Central Goldfields

Flood Emergency Plan

A Sub-Plan of the Municipal Emergency Management Plan

For Central Goldfields Shire Council
and VICSES Dunolly and Maryborough Units

Version 5.0
May 2024

CENTRAL GOLDFIELDS SHIRE COUNCIL

VICTORIA State Government

SES

Acknowledgement

Central Goldfields Shire Council and Victoria State Emergency Service acknowledge the ancestors and descendants of the Dja Dja Wurrung. We acknowledge that their forebears are the Traditional Owners of the area we are on and have been for many thousands of years. The Djaara have performed age old ceremonies of celebration, initiation and renewal. We acknowledge their living culture and their unique role in the life of this region.

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Distribution list

Once endorsed and signed VICSES will electronically distribute the Central Goldfields Municipal Flood Emergency Plan (MFEP) to all Municipal Flood Emergency Planning Committee (MFEPC) members and the following additional agencies. It will then be the responsibility of agencies to arrange for internal distribution of the Plan. Any additional distribution requirements, such as printed copies of maps for Incident Control Centres (ICC), will be undertaken by VICSES in consultation with the MEMPC Chair.

Copy	Name	Organisation	Date
Original		Central Goldfields Shire Council	
1		MEMP Committee Executive Officer	
2		MEMP Committee Chair	
3		Municipal Emergency Management Officer (MEMO)	
4		Deputy MEMO	
5		Municipal Recovery Manager (MRM)	
6		MERC (Maryborough Police Station)	
7		RERC Loddon Mallee Region	
8		Maryborough Police Station	
9		Dunolly Police Station	
10		VICSES Western Region	
11		VICSES Maryborough Unit	
12		VICSES Dunolly Unit	
13		North Central Catchment Management Authority	
14		Bureau of Meteorology (Flood Warning)	
15		DEECA Maryborough	
16		Parks Victoria Maryborough	
17		Ambulance Victoria Maryborough branch	
18		CFA Goldfields Group Brigade	
19		CFA District 2 Headquarters - Bendigo	
20		Department of Transport - Bendigo	
21		Department of Families, Fairness and Housing (DFFH) - Bendigo	
22		Powercor	
23		Goulburn Murray Water	
24		Central Highlands Water	
25		Maryborough District Health Services	
26		Telstra	
27		Coliban Water	

Version control

This Plan will be amended, maintained and distributed as required by VICSES in consultation with Central Goldfields Shire Council.

Suggestions for amendments to this Plan should be forwarded to:

VICSES Western Region
7 Rohs Road
East Bendigo VIC 3550
Phone 03 9256 9500
Email ust.loddon@ses.vic.gov.au

Amendments listed below have been included in this Plan and promulgated to all registered copyholders.

Version	Date	Entered By	Summary
Draft		MCA/WT	Initial preparation of MFEP. Included all available intel.
V1		VicSES	Inclusion of community input to Carisbrook intel.
V2	November 2013	MCA/WT	Reformatted MFEP, various corrections including adjustment to flood / no flood tool for Carisbrook, addition of intel for Dunolly.
V3	August 2017	MFEPC	Full Review
V4	June 2019	MFEPC	Full Review (inc. Dunolly updates)
V5	May 2024	MFEPC	Full review. Update linkages to SEMP. Inclusion of draft Maryborough Flood Study and RFRA data for Bealiba, Bet Bet, Talbot, Timor-Bowenvale and Moliagul. Reviewed by CGSC, NCCMA and with input from Councillors (April 2024).

This Plan will be maintained on the VICSES website (ses.vic.gov.au/plan-and-stay-safe/flood-guides/central-goldfields-shire-council) and on the Central Goldfields Shire website (centralgoldfields.vic.gov.au/Council/Policies-Plans-Strategies-and-Documents/Council-Plans).

Abbreviations and acronyms

The following abbreviations and acronyms are used in the Plan			
AAR	After Action Review	FWS	Flood Warning System
AEP	Annual Exceedance Probability	FZ	Floodway Zone
AHD	Australian Height Datum (the height of a location above mean sea level in metres)	HESP	Health Emergency Sub-Plan
AIDR	Australian Institute of Disaster Resilience	IC	Incident Controller
AIIMS	Australasian Inter-service Incident Management System	ICC	Incident Control Centre
AoCC	Area of Operations Control Centre / Command Centre	IMT	Incident Management Team
AV	Ambulance Victoria	IMS	Incident Management System
BOM	Bureau of Meteorology	LSIO	Land Subject to Inundation Overlay
CEO	Chief Executive Officer	LSV	Life Saving Victoria
CERA	Community Emergency Risk Assessment	MECC	Municipal Emergency Coordination Centre
CGSC	Central Goldfields Shire Council	MEMP	Municipal Emergency Management Plan
CFA	Country Fire Authority	MEMPC	Municipal Emergency Management Planning Committee
CHW	Central Highlands Water	MERC	Municipal Emergency Management Response Coordinator
CMA	Catchment Management Authority	MEMO	Municipal Emergency Management Officer
DFFH	Department of Families, Fairness and Housing	MRM	Municipal Recovery Manager
DH	Department of Health	PMF	Probable Maximum Flood
DoI	Department of Infrastructure	RAC	Regional Agency Commander
DEECA	Department of Energy, Environment and Climate Action	RCC	Regional Control Centre
DJPR	Department of Jobs, Precincts and Regions	RDO	Regional Duty Officer
DSEP	Dam Safety Emergency Plan	RERC	Regional Emergency Response Coordinator
DTP	Department of Transport and Planning	RERCC	Regional Emergency Response Coordination Centre
EMLO	Emergency Management Liaison Officer	SBO	Special Building Overlay
EMMV	Emergency Management Manual Victoria	SCC	State Control Centre
EMT	Emergency Management Team	SEMP	State Emergency Management Plan
EMV	Emergency Management Victoria	SERP	State Emergency Response Plan
ERV	Emergency Recovery Victoria	SEWS	Standard Emergency Warning Signal
EO	Executive Officer	SOP	Standard Operating Procedure
FO	Floodway Overlay	VicPol	Victoria Police
FRV	Fire Rescue Victoria	VICSES	Victoria State Emergency Service

Glossary

Below are terms defined for the purpose of this Plan:

Term	Definition
Annual Recurrence Interval (ARI)	The average or expected value of the period between exceedances of a given rainfall or flow total, accumulated over a given duration.
Annual Exceedance Probability (AEP)	The probability that a given total rainfall or flow is accumulated over a given duration will be exceeded in any one year.
Draining system	A series of drains and waterways into which surface and storm water flows. Features of a drainage system can include underground pipe drains, open channels, retarding basins, floodways, waterway improvements, water quality works and environment protection measures. All drainage under 60 ha is maintained and operated by MRSC.
Flash flooding	Sudden unexpected flooding caused by local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within six hours of the rain which causes flooding.
Flood mapping	The process where the extent of flooding is documented in mapping software based on flood studies and surface elevations.
Floodplain	Area of land adjacent to a creek, river, estuary, lake, dam or artificial channel, which is subject to inundation.
Hot spot	A known flood problem area which has a history of repeat flooding of a road, crossing or property, often highlighted through anecdotal information and customer complaints. It is a localised issue which will vary from council to council.
Natural drainage system	Flow paths which are largely undeveloped by human sources, these include rivers, streams, natural depressions and wetlands. All natural systems greater than 60 ha are managed by Melbourne Water and North Central Catchment Management Authority.
Overland flooding	Flooding by local runoff caused by heavier than usual rainfall. Overland flooding can be caused by local flow exceeding the capacity of an urban stormwater drainage system or by the backwater effects of mainstream flooding causing urban stormwater drainage system to overflow.
Retarding basin	A retarding basin is a large, open, free draining basin that temporarily stores collected stormwater runoff. These basins are normally maintained in a dry condition between storm events.
Runoff	The amount of rainfall that enters the stormwater drainage system (via pits, underground pipes, retarding basins, water sensitive structures, overland flow paths, floodway and waterways) after water which is not absorbed into the ground has been taken into account.

Part 1. Introduction

1.1. Approval and endorsement

The Central Goldfields Municipal Emergency Management Planning Committee (MEMPC) is the owner of this Municipal Flood Emergency Plan (MFEP), pursuant to Part 6A of the Emergency Management Act 2013 (as amended). If the certificate of assurance is signed and dated, then the Loddon Mallee Region Emergency Management Planning Committee (REMPC) has approved this plan.

In accordance with its roles and responsibilities set out in the State Emergency Management Plan (SEMP), Victoria State Emergency Service (VICSES) has prepared this plan in collaboration with the Central Goldfields Municipal Flood Emergency Planning Committee (MFEPC).

This MFEP is a Sub-Plan to the Central Goldfields Municipal Emergency Management Plan (MEMP). It is consistent with the SEMP and the Victorian Floodplain Management Strategy (2016).

The plan is also consistent with and subordinate to:

- SEMP Flood Sub-Plan, SEMP Storm Sub-Plan
- the Loddon Mallee Regional Emergency Management Plan (REMP)
- the Loddon Mallee Region Flood Sub-Plan and Storm Sub-Plan

The MEMPC prepared this plan in alignment with the Guidelines for Preparing State, Regional and Municipal Emergency Management Plans.

It also takes into account the outcomes of the Community Emergency Risk Assessment (CERA) process undertaken by the MEMPC.

This MFEP is a result of the cooperative efforts of the MFEPC and its member agencies.

This Plan requires the approval of the Loddon Mallee REMPC.

This Plan is endorsed by the Central Goldfields MEMPC as a Sub-Plan to the MEMP.

To ensure this plan has both endorsement and approval, refer to the certificate of assurance.

In addition to its member agencies, the MFEPC has consulted with the following people and organisations about the arrangements contained within this plan:

- Central Goldfields Shire Councillors (Maryborough, Flynn, Paddys Ranges and Tullaroop Wards)
- Carisbrook Fire Brigade.

1.2. Certificate of assurance

Certificate of Assurance for the Central Goldfields Municipal Flood Emergency Plan.

Plan Preparer: Victoria State Emergency Service prepared this Sub-Plan on behalf of the Municipal Emergency Management Planning Committee.

I certify that the attached Sub-Plan complies with the requirements of the *Emergency Management Act 2013*, including having regard to any relevant guidelines issues under Section 77 of that Act, to the extent outlined in the attached checklist.

The MEMPC last conducted a review of the plan on 16 May 2024.

On behalf of the Municipal Emergency Management Planning Committee:	**Nominated representative of preparer:**
Insert signature here	*Insert signature here*
Name of Chair	Name of nominated representative of preparer
Chair, Municipal Emergency Management Planning Committee	Title and agency
Date	*Date*

1.3. Purpose and scope of this Plan

The purpose of this Plan is to detail arrangements agreed for the planning, prevention, preparedness, response and recovery from storm and flood incidents within the municipality. As such, the scope of the Plan is to:

- Identify the storm and flood risk to the municipality
- Support the implementation of measures to minimise the causes and impacts of storm and flood incidents within the municipality
- Detail response and recovery arrangements including preparedness, incident management, command and control
- Identify linkages with local, regional and state emergency and wider planning arrangements with specific emphasis on those relevant to storm and flood.

1.4. Municipal Flood Emergency Planning Committee

Membership of the Municipal Flood Emergency Planning Committee (MFEPC), which shall meet at least once per year, will comprise of representatives from the following agencies and organisations:

- VICSES Operations Officer – Emergency Management (Chair)
- VICSES Maryborough and Dunolly Units – Controller, Deputy Controller or delegate
- Central Goldfields Shire Council
  - Emergency Management Coordinator
  - Manager Infrastructure
  - Manager Operations
  - Municipal Emergency Management Officer (MEMO)
  - Municipal Recovery Manager (MRM)
- North Central Catchment Management Authority
- VicPol – Municipal Emergency Response Coordinator (MERC)
- CFA Goldfields Group Officer (as required)
- Bureau of Meteorology (as required)
- Goulburn Murray Water Authority (as required)
- Central Highlands Water (as required).

1.5. Responsibility for planning, review and maintenance of this Plan

This Plan must be maintained to remain effective, and must be assured, approved and published every three years, or more frequently if required. VICSES, through the MEMPC, has responsibility for preparing, reviewing, maintaining and distributing this Plan. Arrangements and information contained in this Plan should be amended:

- Following any new flood or stormwater drainage studies
- Following a change in non-structural and/or structural flood mitigation measures.
- After the occurrence of a significant storm and/or flood event within the municipality.

The lists of properties likely to be flooded (with corresponding levels and indication of over floor flood depth) contained within the Appendices should be updated within twelve weeks of a flood. Information collected as part of post-flood information recording activities or as a consequence of the event debrief as well as the collective experience of the IMT should be gathered and utilised.

Part 2. Mitigation arrangements

2.1. Community awareness for all types of storms and flooding

This Plan will be published and maintained on the VICSES website. This will occur following any updates and amendments and in accordance with assurance, approval and publishing requirements.

VICSES, with the support of Central Goldfields Shire, will coordinate community engagement programs for storm and flooding within the local government area (e.g. Local Flood Guides and public events). Engagement will include raising awareness about the projected impacts on the frequency and intensity of flood and storm events and what actions can be taken to minimise these impacts.

Community engagement programs to support this Plan may be developed in conjunction with the local VICSES unit. VICSES Dunolly and/or Maryborough Units may lead the delivery of programs with support from Central Goldfields and VICSES Western Region.

2.2. Structural mitigation measures

Carisbrook

- A Western flood levee to divert overland flows on the west of the township – A 3km long levee extending from the southern end of Curraghmoor Road Reserve northwards past the Pyrenees Highway, running along Pleasant Street towards Bucknall Street.
- A smaller levee along Williams Road – A 1km long levee along Williams Road running east towards McCallums Creek.
- A non-return valve on culvert under Landrigan Road near Camp Street.

Dunolly

- A levee/contour channel to the east of the township – A 3km long levee/contour channel on the east side of the township from Bridgewater-Dunolly Road heading towards to Burnt Creek, incorporating a retarding basin located between Alice Street and the levee.

2.3. Non-structural mitigation measures

2.3.1. Exercising

Arrangements for exercising this Plan will be at the discretion of the MFEPC, in consultation and conjunction with the MEMPC. This Plan should be regularly exercised (at least every three years and/or reviewed after a significant event).

2.3.2. Flood warnings

Arrangements for storm and flood warning are contained within the State Flood and Storm Emergency Plans (ses.vic.gov.au/prepare/em-planning/state-plans), the SEMP and on the Bureau of Meteorology (BOM) website (bom.gov.au).

Specific details of local storm and flood warning system arrangements are provided in Appendix D.

2.3.3. Local knowledge

Community-based Field Observers (previously Flood Observers or Flood Wardens) provide local knowledge to VICSES and the ICC regarding local insights and the potential impacts and consequences of an incident through either traditional means or using the Snap Send Solve platform.

The existing functionality of the Snap Send Solve app has been adapted for VICSES, allowing Field Observers to capture observations and information before, during and after an emergency event. Field Observers, who may be VICSES members, other response agency personnel or trusted community

members (e.g. waterway volunteers, caravan park owners, etc.) may operate as part of Intelligence or Operations at the ICC.

Local knowledge is incorporated into this Plan through consultation with local response agencies. In line with the VICSES Local Knowledge Policy 10.02, reviews of this Plan will be undertaken with input from multiple local sources to ensure appropriate local knowledge can be captured before, during and after incidents.

Part 3. Response arrangements

3.1 Introduction

3.1.1 Activation of response

Storm and flood response arrangements may be activated by the VICSES Regional Duty Officer (RDO), Regional Agency Commander (RAC) or Incident Controller (IC). The VICSES RDO, RAC or IC will activate agencies as required and documented in the VICSES Loddon Mallee Region Storm and Flood Emergency Plans, the State Storm Emergency Plan and the State Flood Emergency Plan (ses.vic.gov.au/about-us/state-and-regional-emergency-plans).

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 storm and/or flood within the municipality. These agencies will be engaged through the Incident Emergency Management Team (IEMT).

