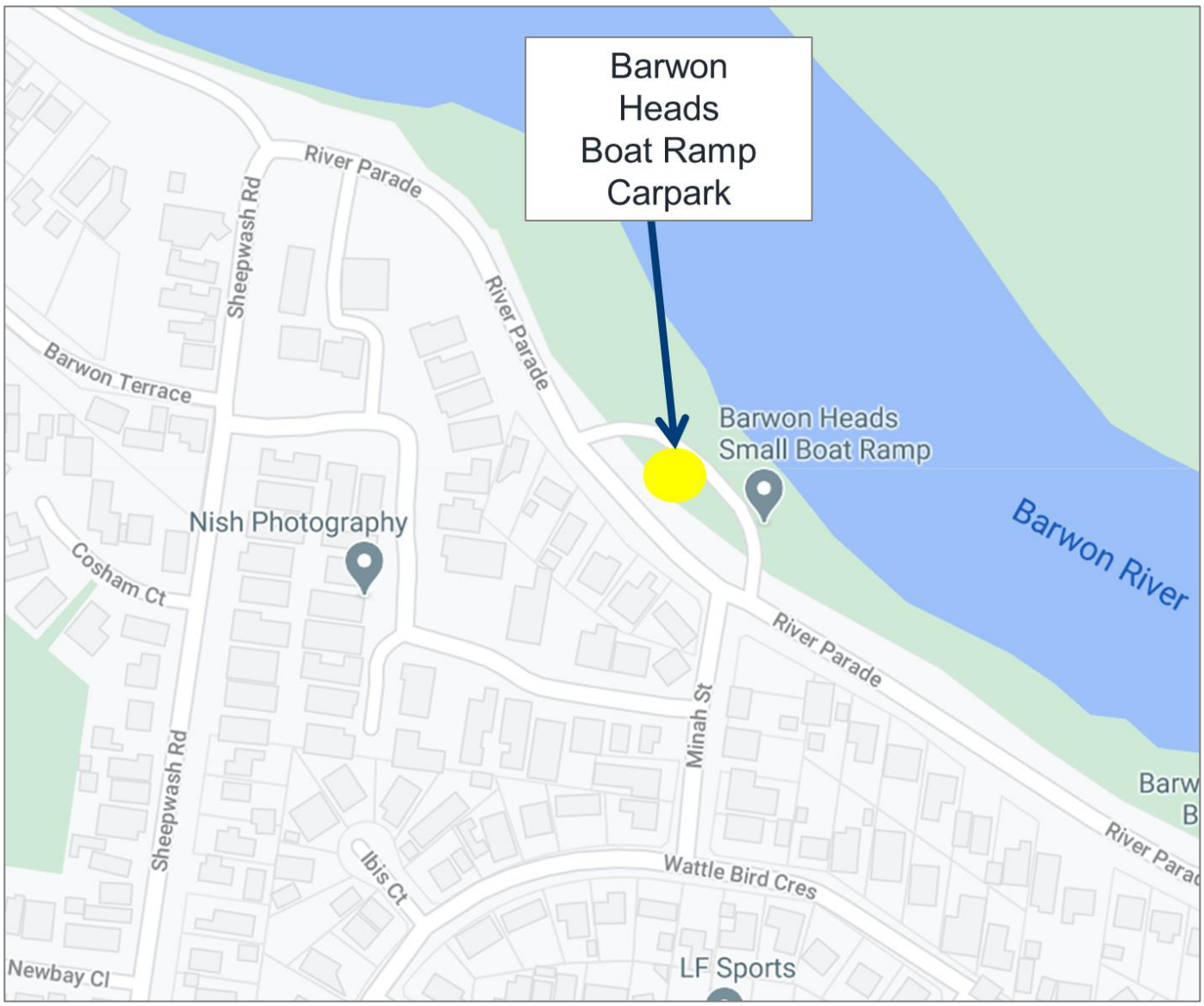
Refer to the list below of key tasks that may be undertaken to prepare sandbag filling and community sandbag collection points.

Agency	Task Description
VICSES	Deliver sandbags to the council depot or other nominated sandbag filling point to prefill the sandbags.
City of Greater Geelong Council / VICSES	Deliver sand to sandbag filling points documented below.
City of Greater Geelong Council / VICSES / CFA	Deliver prefilled sandbags either directly to buildings that need to be sandbagged or to the nominated community Sandbag collection point. Provide staff/volunteers to set up the community sandbag point. Provide staff/volunteers to distribute prefilled sandbags to the community.
City of Greater Geelong Council / VICSES	Notify the community of the location of the community sandbag collection point via local radio and social media channels.