The general roles and responsibilities of supporting agencies are as agreed within the MEMP, SEMP (Roles and Responsibilities) and VICSES Loddon Mallee Region Storm and Flood Emergency Plans and State Flood and Storm Emergency Plans (ses.vic.gov.au/prepare/em-planning/state-plans). Agreed roles/actions of key agencies are listed in the Action Matrix in Appendix E.

3.1.3 Escalation

Most storm and/or flood incidents are of local concern and an appropriate response can usually be coordinated using local resources. However, when these resources are exhausted, Regional arrangements provide for further resources to be made available, firstly from neighbouring municipalities (on a Regional basis) and then on a State-wide basis.

Central Goldfields Shire is a signatory to the MAV Resource Sharing Protocol which includes neighbouring Shires to assist each other during an emergency incident. Currently CGSC does not have any formal resource sharing arrangements established with other agencies. However, the Victorian incident management arrangements established for flood facilitate such sharing. Resourcing and event escalation arrangements are described in the SEMP.

3.2 State Emergency Management Priorities

To provide guidance to the Incident Management Team (IMT) and IEMT, the following Emergency Management Priorities shall form the basis of incident action planning processes:

1. **Protection and preservation of life and relief of suffering is paramount.** This includes:
    a. Safety of emergency services personnel; and
    b. Safety of community members including vulnerable community members and visitors/tourists.
2. **Issuing of community information and community warnings** detailing incident information that is timely, relevant and tailored to assist community members make informed decisions about their safety.
3. **Protection of critical infrastructure and community assets** that support community resilience.
4. **Protection of residential property** as a place of primary residence.
5. **Protection of assets supporting individual livelihoods and economic production** that supports individual and community financial sustainability.
6. **Protection of environmental and conservation assets** that considers the cultural, biodiversity, and social values of the environment.

Circumstances may arise where the IC is required to vary these priorities, with the exception being that the protection of life should remain the highest. This shall be done in consultation with the State Response Controller and relevant stakeholders based on sound incident predictions and risk assessments.

3.3 Command and control

Arrangements in this Plan must be consistent with the State and Regional Flood and Storm Emergency Plans and the MEMP. For further information, refer to the SEMP.

3.3.1 Control

Sections 5(1)(b) and 5(1)(c) of the Victoria State Emergency Service Act 2005 detail the authority for VICSES to plan for and respond to storms and floods.

Table 9 of the SEMP (Roles and Responsibilities) identifies VICSES as the Control Agency for storm and flood. It identifies the Department of Energy, Environment and Climate Action (DEECA) as the Control Agency responsible for dam safety, water and sewerage asset related incidents and other emergencies.

All flood response activities within Central Goldfields, 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 their delegated representative.

3.3.2 Incident Controller (IC)

An IC will be appointed by VICSES (as the Control Agency) to command and control available resources in response to a flood event on the advice of BOM (or other reliable source) that a flood event will occur or is occurring. The IC responsibilities are as defined in the SEMP.

3.3.3 Incident Control Centre (ICC)

As required, the IC will establish an ICC from which to initiate incident response command and control functions. Decisions on when an ICC should be activated rest with the Control Agency.

Pre-determined Incident Control Centres for storm and flood (as per JSOP 02.03) are:

- **Epsom ICC** (DEECA)
  7 Taylor Street
  Epsom Vic 3551
  Phone 03 5430 4444
  iccben.inc@icc.vic.gov.au
- **Ballarat ICC** (VICSES)
  352 Dowling Street
  Wendouree Vic 3355
  Phone 03 5339 1122
  iccbalses.inc@icc.vic.gov.au

3.3.4 Divisions and Sectors

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

Divisions and Sectors may be established to assist with the management of storm and flood impacts within the municipality, with locations to be decided by the IC. The following locations have been pre-identified:

Division (pre-determined Divisional Command locations)	**Sectors** (Pre-determined Sector Command locations)
Central Goldfields (CFA/DEECA) 2/82 Alma Street, Maryborough	**Maryborough (VICSES)** 70 Burns Street, Maryborough
	Dunolly (VICSES) 51 Broadway, Dunolly
	Carisbrook (CFA) 9 Urquhart Street, Carisbrook
	Talbot (CFA) 20 Scandinavian Crescent, Talbot
	Natte Yallock (CFA) 21 School Road, Natte Yallock
	Bealiba (CFA) 8 Grant Street, Bealiba

3.3.5 Incident Management Team (IMT)

The IC will form an Incident Management Team (IMT). Where possible IMTs should be multi-agency and include relevant local and hazard specific knowledge. Refer to the SEMP (Page 63) for guidance.

3.3.6 Emergency Management Team (EMT)

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

Organisations required within the IEMT (including Central Goldfields Shire) 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 (Page 60) for guidance.

3.3.7 Coordination

The Central Goldfields Municipal Emergency Response Coordinator (MERC) will ensure the Coordination function is undertaken. The VICSES IC or RDO will ensure that communications are established with the MERC and that regular situational updates are provided. This may be undertaken through the Division/Sector Commander where appointed.

3.3.8 Municipal Operations Centre (MOC)

Where activated, the function, location, establishment and operation of the MOC (or similar coordination centre) will be as detailed in the MEMP:

- **Central Goldfields Shire Office** (Primary)
  12 Nolan Street
  Maryborough Vic 3465
- **Central Goldfields Shire Depot** (Secondary)
  72 Burns Street
  Maryborough Vic 3465

Liaison with the MOC will be through the Division/Sector Command, or if not established, the VICSES Loddon Mallee Region RDO/RAC or IC may liaise with the MOC directly, supplementing municipal involvement in the IEMT and ongoing contact with the Municipal Emergency Response Coordinator (MERC). If a MOC (or similar) is not operating, the Municipal Emergency Management Officer (MEMO) will be contacted.

3.3.9 On receipt of a Flood Watch or Severe Weather Warning

The VICSES RDO or IC will undertake actions as defined within the flood intelligence cards for each location. General considerations by the RDO or IC should include:

- Review storm and flood intelligence to assess likely flood consequences
- Monitor weather and flood information
- Assess command and control requirements
- Review local resources and consider needs for further resources regarding personnel, property protection, storm/flood rescue and air support
- Notify and brief appropriate officers. This includes the RCC and/or SCC (if established), MEMO (as outlined in the MEMP) and other emergency services through the EMT
- Assess Incident Control Centre readiness (including staffing of IMT and EMT) and open if required
- Ensure flood bulletins and community information are prepared and issued to the community
- Monitor watercourses and undertake reconnaissance of low-lying areas
- Develop media and community information management strategy
- Ensure storm and flood mitigation works are being checked by owners
- Develop and issue incident action plan, if required
- Develop and issue situation report, if required.

3.3.10 On receipt of the first and subsequent flood warnings

The VICSES RDO or IC will undertake actions as defined within the flood intelligence cards for each location. General considerations by the RDO or IC should include:

- 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
- What areas may be at risk of building damage.
- Determine what the at-risk community need to know and do as the storm and/or flood develops.
- Warn the at-risk community including ensuring that an appropriate warning and community information strategy is implemented including details of:
  - The current storm and/or flood situation
  - Storm and/or flood predictions
  - What the consequences of predicted activity and or 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 and power utilities)
- Implement response strategies as required based upon storm and/or flood consequence assessment
- Continue to monitor the storm/flood situation (http://www.bom.gov.au/)
- Continue to conduct reconnaissance of low-lying areas.

3.4 Community information and warnings

Guidelines for the distribution of community information and warnings are contained in the VICSES Loddon Mallee Region Storm and Flood Emergency Plans and SEMP Flood Sub-Plan.

Community information and warnings communication methods available include:

- VicEmergency App, Hotline and website
- Emergency Alert phone messages (including SMS)
- Social media and/or social networking sites (i.e. Twitter and/or Facebook).
- Radio and television
- Community meetings
- Newsletters
- Two-way radio
- Mobile and fixed public address systems
- Sirens
- Verbal messages (i.e. doorknocking)
- Variable message signs (i.e. road signs)
- Newspapers
- Email
- Telephone trees
- Fax stream
- Letter drops.

Refer to Appendix D for the specific details of how community information and warnings are to be provided.

The release of flood warnings and information regarding response activities at the time of a flood event is the responsibility of VICSES, as the control agency.

Responsibility for public information, including media briefings, rests with VICSES as the control agency. Central Goldfields Shire will assist VICSES to warn individuals within the community where practicable including activation of flood warning systems, where they exist. Other agencies such as CFA, DEECA and VicPol may also be requested to assist with the communication of community flood warnings.

The Department of Health (DH) will coordinate information regarding public health and safety precautions.

3.5 Media communication

The IC through the Public Information Section established at the ICC will manage media communication. If the ICC is not established the VICSES Loddon Mallee Region RDO will manage all media communication. Central Goldfields Shire and other agencies should consult with the IC prior to releasing information to the media to ensure that consistent and timely messaging is being provided to the community.

3.6 Impact assessment (IA)

IA is conducted in the aftermath of an emergency event (or during depending on the scale). It assesses the impacts of emergencies on communities and informs government of immediate relief and recovery and long-term recovery needs. IA should be community focused to ensure the data and information will assist decision making on how to best support communities impacted by emergencies. A three-stage process is utilised to gather and analyse information following an emergency event:

- Initial Impact Assessment (IIA)
- Secondary Impact Assessment (SIA)
- Post Emergency Needs Assessment (PENA).

3.6.1 Initial Impact Assessment (IIA)

IIA typically begins in the first 24 to 48 hours of an emergency event and is focused on the collation of immediate impact data. ICs can deploy reconnaissance teams to check for hazards prior to the release of IIA Teams or emergency services' personnel to a potentially unsafe area.

IIA is a preliminary assessment generally from visual inspection undertaken by response agencies, assisting in determining the scale and impact of the emergency on people, community infrastructure, and the economic, natural and built environments.

IIA provides early information to assist in the prioritisation of immediate needs of individuals and communities, requirements of SIA and supports commencement of emergency relief and early recovery planning and activities by Central Goldfields Shire, DFFH and ERV.

3.7 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.

3.8 Response to flash flooding

Emergency management response to storm and flash flooding should be consistent with the VICSES Loddon Mallee Region Emergency Response Plan – Storm and Flood Sub-Plans and the SEMP Storm 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, and resources available.
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. Contact MERC who liaises with MEMO and MRM about activating ERC (see MEMP).
4. Where it is likely people will become trapped by floodwaters safety advice needs to be provided to people at risk advising them not to attempt to flee by entering floodwater if they become trapped, and that it may be safer to seek the highest point within the building and to telephone Triple Zero (000) if they require rescue; This advice needs to be provided even when evacuation may be possible, due the likelihood that not all community members will evacuate.
5. For buildings known to be structurally unsuitable an earlier evacuation trigger will need to be established (return to step 1 of this cycle).
6. 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.
7. Contact MERC and MEMO at the earliest opportunity to allow relief preparation to commence.

Due to the rapid development of storms and flash flooding it will often be difficult to establish emergency relief centres ahead of triggering the evacuation, as is normal practice. This is insufficient justification for not adopting evacuation, which must still be considered as an option for ensuring the safety of people in at risk areas.

3.9 Evacuation

The decision to recommend that people evacuate is made by the IC and where possible and practical, in consultation with the IEMT, if activated. Refer to JSOP 03.12 – Evacuation for Major Emergencies and the Evacuation Guidelines for guidance on evacuations for flood emergencies.

VicPol (or delegate to Australian Red Cross) may take on the responsibility of registering people affected by the emergency through the Register.Find.Reunite. program, including those who have been evacuated.

The Vulnerable Persons Register (VPR), which stores local information about consenting, identified vulnerable people, can be accessed in MECC Central. Access to the VPR is role-based and limited to municipalities, VicPol and DFFH. The VPR is limited and vulnerable people in emergencies may vary depending on the emergency and location in the municipality. Vulnerable persons can also be identified through community network organisations.

3.9.1 Decision

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 risk as a consequence of flooding and evacuation is considered the most effective risk treatment. This role of the Health Commander of the incident is to assess and manage this risk. Refer to the SEMP Health Emergency Sub-Plan (HESP).
- 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 time 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
- Resources required and resources 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.

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

3.9.2 Warning

VICSES is responsible for the development and communication of evacuation warnings. Warnings may include a warning to prepare to evacuate and a warning to evacuate immediately. Once the decision to evacuate has been made, the at-risk community will be warned to evacuate.

Evacuation warning messages will be developed and issued by VICSES in consultation with the MEMO, MERC, MRM and other key agencies and expert advice. It is the choice of individuals as to how they respond to this recommendation.

3.9.3 Withdrawal

VicPol are responsible for coordination of the evacuation process. VICSES and other agencies will assist where practical, including providing advice regarding most appropriate evacuation routes and locations for at-risk communities to evacuate to. Evacuation routes to be utilised will be determined by the extent of flood waters.

VICSES, CFA, AV and local government will provide resources where available to support VicPol and DTP 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 by VicPol.

A landing zones for helicopters is located at:

- Maryborough Aerodrome, Leviathan Road, Maryborough.

3.9.4 Shelter

Relief centres and/or assembly areas which cater for people's basic needs may be established to meet the immediate needs of people affected by flooding. The venues that are suitable for flood events are detailed in the Central Goldfields MEMP. The venue to be used in a particular flood event will be decided by the Central Goldfields Shire MRM in consultation with the Incident Controller and the MERC.

Animal shelter compounds will be established for domestic pets and companion animals of evacuees as required. These facilities will be coordinated under the arrangements in Part 6 of the Central Goldfields Shire MEMP.

3.9.5 Return

The IC 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 it is safe to return include:

- Current flood situation and forecast weather
- 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
- Transportation (particularly for people without access to transport).

3.10 Flood rescue

Rescue is considered separately to the relocation of people who are stranded or isolated by floodwaters. Where waters are either fast or swift flowing and/or the people being assisted are facing actual or threatened danger of physical harm the response escalates from relocation to rescue.

VicPol, as the designated control agency for water rescue, coordinates rescues undertaken during flood events. To activate water rescue services VICSES, as control agency for overall flood response, will identify areas at risk of requiring rescue and notify the Officer in Charge of the Water Police Search and Rescue Squad to request pre-deployment of rescue resources to these areas.

In conducting rescues, VicPol will often require assistance of appropriately trained and equipped personnel from support agencies (including VICSES, Coast Guard, CFA and LSV) to undertake flood rescue. VicPol coordinate with these agencies to ensure operational readiness for activation.

In significant flood events, VicPol will appoint a Flood Rescue Manager, who may be an officer from VicPol or one of the support agencies. The primary responsibilities of the Flood Rescue Manager are to:

- Coordinate all rescue activities
- Identify and source required resources
- Deploy required police and support agency resources.

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 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.

There are no agency-owned or controlled aircraft, boats or specialist rescue resources within Central Goldfields. VicPol and VICSES can access rescue boats, but there is a lead-time required to get them onsite. Aircraft may be available through VicPol for urgent rescue operations.

Known high-risk communities (low-lying islands) where rescues might be required include:

- Carisbrook
- Natte Yallock.

Experience has shown (January 2011 and October 2022) that property isolations can occur quickly in some rural areas, as well as stranded person(s) in vehicles trapped in floodwaters and both types of events may require specialist rescue.

3.11 Aircraft management

Aircraft can be used for a variety of purposes during storm and/or flood operations including evacuation, resupply, reconnaissance, intelligence gathering and emergency travel. Air support operations will be conducted under the control of the IC in line with Interagency Aviation Operating Policy and Procedures (IAOPs). The IC may request aircraft support through the State Air Desk located at the SCC who will establish priorities. Suitable airbase facilities are located at

- Maryborough Aerodrome, Leviathan Road, Maryborough (24-hour lighting).

3.12 Resupply

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

When predictions and/or 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. VICSES will work with Central Goldfields Shire and DFFH to service communities that are isolated.

3.13 Critical infrastructure and property protection

Critical infrastructure and property (e.g. telecommunications, businesses, roads and power supply) may be affected in the event of a flood. The IC will ensure that critical infrastructure owners and providers of are kept advised of the flood situation and they in turn must keep the IC informed of their status and ongoing ability to provide services.

Locations that may require protection include:

Facility	Impact	Trigger point for action	Strategy/Temporary Measures
Telephone exchange	Loss of local land lines	Predicted below 0.5%AEP event	Sandbag
Sewage Pumping Station, Bucknall St	Contaminated water in community	Moderate Flood Warning	Monitor and sandbag if predicted inundation
Castlemaine – Maryborough rail line	Rail stoppage	Little above 2% AEP Event	Contact State Rail Controller Melbourne

Critical infrastructure and 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 within appropriate approval frameworks may occur in consultation with NCCMA, Central Goldfields and VicPol.

Sandbag supplies are available through VICSES and/or at hardware stores. The Incident Controller will determine the priorities related to the use of sandbags, which will be consistent with the strategic priorities.

Refer to Appendix A for further specific details of critical infrastructure requiring protection. Refer to Appendix F for details on sandbag procurement, storage, distribution, use and disposal.

3.14 Disruption to services

Disruption to services other than critical infrastructure and property can occur in flood events. This may include road closures affecting school bus routes, water treatment plant affecting potable water supplies, etc.

Service disruptions in Central Goldfields may include:

Service	Impact	Trigger Point for action	Strategy/Temporary Measures
School Bus services	Bus routes may be closed due to rising flood water.	Road closures likely or actual.	Council to advise Maryborough Education Centre Bus Coordinator of road status
Waste Water Treatment	Pump stations may stop due to rising water	Pump stations inundated	Central Goldfields Shire to advise community

3.15 Road closures

Central Goldfields Shire and Department of Transport and Planning (DTP) are responsible for road closures including observation and placement of warning signs, roadblocks etc. to the road network, walking and bike trails. Central Goldfields Shire staff may also liaise with and advise DTP as to the need for warning

signs and/or of closing roads and bridges under DTP jurisdiction. DTP are responsible for designated main roads and highways and DTP is responsible for the designated local and regional road network.

Central Goldfields Shire will share community information regarding road closures through social media and local networks.

Within Central Goldfields, there are a significant number of roads that are impacted by floodwater. A list of these roads is provided in Appendix A. Several of these roads have permanent flood warning signs in place that can be activated in emergencies to close the road. For details of the highways and arterial roads affected, see the Flood Intelligence Cards for each stream.

3.16 Dam failure

DEECA is the control agency for dam safety incidents (actual or potential breach/failure of a dam), however VICSES is the control agency for any flooding that may result.

Major dams with potential to cause structural and community damage are listed in Appendix A. The owner/operators of these dams are required to develop and maintain emergency plans in case of failure.

3.17 Waste water related public health issues and critical sewerage assets

Inundation of critical sewerage assets including septic tanks and sewage 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:

- 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.

It is the responsibility of the Central Goldfields Environmental Health Officer and/or the Environment Protection Authority (EPA) to inspect and report to the MEMO (or the ICC if activated) any water quality issues that are identified as a result of flooding.

3.18 After Action Review

An After Action Review (AAR) should follow all emergencies. This local debriefing process allows groups to learn from an event and address issues as soon as possible, leading to improved performance and communication. Formal debriefs are usually more structured and can be used to raise issues, highlight positive outcomes, identify areas for improvement and propose actions.

[Fundamental of Emergency Management, February 2015]

All agencies involved in the flood incident should be represented at the AAR.

Part 4. Relief and recovery arrangements

4.1 General

Arrangements for emergency relief and recovery from a flood incident within Central Goldfields are detailed in the Central Goldfields MEMP Section 7 – *Relief Arrangements* (page 44) and Section 8 – *Recovery Arrangements* (Page 49).

4.2 Emergency relief

The IC is responsible for recommending the activation of relief services and ensuring that relief arrangements have been considered and implemented in consultation with IEMT, including the MRM, in accordance with the SEMP (Page 25) and in line with the MEMP.

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 (Table 12).

Central Goldfields has many facilities suitable for relief activities; those identified for use during floods are detailed in the MEMP.

4.3 Animal welfare

Matters relating to the welfare of livestock and companion animals (including emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue) are to be referred to DJPR.

Matters relating to the welfare of wildlife, or requests for emergency supply and/or delivery of fodder to stranded livestock or for livestock rescue are to be referred to DEECA.

Note: Central Goldfields Wildlife Rescue may have some capacity to assist with orphaned, injured or ill wildlife and can be contacted via mobile on 0499 654 950.

Refer to the Northern Victorian Integrated Emergency Animal Welfare Plan and the Victorian Emergency Animal Welfare Plan for detailed arrangements.

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 (Page 28 and 29) and the Central Goldfields MEMP Section 7.5 - *Transition to Recovery*.

Note: Some municipal emergency plans and MEMP Sub-Plans may not be available or current. In the absence of these plans, regional and state emergency management plans should be referenced including:

- Loddon Mallee Region Emergency Management Plan
- Loddon Mallee Region Emergency Relief and Recovery Plan (available on EM-COP)
- State Emergency Management Plan
- State Emergency Relief arrangements
- State Emergency Recovery arrangements.

Accuracy and confidentiality

The information in the following Appendices provides a guide to the likelihood and possible effects of a flood. The information is based on estimates of rainfall rates and depths and on flood behaviours at particular heights or flows following actual flood events and/or hydrologic and hydraulic modelling. However, as all floods are different, those behaviours and effects may occur as a result of different rainfalls and/or heights and flows. They may also occur at different heights in different floods.

This document may contain sensitive information about the effects of flooding on private property. Specific reference to private addresses or businesses may be made directly to owners or other emergency services but should not be made public via broadcast or print media unless authorised specifically by the Incident Controller.

Appendix A – Flood threats for Central Goldfields

1. General

Central Goldfields is bounded by Northern Grampians Shire and Pyrenees Shire to the west, Loddon Shire to the north and northeast, Mount Alexander Shire to the east and Hepburn Shire to the southeast. Avoca River forms part of the northwest boundary for about 25km, between Natte Yallock and downstream from Bealiba. Joyces Creek and Cairn Curran Reservoir form part of the boundary to the east.

The northwestern part of the Shire from Natte Yallock to Bealiba is part of the Avoca catchment. Tributaries of the Loddon River drain the remainder of the Shire. The eastern and western edges of the Shire are basalt plain, while the central portion is undulating to hilly country.

Maryborough is the largest town. Towns in the north include Dunolly, Bealiba and Moliagul. Carisbrook, Bowenvale and Majorca are in the central area while Talbot is the main town in the southern part of the Shire. There is extensive rural residential development north of Dunolly, in the Bet Bet and Betley area, at Alma, around Bealiba, north of Carisbrook, in the Majorca-Red Lion-Dunach corridor, at Daisy Hill, between Amherst and Talbot, and south of Talbot.

Flooding within Whirrakee Rise should be predominantly contained within the road reserves, although there are noticeably greater depths adjacent to the central detention basin at the junction of Quinn Street and Whirrakee Drive. With depths of over 500mm, this may make this junction unpassable.

There are many creeks that are subject to flooding, affecting rural areas along the creeks, many local and larger roads and a number of the urban areas.

2. Major waterways

Joyces Creek, Tullaroop Creek, McCallum Creek, Bet Bet Creek and the Avoca River between Natte Yallock and downstream from Bealiba are the major waterways. A number of smaller tributaries are also important in respect to flooding, such as Burnt Creek at Dunolly.

Joyces Creek rises to the south in Hepburn Shire and discharges into Cairn Curran Reservoir on the Loddon River. Joyces Creek forms the south eastern boundary of the Shire.

Tullaroop Creek rises south of Creswick within Hepburn Shire, on the northern slopes of the Great Dividing Range to the north of Ballarat. Along with McCallum Creek, which originates on the northern slopes of the Great Dividing Range to the east of Lexton and south of Talbot, it drains much of the central part of the Shire. McCallum Creek joins Tullaroop Creek immediately upstream of the Pyrenees Highway Bridge at Carisbrook, flowing downstream to the Loddon River at Laanecoorie Reservoir. Tullaroop Creek forms part of the eastern boundary of the Shire.

Bet Bet Creek rises to the west in Pyrenees Shire around Lexton. The creek and its tributaries drain the central part of the Shire. It flows north/northeast through the localities of Bung Bong, Wareek, Timor West, Bet Bet and Betley and discharges into Laanecoorie Reservoir.

There are many other creeks within the Shire, many of which rise outside the boundary, including:

- Cochranes Creek (a tributary to the Avoca River that flows through Bealiba)
- Dunria Creek (a Bet Bet Creek tributary that passes under the Old Maryborough – Avoca Road)
- Timor Creek (a Bet Bet Creek tributary that passes through Adelaide Lead)
- Emu and Green Hills creeks (Bet Bet Creek tributaries that passes through Dunluce)
- Carmanuel Creek (a Bet Bet Creek tributary that passes under the Dunolly – Stuart Mill Road)
- Burnt Creek (a Bet Bet Creek tributary that rises near Painswick on the southern slopes of Mt Moliagul and includes the eastern slopes of the Bealiba Ranges, passes through Dunolly and joins Bet Bet Creek near Betley)
- Gypsy Creek (a tributary to Burnt Creek that rises near Moliagul)
- Old Lead Creek (a tributary to Burnt Creek that joins it at Dunolly)

- Four Mile Creek (a Bet Bet Creek tributary that passes through Maryborough)
- Splitters Creek (a tributary to Tullaroop Creek that passes under the Talbot – Mount Cameron Road)
- Sandy Creek (a tributary to Tullaroop Creek that passes under the Holmes Road)
- Back Creek (a tributary to McCallum Creek that passes through Talbot)
- Daisy Hills Creek (a tributary to Back Creek that rises near Lillicur)
- Middle Creek (a tributary to Joyces Creek that rises near Mount Duntrulm).

There are also a number of small catchments to the west and southwest of Carisbrook (between Maryborough and Carisbrook) that generate substantial overland flows that drain to Carisbrook during heavy rain events.

3. Flood risks

Central Goldfields Shire experiences both riverine and flash flooding events.

There are a large number of creeks within the Shire that are subject to flooding. The flooding affects rural areas along the creeks, many local and larger roads and a number of the urban areas. Many of the roads affected result in isolation and transport disruption, details of which are listed later in this document.

The major flood risks within the Shire are associated with:

- Runoff from the local catchments to the south and south west of Carisbrook
- Tullaroop Creek and McCallum Creek at Carisbrook and rural areas
- Local drainage and flooding issues at Maryborough
- Burnt Creek and runoff from the local catchment to the north and east of Dunolly
- Bet Bet Creek and the low lying areas along its course (some risk of isolation and inundation of some rural residences and farm buildings) especially in the Bet Bet and Betley areas;
- That part of the Avoca River within the Shire between Natte Yallock and downstream from Bealiba
- Back Creek at Talbot.

4. Riverine flooding

Prolonged moderate to heavy rain often leads to flooding within the Shire. Generally, a wet catchment and a period of heavy rain are required to produce severe flooding along the Shire's waterways. Historically this is normally summer related between September and February. The more severe riverine floods within the Shire generally occur as a result of:

- Moist warm airflow from northern or north western Australia (perhaps from a decaying tropical cyclone) bringing moderate to heavy rainfall over a period of 12 hours or more following a period of general rainfall. The period of general rainfall "wets up" the catchments and (partially) fills both the on-stream dams and the natural floodplain storage. These combine to increase the runoff generated during the subsequent period of heavy rainfall.
- Successive cold fronts, often during winter and spring, that bring periods of rain that wet up the catchments and prime them for flooding from a further front or complex low-pressure system that is perhaps slow moving and brings moderate to heavy rainfall.

5. Flash flooding, overland flows and stormwater flooding

Short duration, high intensity rainfall (usually associated with severe thunderstorms or locally intense and slow-moving weather systems) can cause flash flooding. Such events, which are more likely in Spring and Summer but can occur at any time of year, do not generally create widespread flooding as they only last for a short time and affect limited areas. Flooding from these storms occurs with little warning.

High intensity rainfall such as associated with thunderstorms giving average rainfall rates of typically more than about 40mm/hour for 30 minutes or so (i.e. 20mm or so in 30 minutes) is likely to lead to high flows in

local creeks and/or along overland flow paths, even on a dry catchment. Flooding is also likely in urban areas as the capacity of the stormwater drainage system is likely to be exceeded.

Blocked or capacity impaired stormwater drains can also lead to overland flows and associated flooding: the drains surcharge and excess water flows above ground. Stormwater drains are generally only designed to cope with small frequent events.

This amount of rain on a wet catchment will result in higher flows within waterways but the depth, extent and duration of any flooding will be determined by the volume of rain and the period over which it falls.

6. Dam failure flood risk

All dams have a risk of failure. All major dams have a Dam Safety Emergency Plan (DSEP) implemented by the managing entities:

- Centenary Reservoir (Maryborough) – Central Highlands Water
- Goldfields Reservoir, Nuggety Gully Reservoir and Lake Victoria – Central Goldfields Shire
- Tullaroop Reservoir – GMW – Document No. A3737994.

DSEPs identify possible dam failure scenarios and provide direction on the order and detail of the necessary communications and incident management tasks to be initiated. They also refer to intelligence and maximum inundation extent mapping arising from detailed dam break analyses. Intelligence can include travel times to key locations, maximum depths and velocities and the time to reach those maxima at those key locations, as well as other information that would inform the response effort. Close communication with the dam manager is essential in the event of a dam safety incident.

Additionally, there is the Old Lead Reservoir located due north of Dunolly. It is a former water supply reservoir now managed by Loddon Shire. A dam break from this reservoir is likely to have an impact on flooding in Dunolly. Loddon Shire is currently investigating options for the reservoir's future.

7. Health and environmental risks

There are many septic tanks and sewerage pump stations that may be inundated by floodwaters. Further, chemicals and fuel may be stored in farm sheds and tanks on floodplains.

Inundation of the Powlett St Sewer Pump Station (SPS) wet well in Carisbrook is low risk as pumps are submersible by design. Flood water may however impact above ground electrical cabinets causing them to fail. Failure of the SPS for an extended period may result in downstream wastewater contamination. This may introduce a minor risk to environmental and public health. With sufficient warning (days), CHW is able to apply temporary protections that increase resilience to flooding in the short term. CHW also maintains temporary mobile switchboards that can be deployed in an emergency. Preventative and recovery measures can be expected to avoid any major risks.

A wealth of information on various environmental health risks, including floods and extreme weather, is available on the Better Health Channel website and can be used to develop key community messages during emergencies.

8. Properties at risk

Information on property floor levels and the likelihood of over floor flooding is available for Carisbrook, Dunolly, Maryborough (draft only), Bealiba, Bet Bet, Moliagul, Talbot and Timor-Bowenvale.

The table below is a breakdown of the number of buildings flooded over floor in a 1% AEP flood event. These figures are **indicative only**.

Waterway	Community	# buildings flooded above floor in 1% AEP				
		Residential	Business	Industrial	Rural	Total
Tullaroop Creek	Carisbrook	29	10	0	0	39
Burnt Creek	Dunolly	11	4	0		15

Four Mile Creek	Maryborough	106	30	14		150
Cochranes Creek	Bealiba	0	0	0	0	0
Bet Bet Creek	Bet Bet	2	0	0	0	2
Burnt Creek	Moliagul	1	1	0	2	4
Back Creek Mia Mia Creek	Talbot	3	1	0	0	4
Bet Bet Creek	Timor-Bowenvale	0	0	0	1	1
Total						**220**

9. Infrastructure at risk

Major infrastructure within Central Goldfields includes major highways and rail lines. There are a number of major roads and other infrastructure which may be at risk of inundation in a large event.

Other than at Dunolly, it has not been confirmed that any caravan parks are at risk of being flooded during a 1% AEP event.