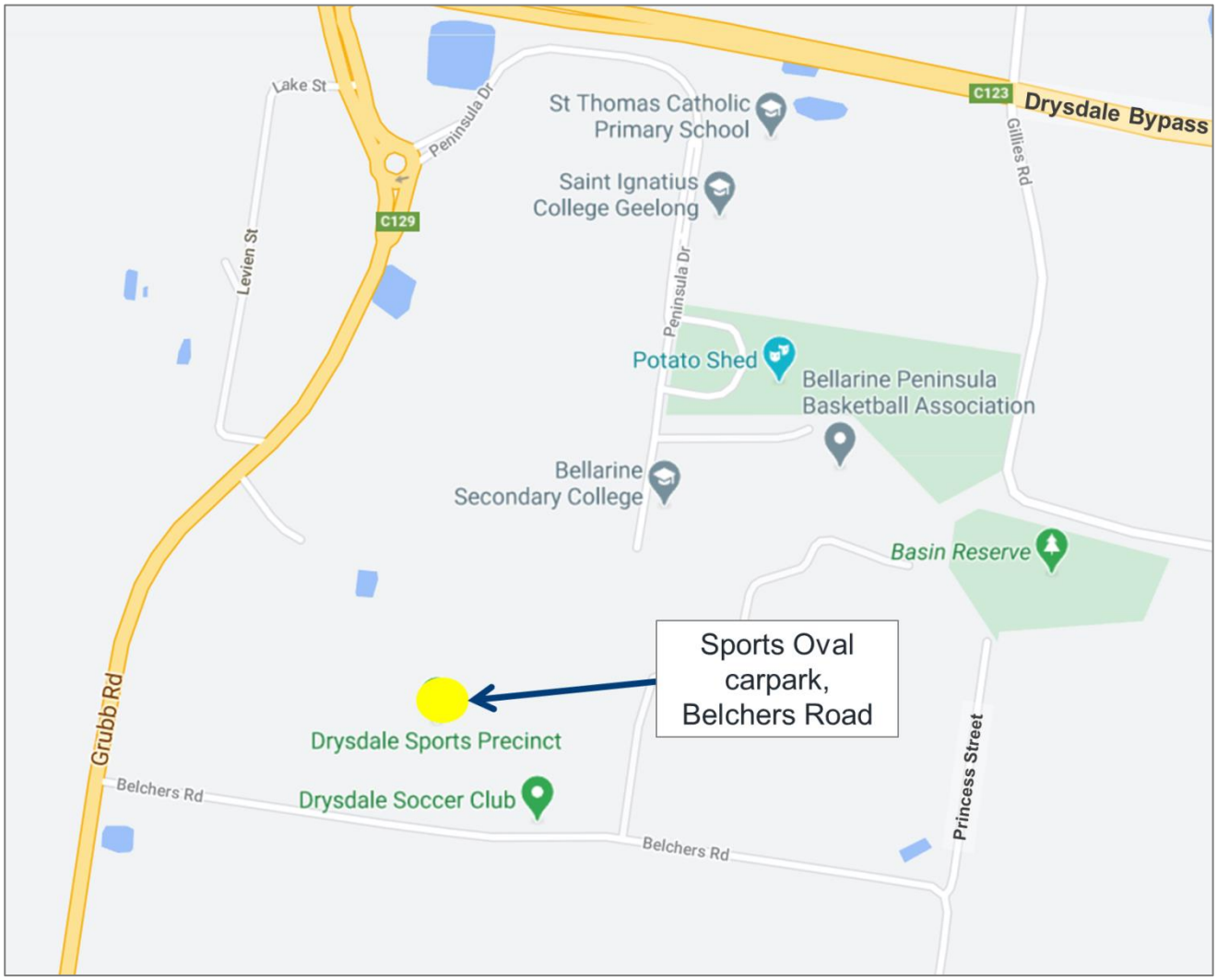
1. Batesford Sandbag Filling and Community Collection Point: Carpark opposite the Batesford Roadhouse at 495 Midland Highway, Batesford.