9.1 Major roads

Dependant on flood magnitude the following roads may be inundated:

- Pyrenees Highway at Carisbrook – overtopped in January 2011
- Bucknall Street, Eddington Road and Landrigan Road, Carisbrook
- Ballarat-Maryborough Road at Dunach and Talbot
- Bendigo-Maryborough Road along Park Road at Maryborough
- Maryborough-Dunolly Road south of Dunolly from reasonably small floods upwards
- Dunolly-Moliagul Road (Dunolly-St Arnaud Road) immediately north of Dunolly from reasonably small floods upwards
- Dunolly-Avoca Road and Dunolly-Stuart Mill Road immediately west of Dunolly
- Dunolly-Eddington Road west of Eddington
- Lexton-Talbot Road and Avoca Road, Talbot
- Logan Road, Bealiba
- Bet Bet-Mt Hooghly Road, Bet Bet
- Bet Bet Creek Road, Timor-Dunolly Road and Timor Road south of Bet Bet Creek Road
- Monument Road and Wedderburn-Dunolly Road, Moliagul
- Archdale-Avoca Road – significant sections of road inundated.

9.2 Other infrastructure

Telecommunications:

- Telstra Exchange at 15 Bucknall Street, Carisbrook
- Telstra Exchange at western corner of McNeil Street and Annesley Street South, Carisbrook
- Telstra Exchange at 122 Broadway, Dunolly
- Telstra Exchange at 20 Campbell Street, Maryborough

Mobile network telephone towers: best source of information is https://www.rfnsa.com.au/home

Water treatment plant: at Maryborough – unlikely to be flooded

Sewer pump stations: at Carisbrook and Dunolly

Community facilities:

- *Carisbrook* – many facilities including the CFA building, Britannia Hotel, Churches, Carisbrook Sports ground and pavilions, Carisbrook indoor leisure centre at the Carisbrook School, etc (all affected by the January 2011 flood), elderly person residential units.

- *Maryborough* - elderly person residential units (Princes Park Lodge, High St).
- *Dunolly* – Dunolly Golf Club may have flood waters affect the property but not up against the building – may be quite deep if in a flow path. Dunolly Recreation Reserve and Dunolly Caravan Park may be affected from a 10% AEP event (see maps at Appendix H).

10. Flooding hotspots

Heavy rain often results in flooding in:

- South of Victoria Street (Pyrenees Hwy), Carisbrook
- Park Road (near Golf Course)
- Northern end of Broadway in Dunolly and particularly between the Inglewood - Dunolly railway line and Raglan Street.

Other flooding hotspots are identified on the maps in Appendix H.

11. Flood inundation mapping

Water Technology has produced a series of flood inundation maps for Carisbrook (2019) and for Dunolly (2013). HARC (2020) has produced a series of flood maps for Talbot, Moliagul, Bet Bet, Bealiba and Timor-Bowenvale. Preliminary mapping from the Maryborough Flood Study (2022) prepared by Water Modelling Solutions is also available. A subset of these maps is included at Appendix H.

A regional flood mapping exercise is currently being undertaken for the remainder of the Central Goldfields Shire. Results from this study will be available mid-2024. In the interim the existing coarse flood extent maps that were developed for parts of the municipality in 2000 as part of the state Flood Data Transfer Project (FDTP) (DNRE, 2000) can be used as a guide.

12. Historic floods

Records indicate that flooding within the Shire has occurred most often between the months of August to November, partially corresponding to the months of highest rainfall.

Floods are reported to have occurred within the Shire in February 1873, November 1893, 1900, 1909, 1933 (Reference Darryl McLeish's book), December 1937, April 1959, 1964, 1975, 1981, September 1983, 1993, June 1995, 1996, December 1999, September 2010, January 2011, September 2016 and October 2022.

Between late 2010 and early 2011, Central Victoria experienced a number of widespread heavy rainfall and flood events. The floods of 2011 were the most severe on record. Floods in September 2010, November 2010 and January 2011 caused in excess of $12 million in damages to public assets throughout the Shire. Many homes were flooded in Carisbrook, Dunolly and Talbot and major transport routes to each of these towns flooded for periods of up to four (4) days. The communities of Maryborough, Bet Bet, Betley and Bealiba as well as outlying properties were also affected.

From Monday 10 January to Friday 14 January 2011, Maryborough received 215mm of rain and Dunolly received 216mm.

Avoca River

- 1893 (3.3% AEP) – Impact unknown
- 1909 - Impact unknown
- September 1983 (4% AEP) - Impact unknown
- June 1995 (4% AEP) - Impact unknown
- October 1996 (5% AEP) - Impact unknown
- September 2010 (20-5% AEP) - Impact unknown
- January 2011 (1-0.5% AEP) - Houses with over floor flooding in the Natte Yallock, Archdale Junction and Archdale areas. Road and bridge infrastructure damage, arterial and local roads closed for several days/weeks. Large areas of rural land flooded, with some kilometres of fencing destroyed. Stock losses unknown

- September 2016 – Flooding affecting roads and property.
- October 2022 - Flooding affecting roads and property.

Tullaroop Creek and McCallum Creek

- Prior to 1999 major flood events were reported to have occurred in 1900, 1964, 1975, 1981 and 1993.

27 December 1999

The flash flood of 27 December 1999 resulted in significant inundation around Carisbrook. The southwest side of the town was impacted by overland flows coming off the hills to the southwest in the Mosquito Flat and Craigie catchment area (i.e. between Carisbrook and Maryborough) following heavy localised rain. A number of properties along the south side of Victoria Street were flooded over floor and the Pyrenees Highway was closed. Neither McCallum Creek nor Tullaroop Creek flooded at Carisbrook.

September 2010

Following a wet August, a major rain event affected the north of the State on 4 and 5 September as a low-pressure system deepened over South Australia and moved into Bass Strait, with an associated trough extending north into NSW. Rain began falling on the 3rd and continued during the 4th.

Tullaroop Reservoir filled and spilled during the event after starting at around 60% capacity.

There was some rural fence damage.

At Carisbrook (see Appendix C1), significant overland flow from the local catchments to the west and southwest impacted the town on the 4th. Runoff accumulated to the south of town well before creek levels rose. The small sandbag levee along Belfast Road near the upstream end of the main bluestone drain was breached which led to the inundation of a number of properties upstream (to the south) of the Pyrenees Highway / Victoria Street, and along the alignment of the bluestone drains through town when it overtopped. Rural and residential areas to the west around the Trotting Track were also inundated. While raised levels in McCallum and Tullaroop creeks inundated low-lying areas along the creek, Bucknall Street was not overtopped. Only Victoria, Green and Powlett Streets were flooded. Approximately 25 buildings were flooded over floor.

January 2011

Significant widespread rainfall affected the majority of the State in January 2011. It was the wettest January on record. The event was significant enough for the Bureau of Meteorology to publish Special Climate Statement 26 to describe the synoptic conditions associated with the event. In summary, the extreme rainfall recorded was generated by the passing of complex and persistent low-pressure systems. A broad slow moving trough centred over western Victoria and a ridge of high pressure to the south of Tasmania were the main drivers for the rainfall that started to fall on 9 January. The two systems created exceptionally humid conditions and an unstable easterly flow across Victoria. The trough strengthened on the 12th and developed into a low-pressure system over eastern South Australia on the 14th as a high-pressure system moved into the Tasman Sea. The low-pressure system cleared the State on the 14th after adding an additional 50 to 100mm to the deluge already received.

Maryborough recorded 90.4mm in the 24 hours to 9am on Friday 14 January, the highest daily total recorded in 131 years. Tullaroop Reservoir spilled during the event after starting from close to capacity. Large area of rural land flooded with some kilometres of fencing destroyed. Stock losses are unknown

At Carisbrook (see Appendix C1), the flood on 14 January 2011 is considered to be the largest on record. It inundated most of the town. Damage was severe caused by a combination of overland flows from the local catchments to the west and south west of town and flows breaking out of McCallum and Tullaroop creeks. Runoff accumulated to the south of town before creek levels rose, and the small levee along Belfast Road near the upstream end of the main bluestone drain was breached. The drainage channels to the south and west of Carisbrook, designed to convey local runoff through the town to the creek, were overtopped. The Pyrenees Highway and Bucknall Street were both overtopped by the creeks some time after the local flows impacted the town. Around 250 residential and commercial buildings were flooded over floor (Council listed 273 properties affected by flooding). A number of damaged houses had to be demolished and rebuilt.

September/October 2016

Carisbrook again came under threat as 25 houses were doorknocked as McCallums Creek peaked at a height of 4.12m and the Tullaroop Creek peaked at a height of 2.58m. Central Goldfields Shire opened a relief centre in Maryborough. Carisbrook Primary School and Highway College were both closed with highways affected by the floodwaters.

October 2022

A third consecutive La Niña was declared in spring 2022 and combined with a negative Indian Ocean Dipole (IOD) and positive Southern Annular Mode (SAM), brought Victoria its wettest October on record. By mid-September, catchments were saturated and emergency service organisations were working closely with Central Goldfields Shire Council to review the Municipal Flood Emergency Plan and confirm response arrangements for what was anticipated to be a challenging season for flash and riverine flooding.

On 12 October, severe weather resulted in flash and riverine flooding across urban and rural areas throughout Loddon Mallee Region; adjacent regions also experienced significant flood impacts. An ICC was established at Epsom and managed the flood response. A total of 160 Requests for Assistance (RFA) were received in Central Goldfields by VICSES between 12 and 14 October. It is acknowledged that property, roads and the agriculture sector sustained substantial damage that was not captured through RFAs.

Epsom ICC coordinated initial impact assessments for a section in Carisbrook, in addition to the agriculture assessments conducted by Agriculture Victoria and the road assessments conducted by DTP. The Shire completed secondary impact assessments to private property and had the infrastructure impact assessment underway, as well as the information from DTP on impacted roads and bridges.

Agriculture Victoria assessments indicate 15.5% of farm area and 1,290km of fencing was impacted by the severe weather in October, with reports of 143 dead and 102 missing livestock. The estimated whole of standing crop loss is 2,603 hectares, in addition to hay and silage and grazing pasture loss.

Initial impact assessment data indicated four properties were inundated in Carisbrook; this was later revised to 12 properties inundated across Central Goldfields:

- Four properties in Carisbrook (not the four that were initially identified)
- Three properties in Dunolly
- Three properties in Talbot
- One property in Bet Bet
- One property in Mt Glasglow.

In Carisbrook, the town was largely protected from overland flooding from the local catchment by the partially constructed western levee. The McCallums Creek gauge, located just upstream of the township, peaked at 5.21m on the evening of 13 October. The Pyrenees Highway at Tullaroop Creek was close to overtopping. Based on two surveyed flood marks this event was estimated to be in the order of a 2% AEP event.

Bet Bet Creek

- December 1937 - Some houses with above-floor flooding in the Timor area. Isolated residences, road and bridge infrastructure damage, large areas of rural land flooded. Stock and fences lost. Result of severe storm event in the Bung Bong – Avoca area.
- September 2010 - Arterial and local roads closed for several days. Large areas of rural land flooded.
- November 2010 – Minor rural flooding
- January 2011 - Houses with above-floor flooding in the Bet Bet and Betley areas. Isolated residences, road and bridge infrastructure damage, arterial and local roads closed for several days/weeks. Large areas of rural land flooded, with some kilometres of fencing destroyed. Stock losses unknown.

Burnt Creek

- 18 February 1873 – Heavy rain with thunderstorms resulted in severe flooding in Dunolly.

- 12 November 1893 – Overnight rain followed by a thunderstorm (a total of around 100mm in about 23 hours including 25mm in 25 minutes) led to severe flooding at Dunolly. Roads were impassable, the railway line was damaged (ballast washed away), houses were flooded, stock were drowned and crops were damaged.
- 1 April 1959 – 150mm of rain reportedly fell at Moliagul and 67mm at Dunolly within a sixty-five minute period. This led to significant flooding at Dunolly with some houses experiencing inundation to window height.
- 8 September 1983 – Flooding resulted from 94mm of rain across the Burnt Creek catchment over a 6-day period from the 25th to 30th September. Information on flood extents and impacts is not available.
- June 1995 – One person drowned in Dunolly.
- 4 September 2010 – Arterial and local roads were closed for several days. Large areas of rural land was flooded.
- 14 January 2011 – The flood of January 2011 was the largest flood in living memory at Dunolly and followed a 5-day period in which more than 200mm of rain was recorded in three separate bursts, The final burst of 84mm fell in a 12-hour period. Dunolly was isolated with only air or rail access. The town also lost power. Forty (40) homes were evacuated. Twenty (20) homes were flooded and areas along Burnt Creek and Broadway were seriously impacted. A relief centre was opened at the Dunolly Bowls Club during the event. Large areas of rural land was flooded with some kilometres of fencing destroyed. Stock losses unknown.

Maryborough (Main Drain / Four Mile Creek)

- December 1960 (New Years Day) – Flash flood event effecting Princes Park.
- January 2011 – Many streets and lower areas in the vicinity of main drains flooded. Local roads flooded including Park Road (Bendigo-Maryborough Road), Gladstone Street, Nolan Street, Majorca Road, Gillies Street, Tullaroop Road, isolated arterial roads and local roads closed for several hours.
- September and November 2010 – Minor flooding only. Flash flooding occurred in isolated areas but cleared quickly.

Back Creek

- January 2011 – Lower areas of Talbot, to the west of the Ballarat-Maryborough Road, flooded. Isolated residences with road and bridge infrastructure damaged. Arterial roads and local roads closed for several days. Large areas of rural land flooded with some kilometres of fencing destroyed.
- November 2010 – Minor rural flooding.
- September 2010 – Arterial road closed for two days.

13. River gauge locations

The following stream gauges are of relevance to flooding within the Shire (with sensors):

- Tullaroop Creek at Clunes (407222A)
- Creswick Creek at Clunes (407214A)
- McCallum Creek at Carisbrook (407213C)
- The head gauge at Tullaroop Reservoir on Tullaroop Creek (407244)
- The Tullaroop Reservoir outlet (407248A)
- Bet Bet Creek at Bet Bet (407211B)
- Bet Bet Creek at Norwood (407220A)
- Bet Bet Creek at Lillicur (407288A)
- Joyces Creek at Strathlea (407230)
- Middle Creek at Rodborough (407239)
- Avoca River at Archdale (408206B) – located approximately 3km upstream of the Cherry Tree Creek junction.

The above sites are monitored and feed data through to warning systems. The gauges are owned and maintained by ALS; GMW and Central Goldfields can access the data.

There are also four gauge boards only (no sensors):

- Burnt Creek at Gooseberry Hill Road (407387A)
- Burnt Creek at Dunolly-Moliagul Road (407388A)
- McCallums Creek at Chapel Street Carisbrook (407401A)
- Tullaroop Creek at Green St Carisbrook (407402A).

14. Major water storages

Dam	Responsible authority	Main embankment height (m)	FSL (mAHD)	Dam capacity (ML)	Comments
Tullaroop Reservoir	G-MW	42.0	222.798	72,950	Fixed crest spillway.
Newlyn Reservoir		15.9	531.790	3,800	Fixed crest spillway.
Hepburn's Lagoon	G-MW	7.0	516.04	2,446	Fixed crest spillway.
Goldfields Reservoir	CGSC	4.7	262.07	150	Situated upstream of Maryborough.
Talbot Reservoir	CHW				South of Clunes – Evansford Road.
Evansford Reservoir	CHW			1,327	Top end of McCallum Creek east of the Waubra – Talbot Road.
Old Lead Reservoir	Loddon Shire	6.55	227.558	120	Located in the Old Lead Creek catchment above Dunolly (north) adjacent to Dunolly – Rheola Rd.
Lake Victoria	CGSC	2.6	230.99	67	Located in centre of Maryborough and discharged to Four Mile Creek.
Nuggety Gully	CGSC	5.3	212.10	75	Located south east upstream of Timor / Bowenvale.

15. Flood mitigation

Works to protect Carisbrook from local overland flooding in a 1% AEP event were completed during 2023. These works direct overland flow that has originated to the west of Carisbrook around the town. The works consist of a number of levees and associated drains. The flood mapping in this Plan has been updated to reflect the completion of these works.

A contour drain in the forest area to the north-east of Dunolly that runs approximately north to south along the eastern side of the town, redirects overland flows from the higher ground to the north and east around the town and into Burnt Creek to the south. Mitigation measures proposed as part of the Dunolly Flood Study (Water Technology, December 2013), have been implemented. These works were incorporated in the flood modelling data and the flood maps have been updated.

16. Digital flood extent datasets and flood photography

DEECA has developed a web-based tool, FloodZoom, that provides an authoritative range of flood information before, during and after floods. This tool contains the information collated and produced from all

the flood studies that have been undertaken in Central Goldfields. This tool cannot be accessed by the general public but can be accessed by registered users from the relevant emergency services including Council, VICSES and CMAs.

The information that is available includes flood extents, flood depths, flow velocities and water surface elevations for a range of possible flood events as well as past flood information.

NCCMA, CHW and Central Goldfields Shire hold a variety of other datasets that include:

- Contour and survey information, including LiDAR data.
- Drainage and road infrastructure data.
- Digital cadastral information.
- Flood and non-flood aerial photography.

Appendix B – Typical flood peak travel times

Avoca River

Location from	Location to	Typical travel time	Comments
Start of rainfall (upper catchment)	Avoca	5 to 10 hours	Begin to rise from normal levels
	Avoca	18 to 23 hours	To peak
	Natte Yallock	10 to 18 hours	Begin to rise from normal levels
	Natte Yallock	21 to 28 hours	To peak
	Archdale Junction	8 to 18 hours	Begin to rise from normal levels
	Archdale Junction	24 to 32 hours	To peak
	Archdale	Unknown	Begin to rise from normal levels
	Archdale	Unknown	To peak
Avoca	Natte Yallock	3 to 7 hours	To peak
Natte Yallock	Archdale Junction	2 to 6 hours	To peak
Archdale Junction	Archdale	Unknown	To peak

Tullaroop Creek (also known as Deep Creek locally at Carisbrook)

Note: BOM does not issue flood warnings for Tullaroop Creek (or for Carisbrook). The following information has been derived from the Carisbrook Flood and Drainage Management Plan (Water Technology, 2013a) and from observations of flood events by agency and community members.

Location from	Location to	Typical travel time	Comments
Start of rainfall (Creswick, Clunes areas)	Creswick		Begin to rise from normal levels
	Clunes		Begin to rise from normal levels
	Tullaroop Res HG		Begin to rise from normal levels
	Carisbrook	6 to 15 hours	Begin to rise from normal levels Tullaroop Creek peaks 6 to 24 hours after McCallum Creek at Carisbrook depending on levels in Tullaroop Reservoir
	Laanecoorie Res.		Begin to rise from normal levels
Start of rainfall over small local catchments to west and southwest of Carisbrook	Carisbrook	2 to 6 hours	Begin to experience overland flows, with water pooling upstream of Pyrenees Highway
Creswick	Clunes		Minor flooding
Clunes	Tullaroop Res HG		Minor flooding
Tullaroop Res HG	Carisbrook		Minor flooding
Carisbrook	Laanecoorie Res.		Minor flooding
Creswick	Clunes		Moderate flooding
Clunes	Tullaroop Res HG		Moderate flooding
Tullaroop Res HG	Carisbrook		Moderate flooding
Carisbrook	Laanecoorie Res.		Moderate flooding
Creswick	Clunes		Major flooding
Clunes	Tullaroop Res HG	Around 6 hours	Major flooding (Jan 2011)

Tullaroop Res HG	Carisbrook		Major flooding
Carisbrook	Laanecoorie Res.		Major flooding

McCallum Creek

Note: BOM does not issue flood warnings for McCallum Creek (or for Carisbrook). The following information has been derived from the Carisbrook Flood and Drainage Management Plan (Water Technology, 2013a) and from observations of flood events by agency and community members.

Location from	Location to	Typical travel time	Comments
Start of rainfall (Talbot, Evansford, Clunes areas)	Talbot	Within hours	Begin to rise from normal levels
	Talbot	5-15 hours	To peak
	Craigie		Begin to rise from normal levels
	Carisbrook	6 to 15 hours	Begin to rise from normal levels McCallum Creek peaks 6 to 24 hours before Tullaroop Creek at Carisbrook depending on levels in Tullaroop Reservoir
Talbot	Craigie		Minor flooding
Craigie	Carisbrook		Minor flooding
Talbot	Craigie		Moderate flooding
Craigie	Carisbrook		Moderate flooding
Talbot	Craigie		Major flooding
Craigie	Carisbrook		Major flooding

Burnt Creek

Note: BOM does not issue flood warnings for Burnt Creek or for Dunolly and there are no stream gauges in the catchment. The following information has been derived from the Dunolly Flood Study (Water Technology, December 2013) and from observations of flood events by agency and community members.

Location from	Location to	Typical travel time	Comments
Start of rain	Moliagul	Within hours	Begin to rise from normal levels
	Dunolly	3.5 hours	Begin to rise from normal levels
	Betley (junction of Bet Bet Crk.)		Begin to rise from normal levels
Start of rain	Moliagul	~3 - ~5 hours	To peak
	Dunolly	~10 – ~12 hours	To peak
	Betley (junction of Bet Bet Crk.)		To peak
Start of rise	Moliagul	2-4 hours	To peak
	Dunolly	6 – 8 hours	To peak
	Betley (junction of Bet Bet Crk.)		To peak

Bet Bet Creek

Location from	Location to	Typical travel time	Comments
Start of rainfall Lexton area	Bung Bong		Begin to rise from normal levels
	Wareek		Begin to rise from normal levels
	Timor	Within hours	Begin to rise from normal levels
	Timor	5-20 hours	To peak
	Bet Bet	Within hours	Begin to rise from normal levels
	Bet Bet	10-30 hours	To peak
Bung Bong	Wareek		Minor flooding
Wareek	Timor		Minor flooding
Timor	Betley (junction with Burnt Crk.)		Minor flooding
Bung Bong	Wareek		Moderate flooding
Wareek	Timor		Moderate flooding
Timor	Betley (junction with Burnt Crk.)		Moderate flooding
Bung Bong	Wareek		Major flooding
Wareek	Timor		Major flooding
Timor	Betley (junction with Burnt Crk.)		Major flooding

Appendix C1 – Carisbrook community flood emergency plan

1. Overview

Carisbrook is a small rural township of 1192 residents (2021 Census) located approximately 66km north of Ballarat at the confluence of McCallum Creek and Tullaroop Creek within the wider Loddon River catchment. The town is generally of low relief and surrounding land use mainly agriculture. It has a history of flooding.

Tullaroop Creek is referred to locally as Deep Creek, from the Pyrenees Highway Bridge to somewhere downstream of Carisbrook, where it is again called Tullaroop Creek. In order to avoid confusion in this document, the creek through the town will be referred to as Tullaroop Creek.

The combined catchment area of the two creeks to Carisbrook is approximately 1,235km^2. The area of the Tullaroop Creek catchment is ~760km^2 while the McCallum Creek catchment is smaller at ~475km^2.

The Pyrenees Highway acts as a small levee as it is elevated slightly. The Castlemaine – Maryborough rail line also acts as a levee.

A number of open channels drain local runoff, from a number of small catchments to the west and south west, around and through Carisbrook and ultimately into Tullaroop Creek. The local catchments have a combined area of approximately 21km^2. The main drains are as follows:

- Main bluestone drain from Belfast Road and flowing from south to north through town to outflow into Tullaroop Creek near Hood Street
- Drain commencing near Wills Street and flowing to the east to outflow into the main bluestone drain adjacent to the railway line
- Drain commencing at Belfast Road at the southern end of the main bluestone drain and flowing east along Belfast Road to outflow into McCallum Creek near Virginia Street
- Bluestone drain near the cemetery flowing to the east from the corner of Landrigan Road and Williams Road to outflow into McCallum Creek
- Bluestone drain near the Primary School flowing to the east from the corner of Landrigan Road and the Pyrenees Highway to outflow into McCallum Creek near Camp Street.

There are also several grassed swales within Carisbrook that act as the local drainage network and that receive water from the underground-piped network. These swales discharge into Tullaroop Creek.

The grass table drain on the north side of Victoria Street flowing into the Bluestone drain has two backflow prevention devices (installed in 2012 by council) – one off Smith Street and one at the drain to prevent backflow along Victoria Street when the Bluestone drain is full.

Grass swales and driveway pipes across Carisbrook have recently been re-graded and renewed to provide a more appropriately functioning low flow drainage system in Carisbrook.

Upstream of Carisbrook, the catchment comprises mainly cleared agricultural land. There are however some pockets of forested areas in the upper catchment in the vicinity of Creswick. The towns of Waubra, Talbot and Majorca are within the McCallum Creek catchment while Clunes, Creswick and Springmount are within the Tullaroop catchment to the south of Carisbrook. There are no towns to the north of Carisbrook along Tullaroop Creek but numerous rural residential properties are situated along the creek.

Tullaroop Creek discharges into Laanecoorie Reservoir some 20km downstream from Carisbrook near Eddington.

Tullaroop Reservoir is situated on Tullaroop Creek, approximately 8km upstream (south) of Carisbrook and downstream from Clunes. It has a catchment area of approximately 743km², which comprises the upper Tullaroop Creek and its tributaries including the catchments of Newlyn Reservoir and Hepburns Lagoon. The reservoir was built in 1959, has a capacity of 72,950 ML and covers an area of 742ha.

The nearest stream gauges to Carisbrook are located at McCallum Creek at Carisbrook (approximately 5km upstream) and the Tullaroop Reservoir head gauge.

In very general terms, a wet catchment with the natural floodplain storage essentially filled and a period of heavy rain are required to produce flooding at Carisbrook.

General rain of around 40 to 60mm over a 12 hours period or so across a wet catchment will cause significant rises with some minor flooding at Carisbrook within 9 to 18 hours or so of rain starting. More substantial rainfall (of order 60 to 70mm in 12 hours or so or around 80 in 24 hours or so), again on a wet catchment, will cause moderate flooding within 9 to 12 hours or so of rain starting. Heavier rainfall (of order 80mm in 12 hours or 90mm or more in 24 hours or less) will cause more severe flooding within 6 to 9 hours or so of rain starting with over floor inundation of a number of buildings within the town.

Within about 2 to 6 hours of the start of heavy rain, runoff from catchments approximately 1000 hectares to the west and southwest will begin to accumulate to the south of town and against the levee along Curragh Moor Road. If runoff is sufficient, water will flow north under Pyrenees Highway / Victoria Street, adjacent to Pleasant Street which forms a levee, and north west to the Trotting Track where it enters an existing watercourse. Water then flows across Bucknall Street and Carisbrook-Eddington Road, before flowing back into Tullaroop Creek downstream of the township. Rural and residential areas to the west and north around the Trotting Track may also be inundated. The creeks will then begin to rise, some 6 to 15 hours or so after the start of heavy rain across the catchment. McCallum Creek will rise first. During large floods, a significant breakout will flow to the northwest over the Pyrenees Highway and over the railway line. Properties along Bucknall Street will also be impacted. Tullaroop Creek will peak some 6 to 24 hours after McCallum Creek with timing determined by the level of Tullaroop Reservoir before and after the event.

Note: In 2015, NCCMA undertook on behalf of Central Goldfields Shire vegetation management works along Tullaroop and McCallums Creeks to lessen the flood risk to urban Carisbrook. The vegetation works included thinning of the river redgums between Pyrenees Highway and the railway line, however the most crucial works were the removal of the dense exotic vegetation that choked both McCallums Creek and Tullaroop Creek upstream of the Pyrenees Highway.

2. Flood behaviour

Flooding in Carisbrook can be caused by overland flows from the small local catchments to the west and south west, between Carisbrook and Maryborough, as well as by high flows within Tullaroop Creek and/or McCallum Creek or some combination. The local catchments tend to respond before the creeks with the result that initial flooding is caused by local runoff. The western levee that was completed in 2023 provides protection to the township area from this local runoff up to the 1% AEP event. More severe flooding occurs several hours later as the creeks rise to a peak with McCallum Creek water arriving before water from Tullaroop Creek. The exception to this may be in longer duration rain events that have embedded thunderstorms: in such circumstances, it is possible that the peak flows from the local catchments will coincide with peak flows in the creeks.

Tullaroop Reservoir does attenuate and delay flows in Tullaroop Creek:

- Even under 1% AEP flow conditions, the reservoir is unlikely to spill if it is less than about 70% capacity at the beginning of the event.
- If the reservoir is above 70% (but not full) and does fill during the event, the peak flow in Tullaroop Creek upstream of Carisbrook can occur up to 24 hours after the peak flow in McCallum Creek (e.g. September 2010).
- Even if the reservoir is near or at full supply level at the start of a flood event, the peak flow in Tullaroop Creek will occur 6 hours or so after the peak flow in McCallum Creek (e.g. January 2011).

What the above demonstrates is that regardless of the initial water level in Tullaroop Reservoir, peak flows through Carisbrook can be dominated by flows in McCallum Creek.

The local overland flows currently drain along a number of wide shallow depressions until they reach the outskirts of town where they are then drained back to McCallum Creek and Tullaroop Creek via three small bluestone drains (one to the south of the town at the cemetery, located on Landrigan Road, another north-south through the town and the other along Virginia Street).

During the 20%, 10% and 5%- AEP events, the creek is well confined with local runoff through town largely confined to the bluestone drains. There is significant shallow flooding of agricultural land to the west and south west of town and the Trotting Track as well as a number of properties in the vicinity begin to be impacted as a result of runoff from the local catchments to the west. In addition, during the 5% AEP event water will bank up on the south (upstream) side of the Pyrenees Highway and the railway line and begin to overtop the Pyrenees Highway at the Potts Lane intersection. One building is within 100mm of flooding above floor.

During the 2% AEP event:

- A number of small breakouts impact properties along Bucknall, Cambridge, and Hood Streets downstream of the railway bridge
- A small breakout from McCallum Creek near Chapel Street also impacts properties
- The bluestone drain adjacent to the Primary School surcharges and inundates property at the corner of Victoria Street and Landrigan Road
- 5 buildings are impacted, with 3 flooded over floor.

NB: Flooding increases significantly between the 2% and 1% AEP events.

During the 1% AEP event:

- A significant breakout from McCallum Creek overtops the Pyrenees Highway, flows northwest inundating properties through the centre of town, overtops the railway line and re-enters the creek further downstream;
- A significant portion of the town is inundated;
- Overland flow from the western catchment is directed north by the western levee, and flows into the racecourse drainage system, before flowing into Tullaroop Creek north of the town.
- 131 buildings are impacted with 39 flooded over floor.

During the 0.5% AEP event:

- A significant breakout from McCallum Creek overtops the Pyrenees Highway, flows northwest inundating most properties in the town.
- The breakout is considerably deeper than in the 1% AEP event causing more inundation in the west and north of the central township.
- 303 buildings are impacted with 274 flooded over floor.

27 December 1999

The flash flood of 27 December 1999 impacted the southwest side of the town with most of the floodwater resulting from overland flows coming off the hills to the southwest in the Mosquito Flat and Craigie catchment area. A number of properties along the south side of Victoria Street were flooded over floor and the Pyrenees Highway was closed. Neither McCallum Creek nor Tullaroop Creek flooded.

4 September 2010 (see inundation map at Appendix H)

The September 2010 flood event (~1.3% AEP event) produced significant overland flow from the local catchments to the west and southwest and swelled McCallum and Tullaroop creeks. The local catchments responded quicker than the creeks and runoff accumulated to the south of town well before creek levels rose. The small levee along Belfast Road near the upstream end of the main bluestone drain was breached which led to the inundation of a number of properties upstream (to the south) of the Pyrenees Highway / Victoria Street, and along the alignment of the bluestone drains through town when they overtopped.

Flooding started in the early hours of 4th September. Residents reported that by around 8:40am on the 4th the culvert under Landrigan Road that drains the Belfast Road drain had reached capacity and water was starting to break out of the drain and flow north adjacent to Landrigan Road. Significant breakouts occurred from around mid-morning at the confluence of the two major drains on Belfast Road. This breakout flowed down a natural drainage line to the northeast and inundated properties on the south side of Victoria Street. Breakouts also occurred from the main bluestone drain on the upstream, side of the Pyrenees Highway culvert and further downstream near High Street. Residents reported that by 12:50pm the Belfast Road drain had overtopped over Virginia Street and that within about 85 minutes (around 2:15pm) water was approximately 200-300mm deep along Virginia Street. Rural and residential areas to the west around the Trotting Track were also inundated.