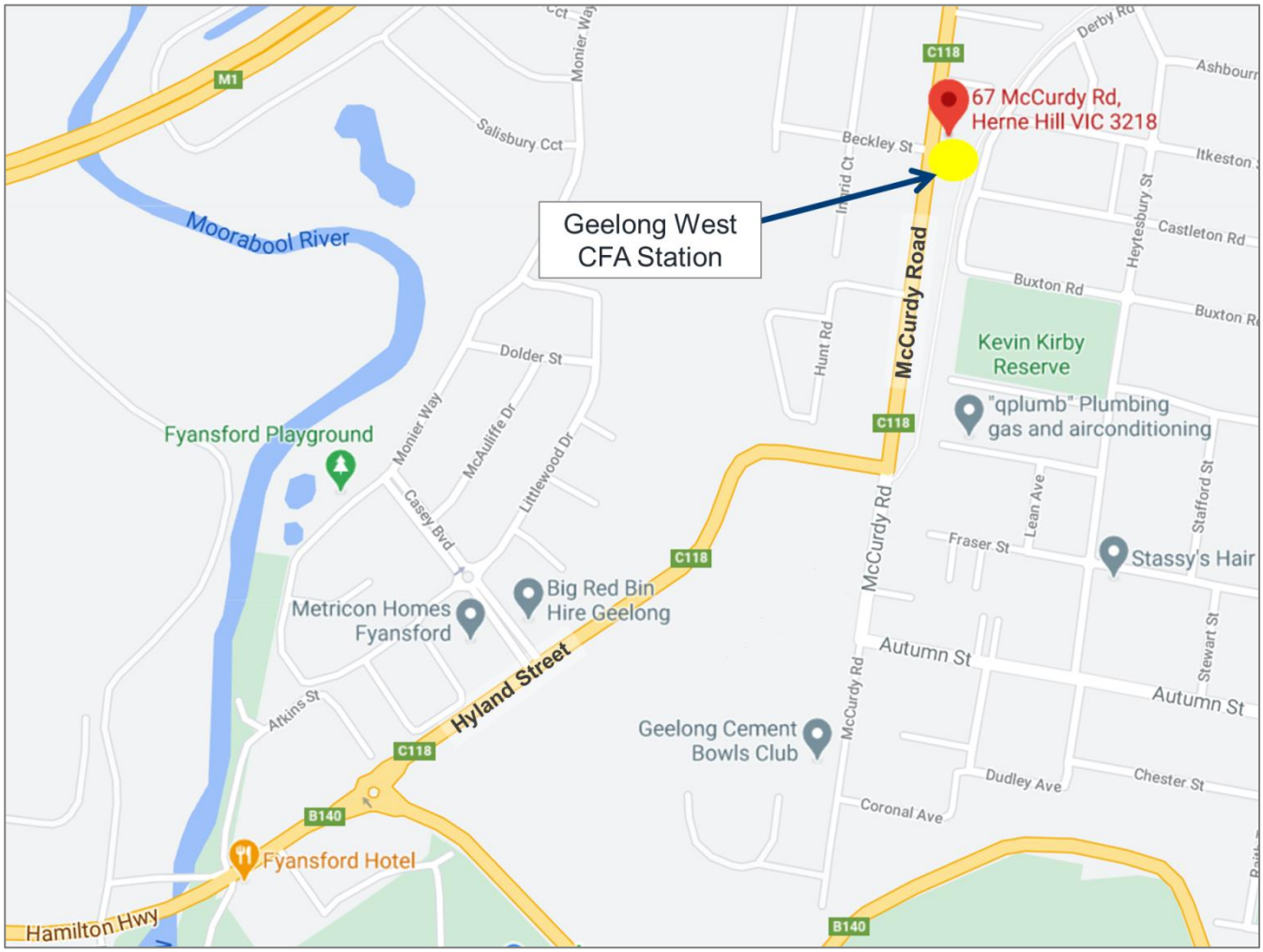
2. Barwon Heads Sandbag Filling and Community Collection Point: Barwon Heads Boat Ramp Carpark, River Parade. If this site is impacted by flooding, change to the corner of Sheepwash Road and River Parade.