McCallum and Tullaroop creeks continued to rise through this time and peaked downstream of the confluence between noon and 1pm. Tullaroop Creek inundated the rear of properties along Bucknall Street: Bucknall Street was not overtopped. By this time around 25 properties had been inundated, primarily along the south side of Victoria Street as a result of flows from the local catchments. Victoria, Green and Powlett Streets were flooded.

Levels in McCallum Creek receded over the next few hours. Tullaroop Creek continued to rise slowly through the afternoon and peaked during the evening. Flows were less than in McCallum Creek largely due to attenuation through Tullaroop Reservoir.

Tullaroop Reservoir filled and spilled during the event after starting at around 60% capacity.

14 January 2011 (see inundation map at Appendix H)

The flood of January 2011 (~0.75% AEP) was larger than the September 2010 event. It occurred on a wet catchment and was caused by a combination of overland flows from the local catchments to the west and south west of town and flows within the creeks. Runoff accumulated to the south of town, again before creek levels rose. Local runoff flowed into the south and west of the town more than 12 hours before the creeks broke out through the town. Significant local flows were reported around the Gun Club and Trotting Track from around 7 to 8pm on the 13th with drains overflowing and minor roads in the area being closed. The road between Carisbrook and Red Lion was reported as being impassable from about 8:30pm on the 13th. By 10pm, residents in Bucknall Street were advised to evacuate due to concerns about rising levels in Tullaroop Creek.

The small temporary sandbag levee along Belfast Road near the upstream end of the main bluestone drain was breached and the drainage channels to the south and west of Carisbrook, designed to convey moderate local runoff through the town to the creek, were overtopped.

The first buildings were impacted by local runoff at the confluence of the two major drains on Belfast Road. The breakout flowed down the natural drainage line to the northeast and inundated properties on the south side of Victoria Street during the night. By 4:30am a number of properties along Victoria Street had been inundated and Victoria Street was about to be overtopped. Additional breakouts were also occurring along the main bluestone drain between Victoria Street and High Street.

Flooding occurred in the drainage line that flows under the Carisbrook – Eddington Road to the north of town. Initially this was due to local catchment flows and then later as a result of high levels in Tullaroop Creek backing up the drainage line. At 8am, water was too deep to drive through – up to car windows.

Levels in both McCallum and Tullaroop Creek continued to rise through the night. The Pyrenees Highway was first overtopped between Chapel Street and the Highway Bridge at around 9:30am on the 14th following a large breakout from McCallum Creek. By 10:10am water was flowing into the Fire Station (the CFA building in Urquhart Street in central Carisbrook) and much of the town was inundated.

The breakout over the Pyrenees Highway flowed northwest across the town and overtopped the railway line in a number of places although the line did act as a levee and increase depths on the upstream side. It is apparent that flood levels in properties along the Pyrenees Highway rose significantly, as the breakout from McCallum Creek flooded the town. A smaller breakout occurred to the south of Camp Street and flowed

westwards to merge with the larger breakout and flood the Primary School at the corner of Landrigan Road and Camp Street.

The flood peaked between 1pm and 2pm on the 14th. Floodwater had receded from much of the town by late afternoon.

Tullaroop Reservoir spilled during the event after starting from close to capacity.

The January 2011 event was larger than the 1% AEP design event with:

- Deeper inundation through the central part of town
- Flooding around Smith, Powlett, Albert and McLachlan Streets
- Additional inundation to the north and northwest of the town resulting from the large breakout from McCallum Creek flowing northwest over the railway line
- Additional properties impacted along Pleasant and Rose Streets
- Inundation around the Primary School.

Comparison of September 2010 and January 2011 floods

The January 2011 peak flood level was approximately 1.6m higher than the September 2010 event upstream of the Pyrenees Highway Bridge. The higher flood level in January led to the large breakout from McCallum Creek. Upstream of the railway bridge over Tullaroop Creek, the January level was approximately 1.3m higher than in September 2010. The difference in flood levels is reflected in the significantly greater flood extent, depths and damage that occurred in the January event.

Runoff from the local catchments had a significant role in both events with runoff accumulating to the south of the town well before creek levels rose. In both events, the small temporary sandbag levee along Belfast Road near the upstream end of the main bluestone drain was breached resulting in inundation of properties to the south of Victoria Street. The bluestone drain also overtopped at other locations leading to inundation of adjacent properties in the west of town.

13 October 2022

From the afternoon of 12 October steady rainfall of approximately 70 to 90mm occurred over a 30 hour period. This event occurred on a wet catchment following several rainfall events over the preceding month. The town was largely protected from overland flooding from the local catchment by the partially constructed western levee, however four properties in Carisbrook were inundated. The McCallums Creek gauge, located just upstream of the township, peaked at 5.21m on the evening of 13 October. Tullaroop Reservoir was above full supply at the beginning of the event and peaked early on 14 October, approximately 7 hours after McCallums Creek peaked. The Pyrenees Highway at Tullaroop Creek was close to overtopping. Based on two surveyed flood marks this event was estimated to be in the order of a 2% AEP event.

3. Overview of flooding consequences

3.1 Warning times

The flood warning time for Carisbrook is of order 9 to 18 hours (see Appendix B). The approximate time between start of rain and flooding in Carisbrook is:

- 2 to 6 hours from the small local catchments to the west and southwest; and
- 6 to 15 hours from McCallum Creek and Tullaroop Creek although Tullaroop Creek will rise slower than McCallum Creek and peak somewhere between 6 and 24 hours later, depending on the level of Tullaroop Reservoir before and after the event.

3.2 Areas affected

Maps at Appendix H provide guidance on where flooding is likely to occur within Carisbrook for flood events ranging from the 20% AEP event up to the 0.5% AEP event. Flooding to the extent and depths shown for

each event may not occur simultaneously as the maps display the outer envelope of expected flooding from both the local catchments to the west as well as from McCallum Creek and Tullaroop Creek. As discussed above, the timing of peak flows from these sources differs; flows from the local catchments are likely to affect Carisbrook several hours before flows from the creeks.

3.3 Roads affected

The main access roads for Carisbrook, the Pyrenees Highway (east and west), the Carisbrook – Eddington Road (north), Landrigan Road (Carisbrook-Talbot Road) (south) and Tullaroop Road (west to Maryborough) are all affected by flooding.

Water first flows over the Pyrenees Highway near the corner of Potts Lane in a 5% AEP event. It is shallow and during a 100-year event is still only 50 to 100mm deep. Water flows over the Pyrenees Highway on the western side of the bridge (between Chapel Street and the bridge) from a little above the 2% AEP event. The Highway becomes impassable from a little below the 1% AEP event and some 6 or more hours after the start of rise during a large flood. During a large flood, the Highway is likely to remain impassable for a day or more.

The Carisbrook – Eddington Road is affected from around the 5% AEP event. During a 1% AEP event, water is up to 800mm deep.

Landrigan Road (Carisbrook-Talbot Road) is overtopped by overland flows from the local catchments in two locations: next to the Primary School at the corner of the Pyrenees Highway and approximately 400m south of Belfast Road. At both locations, water depths are shallow at around 50mm during a 1% AEP event. Further south, Landrigan Road was inundated over a significant length between Craige and Commercial Road during the January 2011 event.

Other roads further up and down the catchment are likely to be impassable for a couple of days or more.

Most of the roads within Carisbrook will be affected in big floods, so it is important that residents are urged to evacuate early in a large flood event – see the flood inundation maps at Appendix H.

3.4 Properties affected

A summary of the number of properties likely to be flooded and the number likely to be inundated over floor is provided in Section 7.3.

Around 250 residential and commercial buildings were flooded over floor (Council listed 273 properties affected by flooding) during the January 2011 event as a result of runoff from the local catchments initially and then later due to large breakouts from McCallum and Tullaroop Creeks (see Figure C1-1). A number of damaged houses had to be demolished and rebuilt.

The September 2010 event was not as severe and resulted in the inundation of approximately 25 buildings. These were located mainly along the southern side of Victoria Street and primarily a result of the runoff from the local catchments.

3.4.1 Detailed list

A list of properties likely to be flooded for a range of floods along with the expected depth of over-ground flooding and the likely depth of over floor inundation is provided in Section 7.5**.** Properties within 100mm of over floor flooding are also identified.

It is strongly recommended that the list is used in conjunction with the flood inundation maps (Appendix H) and the indicative flood guidance tool provided in Section 7.6.

Figure C1-1: Carisbrook township on 14 January 2011 looking west into town along the Pyrenees Highway (source: North Central CMA)

3.5 Isolation

The main access roads for Carisbrook are the:

- Pyrenees Highway (east and west) – impassable from a little below 1% AEP event
- Carisbrook-Talbot Road or Landrigan Road (south) – shallow flooding even at 1% AEP event, deeper flooding near Craige in a large event
- Carisbrook-Eddington Road (north) – impassable from a little below the 2% AEP event
- Maryborough-Bendigo Road – inundated (near Shelbourne) during the January 2011 event and may prevent access to Bendigo in a large event
- Old Tullaroop Road (west to Maryborough).

The Castlemaine – Maryborough railway line is also overtopped at Carisbrook from between the 2% and 1% AEP flood event.

3.6 Essential infrastructure

There is no known essential infrastructure affected by flooding at Carisbrook, other than the:

- Pyrenees Highway and Castlemaine – Maryborough railway line from a little above the 2% AEP event
- Sewerage Pumping Stations located on the river side of Bucknall Street and at corner of Landrigan Road and Pyrenees Highway
- Telephone Exchange from a little below the 0.5% AEP event.

The CFA building, town hall and senior citizens centre in Urquhart Street are flooded over floor from somewhere between the 2% and 1% AEP events. The Britannia Hotel, bakery, newsagency, supermarket, roadhouse shop and churches are also similarly impacted.

4. Flood mitigation

Flood intelligence must have regard for changes within the catchment that modify likely flood behaviour (e.g. mitigation works that reduce the severity of flood risk).

4.1 Flood protection levees

Flood mitigation works implemented from the recommendations of the Carisbrook Flood Mitigation Plan, 2013 have been constructed. The levees that have been constructed include:

- Western Levee/drain - A 3km long levee extending from the southern end of Curraghmoor Road Reserve northwards past the Pyrenees Highway, running along Pleasant Street towards Bucknall Street.
- Williams Road Levee/drain - A 1km long levee along Williams Road running east towards McCallums Creek.

4.2 Drainage works

The bluestone drains within and around Carisbrook provide some protection from and alleviation of flooding arising from local runoff from the small local catchment to the west and south west of town. They are all of modest proportions and not capable of discharging the large flows during flood events. The north south bluestone drain has a limited capacity of 229 ML/day, and probably makes flooding worse for properties that back onto it once it overtops in larger events.

5. Flood impacts and required actions

Refer to the following Flood Intelligence Card.

Note that users of the flood intelligence card should consider rainfall depth and rates at locations in the vicinity of Carisbrook and across the upper catchment and use the indicative tool at Section 7.6 in order to better appreciate the likely severity of flooding and its impacts in the town. Local data and/or data from the BOM website (http://www.bom.gov.au/) should be used. It is suggested that the following sites, available from the BOM website, will provide useful indicative rainfall data:

- Creswick (407249A Gauge Location Number)
- Upper McCallums (Evansford) (GLN still to be issued)
- Clunes (407214A GLN & 407222A GLN)
- Lower McCallums (Carisbrook) (407213C GLN)
- Lillicur (407288A GLN)
- Norwood (407220A GLN)
- Bet Bet (407211B GLN)
- Avoca (408220A GLN).

6. Gauge information

The tables below provide flows and levels for design flood events along with the September 2010 and January 2011 events for the McCallum Creek at Carisbrook gauge and the Tullaroop Reservoir head gauge. There is significant uncertainty in the data presented for the McCallum Creek gauge due to the rating curve used only extending up to 45,000 ML/d.

AEP	Flow (ML/d)	Gauge level (m)	Extrapolated level (m)	Estimated range (m)
20	10,700	3.67		
10	18,100	4.24		
5	26,800	4.74		
2	48,800	N/A*	5.60	5.4-5.8
1	69,600	N/A*	6.20	6.0-6.4
0.5	94,800	N/A*	6.78	6.6-7.0
January 2011 event	67,200	N/A*	6.14	5.9-6.3
September 2010 event	60,400	N/A*	6.00	5.8-6.2

AEP	Flow (ML/d)	Level (mAHD)
20	1,490	223.17
10	3,260	223.43
5	6,330	223.76
2	14,500	224.45
1	21,500	225.00
0.5	32,000	225.50
January 2011 event	31,400	225.20
September 2010 event	5,260	223.65

7. Flood intelligence card, property inundation list and flood / no flood Guidance Tool

7.1 Introduction

BOM does not currently provide flood forecasts for Carisbrook. All actions must therefore be driven by rainfall and/or river level observations.

Water level / flood gauges within the catchment upstream of Carisbrook are listed in Appendix D. Those of direct relevance to Carisbrook are:

- Tullaroop Creek at Clunes (407222)
- McCallum Creek at Carisbrook (407213)
- The head gauge at Tullaroop Reservoir on Tullaroop Creek (407244)
- The Tullaroop Reservoir outlet (407248).

BOM collects and records rainfall at a number of locations within or close to the McCallum and Tullaroop creek catchments. Data from a number of these sites are available from the BOM website at intervals ranging from around 30 minutes to daily. Daily-read rainfall data is available from the BOM website for five sites near to Carisbrook: Bet Bet, Cairn Curran, Clunes, Dunolly and Maryborough. BOM also operates a number of AWS' in the general vicinity for which rainfall data is available every half hour: at Ballarat on the southern side of the Divide in the upper Leigh River catchment and further to the west at Ben Nevis at the top end of the Wimmera catchment near Mt Cole. Synoptic stations are operated by BOM at Castlemaine and Maryborough. An event reporting radio telemetry (ERTS) rainfall station is located at Mt Hope in the upper parts of the Werribee catchment. Central Highlands Water (CHW) also operates a number of rain gauges in the general vicinity. Rainfall data is also available from BOM website at around 3-hourly intervals during heavy rain events from the rain gauge at the Tullaroop Creek at Clunes site and the Bet Bet Creek at Bet Bet site. Similar data is available from Avoca and Archdale to the west and north and from Daylesford, Vaughan and Yandoit to the east. Rainfall data will also become available from the Bet Bet Creek at Norwood site and from a site in the Upper McCallums Creek catchment (possibly from near Evansford).

Users of the flood intelligence card should consider rainfall depth and rates at locations in the vicinity of Carisbrook and across the upper catchment (Clunes in particular) and use the indicative flood / no flood guidance tool at Section 7.6 in order to better appreciate the likely severity of flooding and its impacts in the town.

Note:

1. While flood intelligence cards provide guidance on the relationship between flood magnitude and flood consequences, flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Further, the hydrologic and hydraulic modelling that underpins much of the intel detailed below is informed by a number of assumptions and approximations that are unlikely to be replicated exactly during a flood event. Actual impacts under similar rainfall conditions are therefore expected to be similar but may not be exactly the same; there are likely to be some differences.
2. All levels, impacts and actions listed in the following flood intelligence card and graph may need to be adjusted to better reflect experience.

7.2 Flood Intelligence Card

Observed rainfall (see graph)	AEP	Water level at Carisbrook (mAHD)	Consequence / Impact	Actions *May include (but not limited to) evacuation, road closures, sandbagging and community warnings*
The location for the water level at Carisbrook is immediately upstream of the Pyrenees Highway Bridge on the east bank – see **red dot** on map at Section 7.4.				
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be to call VICSES, followed by the Central Goldfields MERC and MEMO. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Note that flooding from the small local catchments to the west and southwest is likely to affect Carisbrook before flooding from McCallum and Tullaroop Creeks and that McCallum Creek dominates.				
Proposed minor flood level		190.700		◦ Monitor rainfall and water levels
~47mm in 12 hours to ~75mm in 48 hours	20% AEP (5-yr ARI)	191.03	Some shallow flooding to the west and southwest of town including parts of the Trotting Track and Carisbrook Racecourse. Water banking up upstream of Wills Street along the Western Levee. No buildings flooded over-floor. Flows well confined along McCallum Creek and Tullaroop Creek and along the bluestone drains through town.	◦ Monitor rainfall and water levels. ◦ Use the indicative flood / no flood tool in order to develop an appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions. This may include organising necessary resources, sandbagging at key locations (see maps), the removal of furniture etc from buildings likely to be flooded over floor and/or sandbagging buildings.
~56mm in 12 hours to ~88mm in 48 hours	10% AEP (10-yr ARI)	191.87	Some shallow flooding to the west and southwest of town including parts of the Trotting Track and Carisbrook Racecourse. Water banking up upstream of Wills Street along the Western Levee. No buildings flooded over-floor. Flows well confined along McCallum Creek and Tullaroop Creek and along the bluestone drains through town. The build up and overflow of local runoff at the confluence of the two major drains on Belfast Road is an indicator of serious flooding	◦ Continue to monitor rainfall and water levels. ◦ Maintain the plot on the indicative flood / no flood tool in order to further develop appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions and secure necessary resourcing.
Proposed moderate flood level		192.200		◦ SES to issue initial Warnings/Advice to community ◦ Ensure Communications established between Local Agencies

Observed rainfall (see graph)	AEP	Water level at Carisbrook (mAHD)	Consequence / Impact	Actions *May include (but not limited to) evacuation, road closures, sandbagging and community warnings*
The location for the water level at Carisbrook is immediately upstream of the Pyrenees Highway Bridge on the east bank – see **red dot** on map at Section 7.4.				
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be to call VICSES, followed by the Central Goldfields MERC and MEMO. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
~65mm in 12 hours to ~105mm in 48 hours	5% AEP (20-yr ARI)	192.57	Shallow flooding to the west and south west of town including parts of the Trotting Track. Shallow flooding to the west and south west of town including parts of the Trotting Track and Carisbrook Racecourse. Water backing up upstream of Wills Street along the Western Levee. Water beginning to bank up on the southern (upstream) side of the Pyrenees Highway and to the south of the railway line. 1 building likely to flood over floor soon at 6 Bucknall Street. Water around 1 other building. Flows still reasonably well confined along McCallum Creek and Tullaroop Creek and along the bluestone drains through town. The Carisbrook – Eddington Road begins to flood d/s of town. Pyrenees Highway west of town near Potts Lane overtops – water shallow.	◦ Continue to monitor rainfall and water levels. ◦ Maintain the plot on the indicative flood / no flood tool in order to further develop appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts ◦ Monitor High St, Victoria St, Belfast Road, 44 Pleasant Street ◦ Implement appropriate response actions and secure necessary resourcing. Deploy “water over road” and other signs. ◦ If flood likely to be bigger than a 2% AEP event, identify and plan to operationalise evacuation centres and plan to evacuate identified properties.
Proposed major flood level		193.000		◦
~76mm in 12 hours to ~123mm in 48 hours	2% AEP (50-yr ARI)	193.28	Small breakouts occurring along Tullaroop Creek and impacting properties on Bucknall, Hood and Brown Streets downstream from the railway bridge. Small breakout from McCallum Creek near Chapel Street affecting properties. Water surcharging the bluestone drain adjacent to the Primary School causing some flooding of the property at the corner of Victoria Street and Landrigan Road. Unless protected, 3 buildings will flood over floor – in Bucknall Street (at Nos 6, 14 & 30).	◦ Continue to monitor rainfall and water levels. ◦ Maintain the plot on the indicative flood / no flood tool in order to further develop appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions and check resourcing. Actions may include protection of further properties from over floor flooding and/or removal of household effects. ◦ Consider school situation and related transport. ◦ Deploy “water over road” and other signs.

Observed rainfall (see graph)	AEP	Water level at Carisbrook (mAHD)	Consequence / Impact	Actions *May include (but not limited to) evacuation, road closures, sandbagging and community warnings*
The location for the water level at Carisbrook is immediately upstream of the Pyrenees Highway Bridge on the east bank – see **red dot** on map at Section 7.4.				
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be to call VICSES, followed by the Central Goldfields MERC and MEMO. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
			Water now around another 2 buildings – see table below. Another 36 buildings to flood over floor soon including the CFA, Britannia Hotel, Bakehouse, Newsagency/Supermarket, Roadhouse shop and 4 churches – see table below. Most of these buildings are in Annesly, Bucknall, Green, McLachlan, McNeil, Powlett, Simson (Pyrenees Highway), Urquhart, and Victoria (Pyrenees Highway). The Pyrenees Highway is likely to be over-topped on the western side of the bridge soon (at 193.79mAHD) – initially between Chapel Street and the Bridge. The Highway will need to be closed if water continues to rise. The Castlemaine – Maryborough rail line will be overtopped soon.	◦ Close Carisbrook – Eddington Road. ◦ Discuss closure of the Pyrenees Highway with Department of Transport and Planning. ◦ If flood is going to be bigger than a 2% AEP event, continue to evacuate identified properties. ◦ Keep all but essential vehicles out of flooded areas. ◦ Record flood impacts and ensure this MFEP is updated.
Flood peak 4 September 2010 70mm in 8 hours			Significant overland flow from the small local catchments to the west and southwest. Runoff accumulated to the south of town well before creek levels rose. The small levee along Belfast Road near the upstream end of the main bluestone drain was breached which led to the inundation of a number of properties upstream (to the south) of the Pyrenees Highway / Victoria Street, and along the alignment of the bluestone drains through town when they overtopped. Rural and residential areas to the west around the Trotting Track were also inundated. While raised levels in McCallum and Tullaroop creeks inundated low-lying areas along the creek, Bucknall Street was not overtopped. Approx 25 buildings flooded over floor.	
~86mm in 12 hours ~142mm in 48 hours	1% AEP (100-yr ARI)	193.89	Levels may drop a little and then rise again due to creek flows. There is significant inundation of properties through the central part of town (39 properties flooded over floor and a further 92 with water around them) due to a large breakout from McCallum Creek that overtops the Pyrenees Highway and flows through town.	◦ Continue to monitor rainfall and water levels. ◦ Maintain the plot on the indicative flood / no flood tool in order to further develop appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts.

Observed rainfall (see graph)	AEP	Water level at Carisbrook (mAHD)	Consequence / Impact	Actions *May include (but not limited to) evacuation, road closures, sandbagging and community warnings*
The location for the water level at Carisbrook is immediately upstream of the Pyrenees Highway Bridge on the east bank – see **red dot** on map at Section 7.4.				
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be to call VICSES, followed by the Central Goldfields MERC and MEMO. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
			Pyrenees Highway closed through town due to fast flowing water, 23 hours or so after start of heavy rain. Likely to remain closed for day or so. Unless protected the following buildings are flooded over floor: - CFA and St Pauls Anglican Church in Urquhart Street; - Britannia Hotel and Newsagency/Supermarket in Green Street; - Scots Presbyterian Church in and Hall in McLachlan Street; - Uniting Church in Simson Street; - Old St Francis Church in McNeil Street. The number of buildings flooded over floor will begin to increase rapidly as water levels continue to rise: a further 235 as water rises another ~700mm.	◦ Continue to deliver appropriate response actions and monitor implementation of plans – evacuation, removal of furniture etc from buildings, sandbagging, etc. ◦ Ensure the Pyrenees Highway is closed. ◦ Keep all but essential vehicles out of flooded areas. ◦ Record flood impacts and ensure this MFEP is updated.
Flood peak 14 January 2011 166mm in 72 hours on a wet catchment			A combination of overland flows from the small local catchments to the west and south west of town and flows within the creeks flooded the majority of the town. Approx 250 buildings were flooded over floor. Runoff accumulated to the south of town before creek levels rose, and the small levee along Belfast Road near the upstream end of the main bluestone drain was breached. The drainage channels to the south and west of Carisbrook, designed to convey local runoff through the town to the creek, were overtopped. There was inundation to the north and northwest of the town resulting from the large breakout from McCallum Creek flowing northwest over the railway line. The Pyrenees Highway was overtopped by the creeks. Smith, Powlett, Albert and McLachlan Streets were also flooded, properties were impacted along Pleasant and Rose Streets, and there was water around the Primary School.	
~98mm in 12 hours ~160mm in 48 hours	0.5% AEP	194.68	Flooding is more extensive and significantly deeper than the 1% AEP event through the majority of town due to the breakout from McCallum Creek upstream of the Pyrenees Highway. Flooding also extends further to the west and north of the central part of town. The Pyrenees Highway remains closed – water deep and fast.	◦ Continue to monitor rainfall and water levels and maintain the plot on the indicative flood / no flood tool in order to further develop appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts.

Observed rainfall (see graph)	AEP	Water level at Carisbrook (mAHD)	Consequence / Impact	Actions *May include (but not limited to) evacuation, road closures, sandbagging and community warnings*
The location for the water level at Carisbrook is immediately upstream of the Pyrenees Highway Bridge on the east bank – see **red dot** on map at Section 7.4.				
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be to call VICSES, followed by the Central Goldfields MERC and MEMO. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
			Expect 274 buildings to be flooded over floor and a further 29 to have water around them.	◦ Continue to deliver appropriate response actions. ◦ Continue to deliver appropriate response actions and monitor implementation of plans – evacuation, removal of furniture etc from buildings, sandbagging, etc. ◦ Ensure the Pyrenees Highway remains closed. ◦ Keep all but essential vehicles out of town. ◦ Record flood impacts and ensure this MFEP is updated.

7.3 Summary of properties flooded

Summary of number of flood affected properties in Carisbrook (WaterTech, 2019 – based on ultimate mitigation scenario)						
	Design Flood AEP (%)					
	20%	10%	5%	2%	1%	0.5%
Level upstream of Pyrenees Highway at Carisbrook (mAHD)	**191.03**	**191.87**	**192.57**	**193.28**	**193.89**	**194.68**
Number of buildings flooded above floor	0	0	0	3	39	274
Number of buildings flooded below floor only	0	0	2	2	92	29
Total number of flooded buildings	**0**	**0**	**2**	**5**	**131**	**303**
Number of buildings within 100mm of flooding above floor	0	0	1	0	24	17

7.4 Location for the above levels – at Carisbrook upstream of the Pyrenees Highway Bridge on the east (right hand) bank

Details of this location are provided so that if a flood event occurs before a gauge is installed at the Highway Bridge, a PALS (or similar) can be installed and maximum value can be extracted from the intelligence contained in this MFEP.

The **red dot** on the map to the right indicates the location to which the above levels refer.

7.5 Detailed list of properties flooded

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor						Depth of over floor flooding						Comments
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
7 Albert Street						0.27						-0.08	Dwelling
9 Albert Street						0.37						-0.05	Dwelling
12 Albert Street						0.27						0.13	Dwelling
13 Albert Street						0.55						0.37	Dwelling
14 Albert Street						0.35						0.19	Dwelling
16 Albert Street						0.31						0.19	Dwelling
17 Albert Street						0.67						0.14	Dwelling
19 Albert Street						0.72						0.29	Dwelling
20 Albert Street						0.62						0.24	Unit
20 Albert Street						0.61						0.26	Unit
21 Albert Street						0.80						0.30	Dwelling
2 Annesly Street S					0.17	0.75						0.01	Dwelling
4 Annesly Street S					0.26	0.85					0.02	0.61	Dwelling
6 Annesly Street S					0.34	0.93						0.41	Dwelling
8 Annesly Street S					0.37	0.96					-0.02	0.57	Dwelling
10 Annesly Street S					0.35	0.96					0.14	0.75	Dwelling
14 Annesly Street S						0.78						0.20	Dwelling
16 Annesly Street S					0.19	0.79					-0.04	0.56	Dwelling
18 Annesly Street S						0.80						0.27	Dwelling
12 Annesly Street N						0.63						0.39	Dwelling
14 Annesly Street N						0.53						-0.07	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
18 Annesly Street N						0.44						0.43	Dwelling
20 Annesly Street N						0.60						0.83	Dwelling
41 Annesly Street N						0.56						0.36	Shed
41 Annesly Street N						0.33						0.06	Dwelling
3 Aston Street						0.73						0.37	Dwelling
3 Birch Street					0.23	0.73					0.03	0.53	Dwelling?
5 Birch Street						0.54						0.46	Dwelling
13 Birch Street					0.31	0.97						0.27	Dwelling
14 Birch Street					0.16	0.81					0.02	0.67	Dwelling
15 Birch Street					0.21	0.86						0.54	Dwelling
16 Birch Street						0.62						0.41	Dwelling
17 Birch Street					0.16	0.82					-0.09	0.57	Dwelling
19 Birch Street						0.74						0.34	Dwelling
22 Birch Street						0.62						0.43	Dwelling
24 Birch Street						0.87						0.20	Dwelling
14 Brown Street						0.51						0.14	Dwelling
5 Bucknall Street						0.55						0.31	Bowls Club
6 Bucknall Street			0.32	0.97	1.49	2.17			-0.06	0.59	1.11	1.79	Dwelling - southern building
6 Bucknall Street				0.30	0.82	1.48					0.28	0.94	Old Pink House - Old Butcher (northern
9 Bucknall Street						0.76						0.49	Dwelling
11 Bucknall Street						0.73						0.58	Carolines Colonial Restaurant - eastern
11 Bucknall Street						0.71						0.58	Dwelling - western building

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
13 Bucknall Street					0.19	0.86						0.48	Post Office
13 Bucknall Street					0.09	0.72						0.11	Post Office
14 Bucknall Street			0.15	0.78	1.31	1.97				0.04	0.57	1.23	Dwelling
15 Bucknall Street						0.77						0.23	Telstra Exchange
17 Bucknall Street					0.26	0.97						0.37	Historical Society
18 Bucknall Street					0.44	1.08						0.40	Dwelling
19 Bucknall Street						0.66						0.47	Town Hall
20 Bucknall Street						0.68						0.25	Dwelling
21 Bucknall Street						0.74						0.34	Dwelling
23 Bucknall Street						0.50						0.45	Masonic Hall
24 Bucknall Street					0.38	1.03						0.44	Dwelling
26 Bucknall Street					0.76	1.38					0.11	0.72	Dwelling
27 Bucknall Street						0.63						0.40	Dwelling
28 Bucknall Street				0.28	0.76	1.44					0.23	0.91	Dwelling
29 Bucknall Street						0.74						0.29	Dwelling
30 Bucknall Street				0.47	0.96	1.63				0.26	0.75	1.42	Dwelling
33 Bucknall Street						0.67						0.51	Dwelling
34 Bucknall Street					0.29	0.96					-0.07	0.60	Dwelling
35 Bucknall Street					0.19	0.82						0.45	Dwelling
37 Bucknall Street					0.30	0.92					0.19	0.81	Dwelling
39 Bucknall Street					0.40	1.00						0.36	Dwelling
40 Bucknall Street					0.34	1.01						0.33	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
41 Bucknall Street					0.31	0.92						0.35	Dwelling
42 Bucknall Street					0.23	0.88						0.43	Dwelling
45 Bucknall Street					0.37	0.93					-0.03	0.53	Dwelling
48 Bucknall Street						0.60						0.24	Dwelling
51 Bucknall Street						0.62						0.01	Dwelling
52 Bucknall Street						0.68						0.56	Dwelling
53 Bucknall Street						0.60						0.48	Dwelling
57 Bucknall Street						0.38					-0.05	0.37	Shed
57 Bucknall Street					0.15	0.63					-0.07	0.41	Dwelling
2 Cain Street						0.47						0.33	Bryan Perry P/L - northern building
2 Cain Street					0.09	0.50					0.06	0.47	Bryan Perry P/L - southern building
10 Cambridge Street						0.34						0.15	Dwelling
2 Camp Street						0.51						-0.06	Carisbrook Primary school - southeastern
2 Camp Street						0.39						-0.09	Carisbrook Primary school - southern
2 Camp Street						0.33						-0.04	Carisbrook Primary school - northeastern
2 Camp Street						0.32							Carisbrook Primary school - southwestern
2 Camp Street						0.17							Carisbrook Primary school - northwestern
7 Camp Street						0.71						0.36	Dwelling
13 Camp Street						0.83						0.61	Dwelling
17 Camp Street						0.77						0.55	Dwelling
78 Camp Street						0.54						0.34	Dwelling
79 Camp Street						0.47						0.27	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
4 Chapel Street					0.41	1.14					0.10	0.83	Dwelling
6 Church Street						0.36							Dwelling
20 Church Street						0.19							Dwelling
26 Church Street						0.27						-0.03	Dwelling
1 Green Street						0.67						0.30	Dwelling
2 Green Street					0.18	0.58						0.02	Dwelling
3 Green Street						0.69						0.01	Dwelling
4 Green Street						0.49						0.33	Dwelling
8 Green Street						0.50						0.18	Dwelling
9 Green Street					0.20	0.81						0.30	Lions Hall
10 Green Street					0.22	0.71					-0.06	0.43	Dwelling
12 Green Street					0.19	0.69						0.06	Dwelling
14 Green Street						0.63						0.64	Shed
15 Green Street					0.20	0.75					-0.08	0.47	Dwelling
16 Green Street					0.17	0.73					0.08	0.64	Dwelling
18 Green Street					0.27	0.90					0.11	0.74	Dwelling
20 Green Street					0.40	0.98					0.11	0.69	Newsagency/Supermarket
25 Green Street					0.05	0.68					-0.09	0.54	Commercial?
28 Green Street						0.67						0.66	Bakehouse
29 Green Street					0.15	0.76					0.01	0.63	Britania Hotel
30 Green Street					0.14	0.77						0.26	Dwelling
32 Green Street						0.77						0.53	Jacinta's Hair Styles