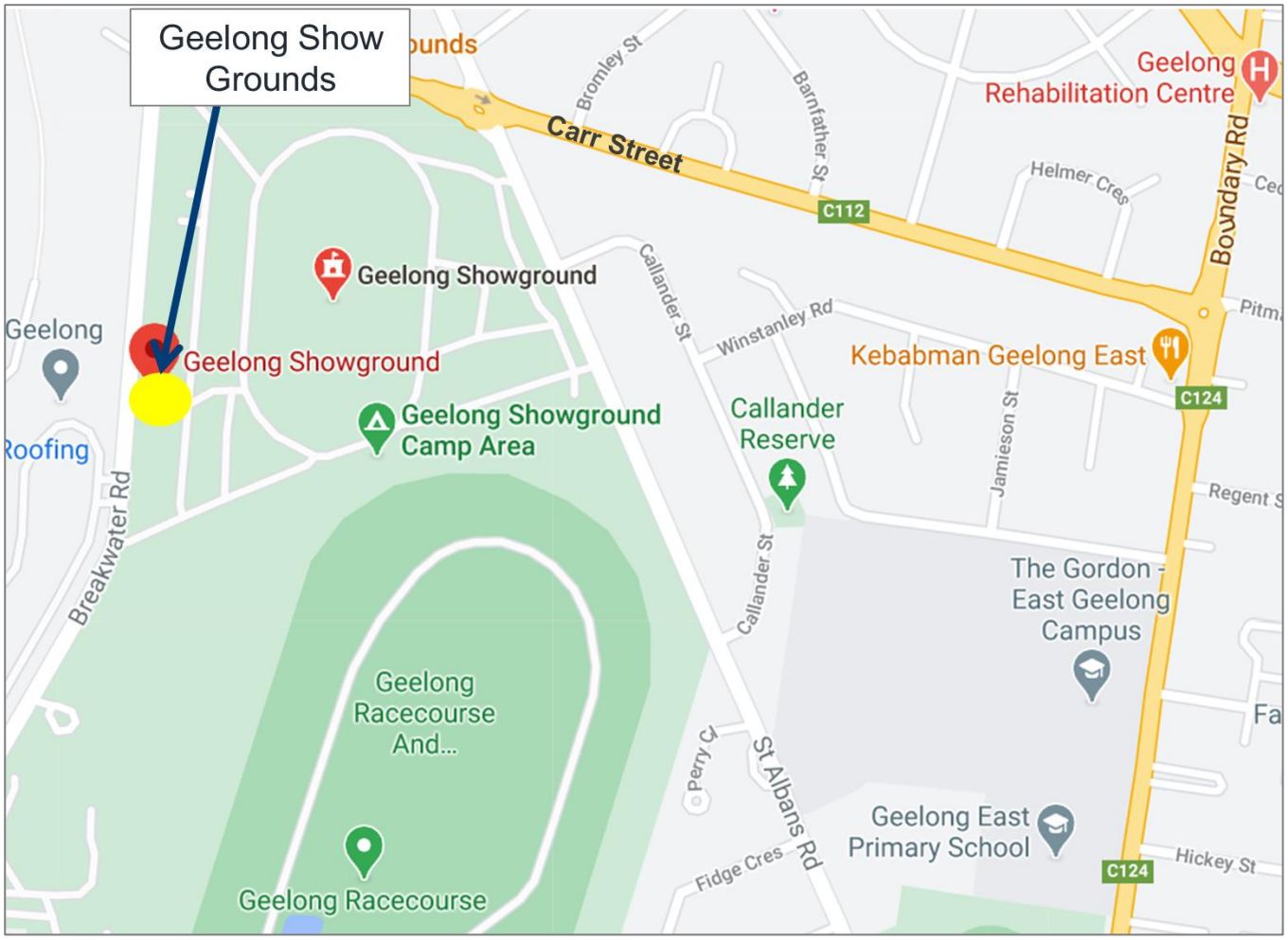
3. Drysdale: Barwon Heads Sandbag Filling and Community Collection Point: Barwon Heads Boat Ramp Carpark, River Parade.



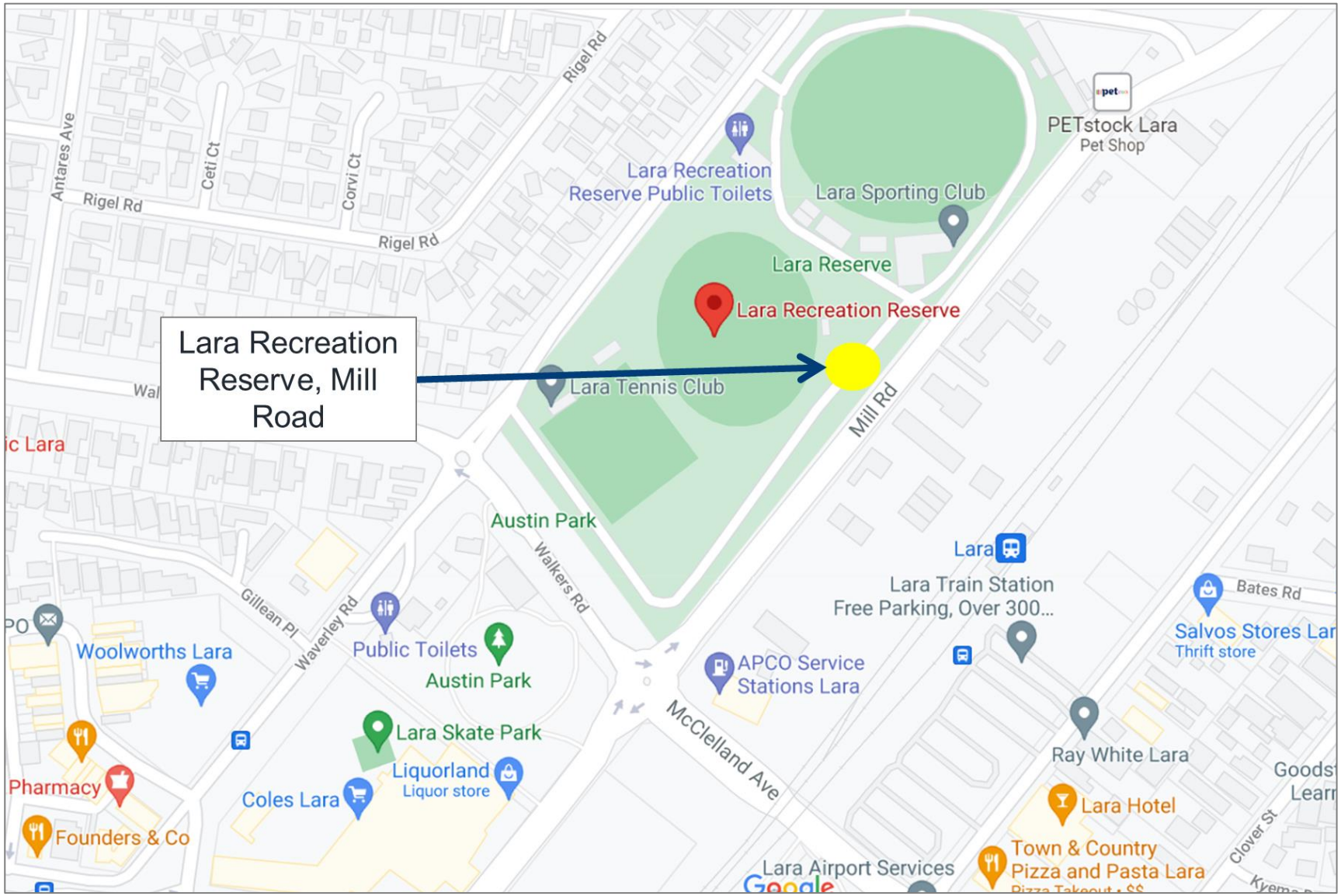
4. Fyansford Sandbag Filling and Community Collection Point: Geelong West CFA Station, 67A McCurdy Road, Herne Hill.



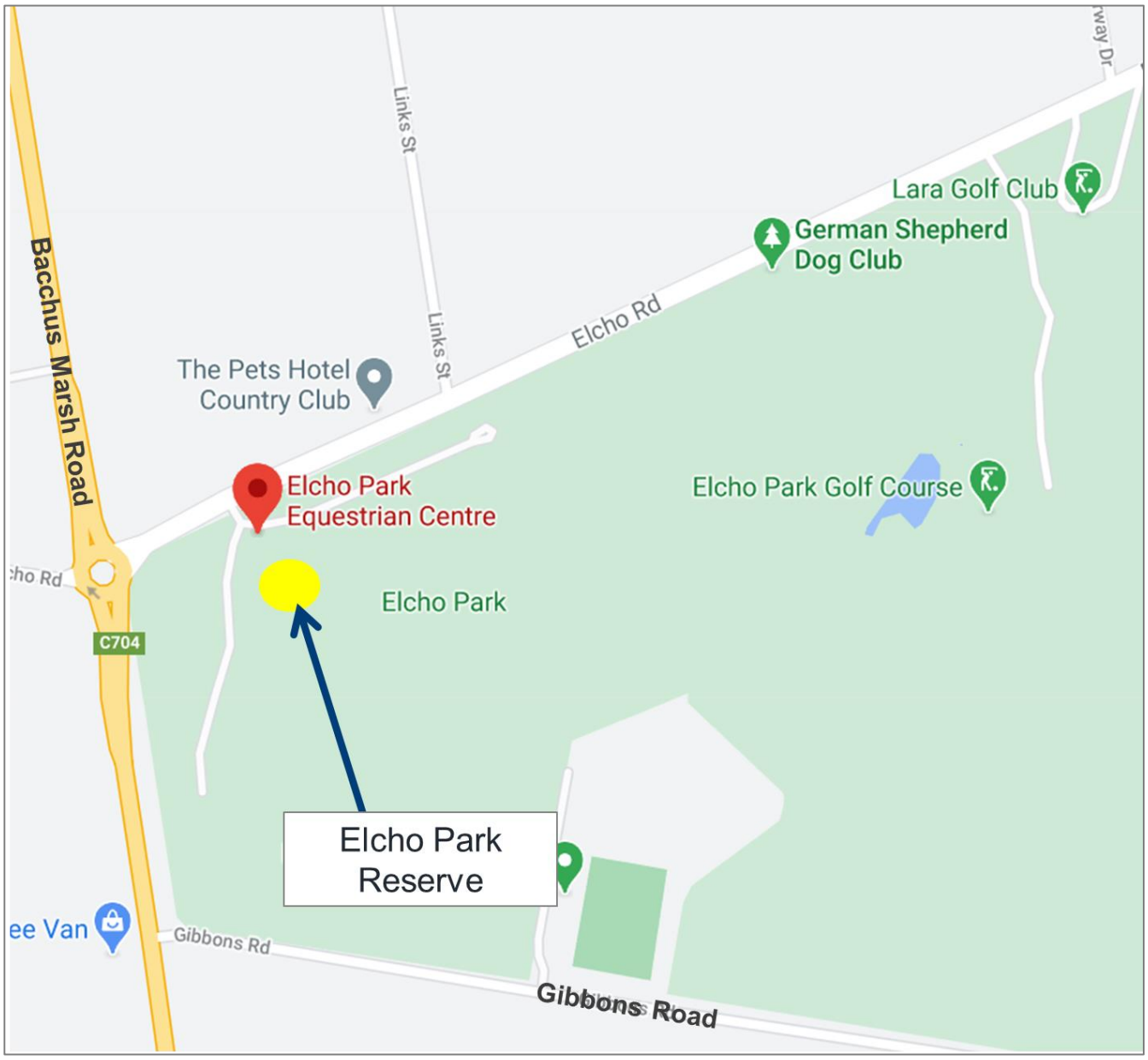
5. Geelong Sandbag Filling and Community Collection Point: Geelong Show Grounds, 77 Breakwater Road, Thompson.



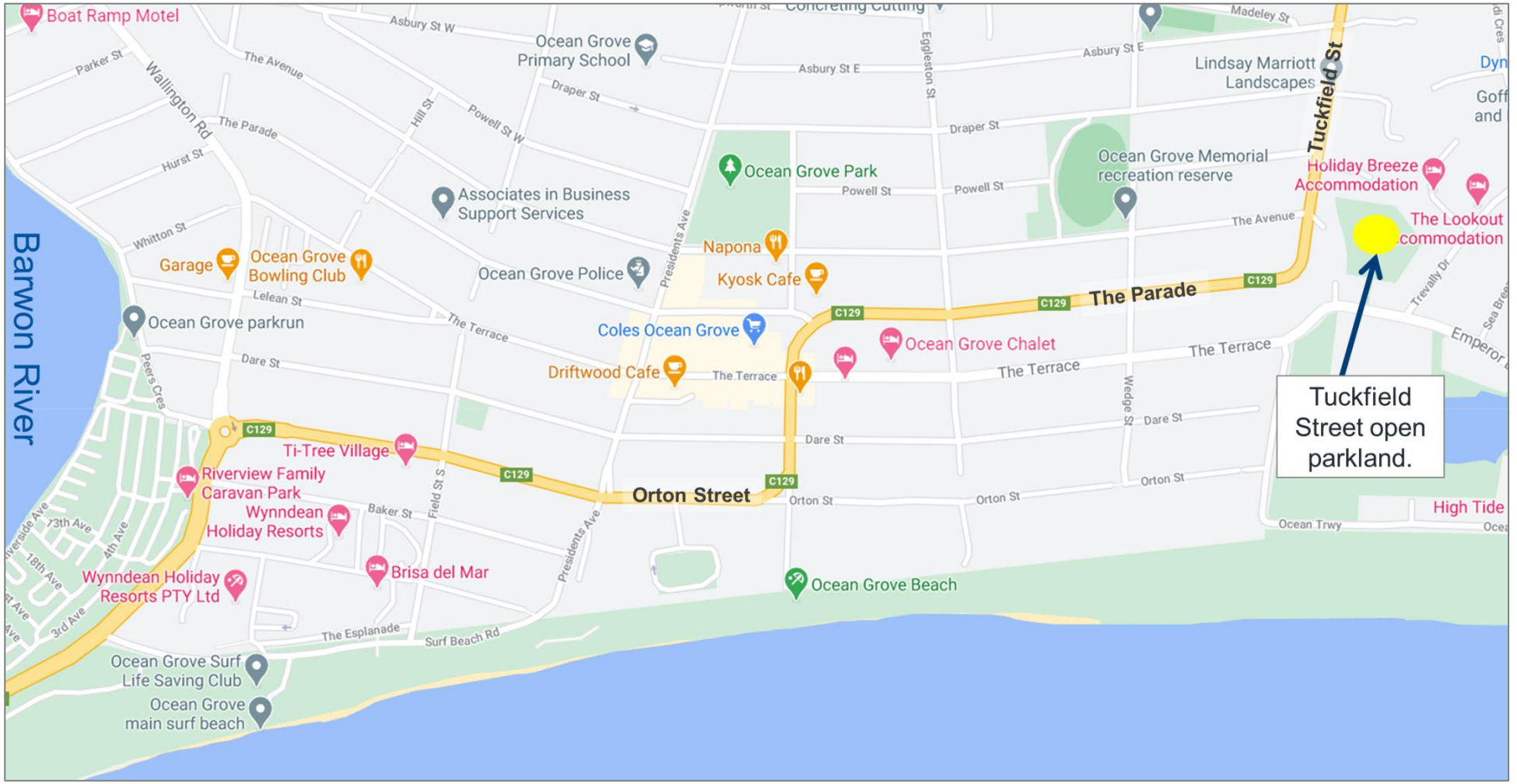
6. Lara East Sandbag Filling and Community Collection Point: Lara Recreation Reserve, 2 Mill Road, Lara.



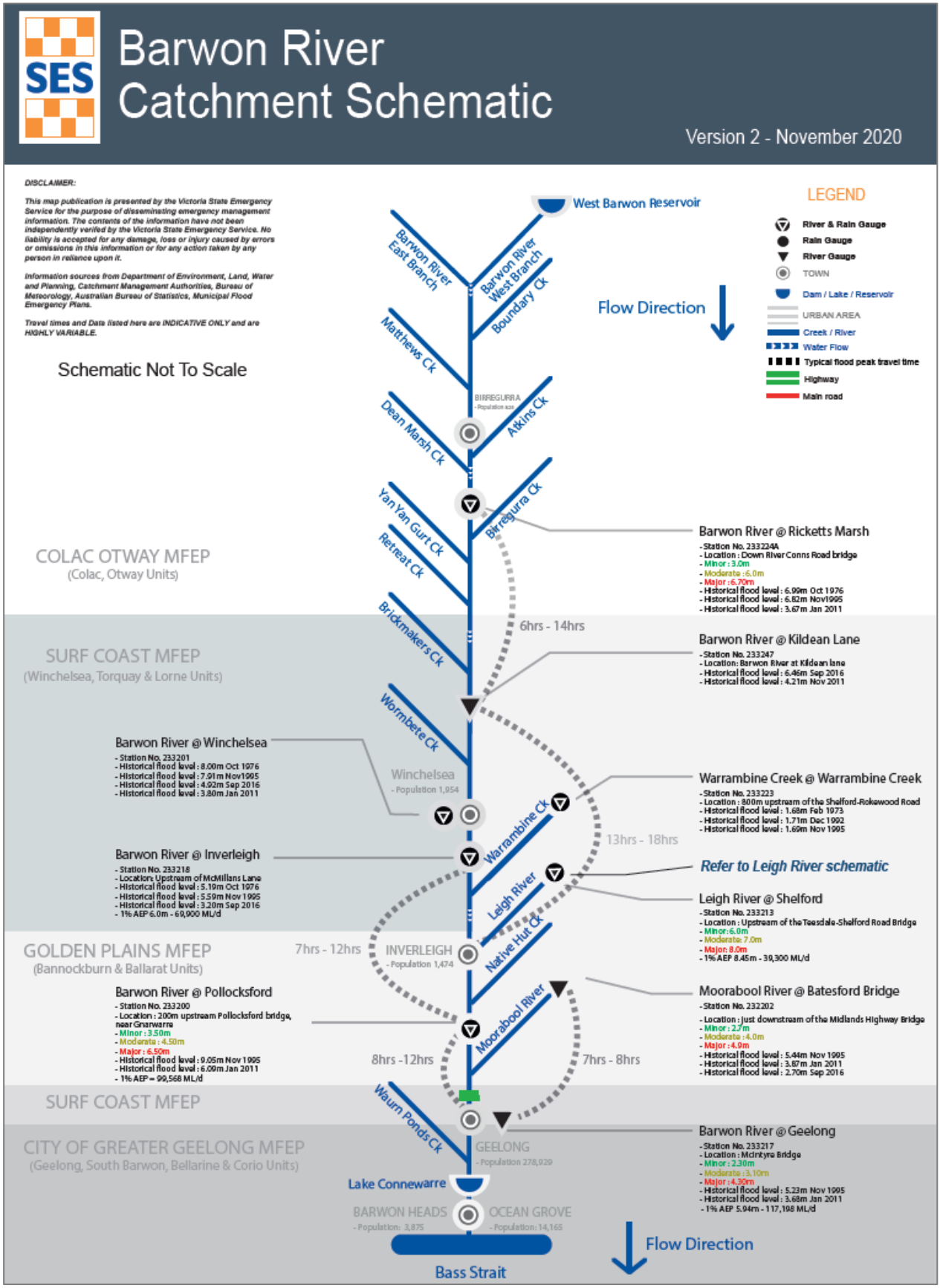
7. Lara West Sandbag Filling and Community Collection Point: Elcho Park Reserve, 185 Elcho Road, Lara.



8. Ocean Grove Sandbag Filling and Community Collection Point: Open Parkland at 86 Tuckfield Street, Ocean Grove.

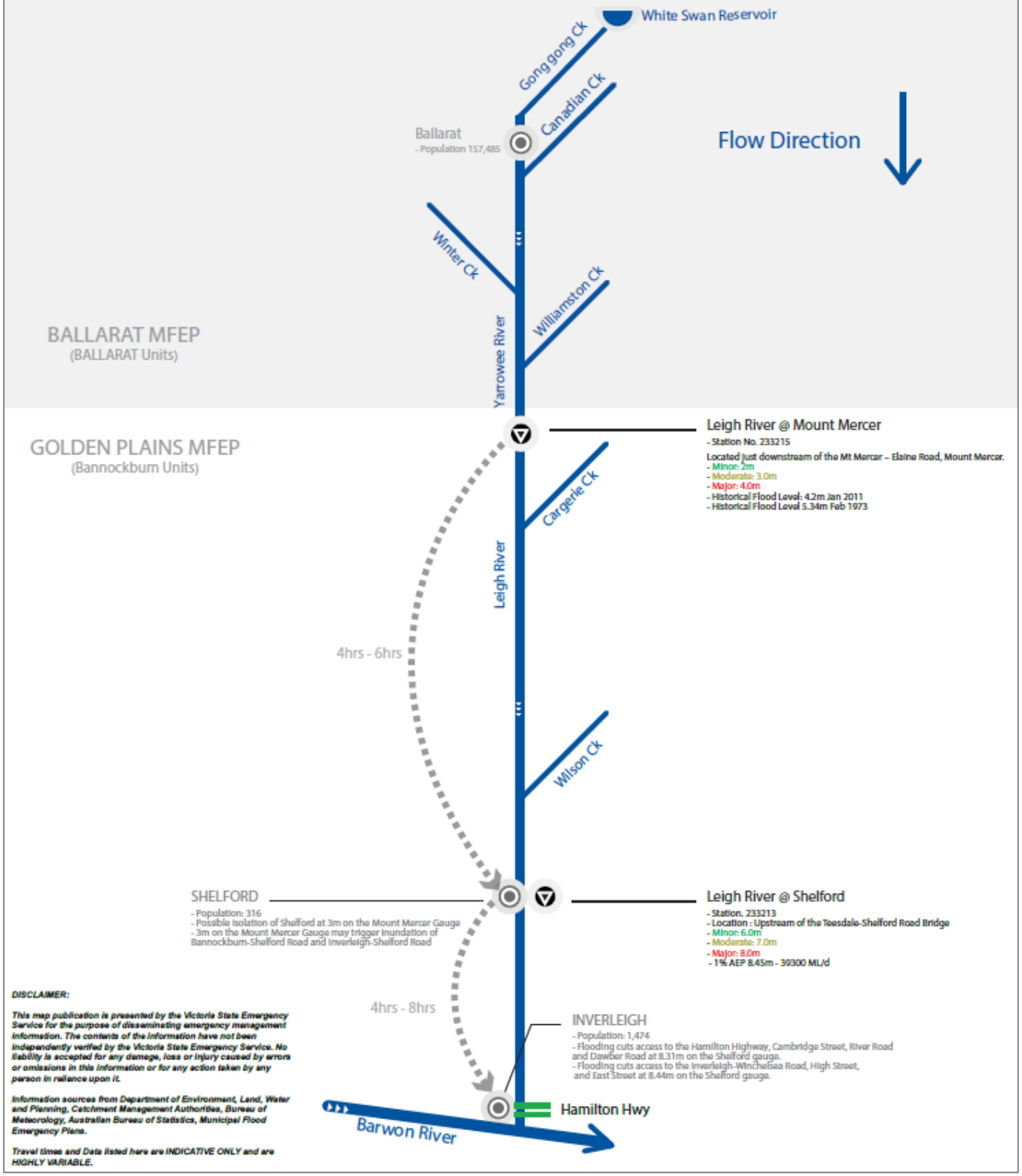


Appendix I: Schematics



Leigh River Catchment Schematic

Version 2 - November 2020



DISCLAIMER:

This map publication is presented by the Victoria State Emergency Service for the purpose of disseminating emergency management information. The contents of the information have not been independently verified by the Victoria State Emergency Service. No liability is accepted for any damage, loss or injury caused by errors or omissions in this information or for any action taken by any person in reliance upon it.

Information sources from Department of Environment, Land, Water and Planning, Catchment Management Authorities, Bureau of Meteorology, Australian Bureau of Statistics, Municipal Flood Emergency Plans.

Travel times and Data listed here are INDICATIVE ONLY and are HIGHLY VARIABLE.

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