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
33 Green Street					0.18	0.80						0.49	Dwelling
34 Green Street					0.33	0.99						0.41	Dwelling
35 Green Street					0.17	0.77						0.34	Dwelling
36 Green Street					0.35	1.00						0.35	Dwelling
37 Green Street					0.25	0.88						0.40	Dwelling
38 Green Street					0.34	0.98						0.45	Dwelling
39 Green Street					0.28	0.89					-0.03	0.58	Dwelling
40 Green Street					0.39	1.01					0.04	0.66	Dwelling
41 Green Street					0.12	0.74						0.15	Dwelling
42 Green Street					0.26	0.87					-0.07	0.54	Dwelling
43 Green Street						0.73						0.23	Dwelling
44 Green Street						0.61						0.44	Dwelling
1/17 Green Street						0.61						0.22	Unit
2/17 Green Street						0.63						0.32	Unit
3/17 Green Street						0.49						0.29	Unit
4/17 Green Street						0.52						0.28	Unit
5/17 Green Street						0.61						0.26	Unit
6/17 Green Street						0.62						0.28	Unit
7/17 Green Street						0.59						0.30	Unit
8/17 Green Street						0.51						0.21	Unit
9/17 Green Street						0.52						0.25	Unit
10/17 Green Street						0.49						0.22	Unit

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
11/17 Green Street						0.58						0.25	Unit
12/17 Green Street						0.50						0.18	Unit
13/17 Green Street						0.45						0.18	Unit
14/17 Green Street						0.47						0.16	Unit
15/17 Green Street						0.47						0.13	Unit
1 Hare Street						1.06						0.56	Dwelling
6 Hare Street						0.51						0.31	Bowling Pavilion
6 Hare Street					0.19	0.88						0.52	Football Pavilion
6 Hare Street					0.19	0.92					-0.01	0.72	Tennis Pavillion
9 Hare Street					0.39	1.24					-0.07	0.78	Dwelling
12 High Street						0.75						0.42	Dwelling
17 Hood Street						0.67						0.25	Dwelling
7 King Street						0.81						0.60	Dwelling
9 King Street						0.70						0.46	Dwelling
11 King Street						0.83						0.56	Dwelling
13 King Street						0.66						0.40	Dwelling
15 King Street					0.12	0.79						0.14	Dwelling
8 Landrigan Road					0.36	0.82						0.02	Dwelling
10 Landrigan Road						0.40						0.22	Dwelling
15 Landrigan Road						0.30						0.26	Tullaroop Leisure Centre
27 Landrigan Road						0.24						0.17	Southern Cross Feeds - northwestern
27 Landrigan Road						0.23						0.17	Southern Cross Feeds - southwestern

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
27 Landrigan Road						0.17						0.40	Southern Cross Feeds - northeastern
30 Landrigan Road						0.24						-0.02	Dwelling
1 Marion Street						0.50						-0.01	Dwelling
7 King Street						0.68						0.48	Dwelling
3 McLachlan Street						0.67						0.44	Dwelling
4 McLachlan Street						0.69						0.17	Dwelling
6 McLachlan Street						0.69						0.21	Dwelling
7 McLachlan Street						0.65						0.18	Dwelling
9 McLachlan Street						0.85						0.30	Dwelling
12 McLachlan Street						0.61						0.34	Dwelling
13 McLachlan Street						0.81						0.57	Dwelling
14 McLachlan Street						0.56						0.05	Dwelling
15 McLachlan Street						0.75						0.56	Dwelling
16 McLachlan Street					0.29	0.89					-0.09	0.51	Dwelling
17 McLachlan Street						0.76						0.63	Dwelling
20 McLachlan Street						0.74						0.34	Dwelling - floor levels approx
21 McLachlan Street						0.85						0.71	Dwelling
24 McLachlan Street					0.15	0.80						0.55	Dwelling
30 McLachlan Street					0.31	0.99					0.00	0.68	Dwelling
32 McLachlan Street					0.24	0.91						0.56	Dwelling
1/10 McLachlan Street						0.60						0.22	Dwelling
2/10 McLachlan Street						0.52						0.22	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
2 McNeil Street						0.82						0.64	Dwelling
4 McNeil Street					0.24	0.98					0.04	0.78	Dwelling
6 McNeil Street						0.85						0.61	Recreation Complex
8 McNeil Street					0.18	0.81						0.42	Dwelling
12 McNeil Street						0.68						0.50	Dwelling
16 McNeil Street					0.50	1.14					0.11	0.75	Old St Francis Church
17 McNeil Street					0.47	1.09					0.33	0.95	Exchange Building?
20 McNeil Street					0.34	1.04					0.00	0.69	Scots Presbyterian Church - western
20 McNeil Street					0.32	0.94					0.03	0.65	Dwelling
20 McNeil Street					0.19	0.88						0.58	Scots Presbyterian Hall - eastern building
21 McNeil Street					0.21	0.82						0.09	Dwelling
25 McNeil Street						0.61						0.47	Dwelling
78 Newmarket Road						0.25						0.05	Dwelling
97 Newmarket Road						0.36						0.16	Dwelling
44 Pleasant Street						0.74						0.64	Dwelling
50 Pleasant Street						0.47						0.01	Dwelling
1 Powlett Street						0.50						0.36	Dwelling
5 Powlett Street						0.53						0.25	Dwelling
7 Powlett Street						0.59						0.17	Dwelling
11 Powlett Street						0.56						0.27	Dwelling
15 Powlett Street					0.12	0.82						0.52	Dwelling
17 Powlett Street					0.19	0.88					-0.03	0.66	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
19 Powlett Street						0.66						0.29	Dwelling
21 Powlett Street						0.73						0.28	Dwelling
25 Powlett Street					0.12	0.72						0.34	Dwelling
29 Powlett Street					0.23	0.84						0.40	Dwelling
31 Powlett Street					0.33	0.98					-0.10	0.55	Dwelling
34 Powlett Street					0.24	0.91					-0.04	0.63	Dwelling
35 Powlett Street					0.25	0.89						0.48	Dwelling
36 Powlett Street					0.21	0.88						0.54	Dwelling
37 Powlett Street					0.34	0.99					0.09	0.74	Dwelling
39 Powlett Street					0.26	0.91					0.06	0.71	Dwelling
40 Powlett Street					0.42	1.08						0.30	Dwelling
41 Powlett Street					0.27	0.92					0.04	0.69	Dwelling
43 Powlett Street					0.15	0.80						0.32	Dwelling
44 Powlett Street					0.23	0.89					0.05	0.71	Dwelling
45 Powlett Street					0.17	0.81					-0.07	0.57	Dwelling
1 Queen Street					0.18	0.94					-0.02	0.74	Dwelling
1 Rose Street						0.41						0.10	Dwelling
3 Rose Street						0.37							Dwelling
1 Simson Street					0.17	0.69						0.34	Dwelling
3 Simson Street					0.29	0.84						0.13	Dwelling
4 Simson Street						0.49						0.22	Dwelling
7 Simson Street					0.26	0.81						0.28	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
8 Simson Street					0.19	0.80						0.10	Dwelling
9 Simson Street						0.69						0.53	Saddlery
9 Simson Street						0.63						-0.02	Dwelling
10 Simson Street					0.15	0.77						0.51	Dwelling
12 Simson Street					0.11	0.72						0.49	Dwelling
13 Simson Street					0.17	0.78						0.35	Dwelling
15 Simson Street					0.17	0.84						0.52	Dwelling
16 Simson Street					0.46	1.13					0.13	0.80	Dwelling
17 Simson Street					0.19	0.88						0.59	Dwelling
18 Simson Street					0.29	0.97						-0.09	Dwelling
19 Simson Street					0.33	1.03						0.55	Dwelling
20 Simson Street					0.34	1.03						0.29	Dwelling
24 Simson Street					0.68	1.42					0.48	1.22	Church Hall
24 Simson Street					0.49	1.21					0.10	0.82	Church Uniting
29 Simson Street					0.43	1.13					-0.04	0.66	Dwelling
33 Simson Street						0.82						0.35	Dwelling
35 Simson Street					0.28	0.99						0.37	Dwelling
37 Simson Street					0.19	0.88						0.54	Dwelling
41 Simson Street					0.24	0.95					-0.04	0.67	Dwelling
46 Simson Street					0.33	1.08					0.14	0.89	Dwelling
1 Smith Street						0.54						-0.09	Dwelling
3 Smith Street						0.35						-0.05	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
4 Smith Street						0.40						0.28	Dwelling
6 Smith Street						0.47						0.21	Dwelling
9 Smith Street						0.36						0.12	Dwelling
10 Smith Street						0.51						0.21	Dwelling
11 Smith Street						0.49							Dwelling
13 Smith Street						0.48						0.29	Dwelling
14 Smith Street						0.50						0.89	Dwelling
17 Smith Street						0.36						0.24	Dwelling
20 Smith Street						0.46						0.05	Dwelling
23 Smith Street						0.48						0.29	Dwelling
25 Smith Street						0.52						-0.04	Dwelling
26 Smith Street						0.52						0.37	Dwelling
28 Smith Street						0.61						0.42	Dwelling
29 Smith Street						0.61						0.26	Dwelling
30 Smith Street						0.74						0.36	Dwelling
32 Smith Street						0.84						0.55	Dwelling
34 Smith Street						0.84						0.60	Dwelling
39 Smith Street						0.59						0.35	Dwelling
1 Urquhart Street					0.49	1.20						0.56	Dwelling
3 Urquhart Street					0.34	0.99					0.06	0.71	St Pauls Anglican church
4 Urquhart Street					0.34	1.01							Dwelling
6 Urquhart Street					0.27	0.90						0.43	Dwelling

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
9 Urquhart Street					0.39	1.01					0.17	0.79	CFA
12 Urquhart Street					0.29	0.88					0.06	0.66	Dwelling
14 Urquhart Street					0.27	0.90						0.24	Dwelling
15 Urquhart Street					0.24	0.82						0.11	Senior Citizens Hall cnr Powlett &
17 Urquhart Street					0.33	0.95						0.42	Dwelling
19 Urquhart Street					0.26	0.89					0.05	0.68	Dwelling
20 Urquhart Street					0.45	1.12						0.52	Dwelling
21 Urquhart Street					0.24	0.90					-0.03	0.63	Dwelling
22 Urquhart Street					0.31	1.00						0.31	Dwelling
23 Urquhart Street					0.19	0.87						0.33	Dwelling
25 Urquhart Street					0.46	1.16						0.54	Dwelling
27 Urquhart Street					0.32	1.00						0.32	Dwelling
29 Urquhart Street					0.33	0.99						0.41	Dwelling
31 Urquhart Street					0.32	0.95						0.46	Dwelling
1/26 Urquhart Street					0.52	1.20					0.37	1.05	Unit
2/26 Urquhart Street					0.39	1.06					0.26	0.93	unit
3/26 Urquhart Street					0.18	0.86					0.00	0.68	Unit
4/26 Urquhart Street					0.19	0.86					-0.01	0.66	Unit
4 Victoria Street					0.17	0.62						0.16	Dwelling
5 Victoria Street						0.68						0.37	Dwelling
7 Victoria Street						0.59						0.10	Dwelling
10 Victoria Street						0.53							Shed

Carisbrook – EXISTING CONDITIONS

(ref WaterTech, 2019 - updated based on Ultimate Mitigation Scenario)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Carisbrook

LEGEND		Within ~100mm of flooding over floor							Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
	191.03	191.87	192.57	193.28	193.89	194.68	191.03	191.87	192.57	193.28	193.89	194.68	
10 Victoria Street					0.10	0.54						0.30	Dwelling
13 Victoria Street						0.45						0.16	Dwelling
14 Victoria Street						0.54							Dwelling
14 Victoria Street						0.44						0.16	Shed
17 Victoria Street						0.54						0.29	Dwelling
22 Victoria Street						0.46						0.25	Dwelling
24 Victoria Street						0.48							Dwelling
25 Victoria Street						0.53						-0.08	Dwelling
26 Victoria Street						0.58						-0.04	Dwelling
28 Victoria Street						0.63						0.06	Dwelling
30 Victoria Street						0.47							Dwelling
32 Victoria Street						0.62						0.51	Roadhouse Shop
36 Victoria Street						0.58						0.19	Dwelling
37 Victoria Street						0.16							Dwelling
38 Victoria Street						0.64						-0.08	Dwelling
42 Victoria Street						0.78						0.37	Dwelling
44 Victoria Street						0.75						0.37	Dwelling
48 Victoria Street						0.45						0.18	Dwelling

7.6 Indicative flood / no flood guidance tool for Carisbrook

The BoM does not currently provide flood forecasts for Carisbrook. All flood response actions must therefore be driven by rainfall and/or river level observations. See Section 7.1.

7.6.1 Indicative flood Behaviours

In very general terms, the approximate time between start of heavy rain and flooding at Carisbrook from the small local catchment to the west and southwest is 2 to 6 hours.

For McCallum Creek and Tullaroop Creek it is around 6 to 15 hours although Tullaroop Creek will rise slower than McCallum Creek and peak somewhere between 6 and 24 hours later, depending on the level of Tullaroop Reservoir before and after the event. Levels fall around a half to a third the rate of rise – it takes 2 to 3 times as long to fall as it does to rise.

7.6.2 Using the indicative flood / no flood guidance tool

In the lead up to a flood event

Rainfall data from the rain gauge at the Clunes stream gauge site and an average of the rainfall recorded at Clunes and Avoca (or Avoca, Norwood and Clunes) should be used to determine an appropriate rainfall depth for use in the Indicative Flood / No Flood guidance tool provided below, unless data from alternative locations closer to areas considered likely to experience the heaviest rainfall is available. Care should be exercised however, as it must be remembered that runoff from headwater as well as low land areas contribute to flooding.

If the catchment is very wet, it would be appropriate to step up one level. For example, rainfall approaching the 5% AEP curve on a very wet catchment would likely result in flood extents and depths in and around Carisbrook similar to a 2% AEP event.

Two approaches can be used during a rainfall event to determine an indication of the likelihood and severity of flooding at Carisbrook. Both approaches can be used simultaneously using the same copy of the tool. **Unless there are unusual circumstances, actions as per the Flood Intelligence Card should be initiated as soon as the tool suggests flooding is likely.** Response can be escalated if the tool indicates an increase in the expected severity of flooding.

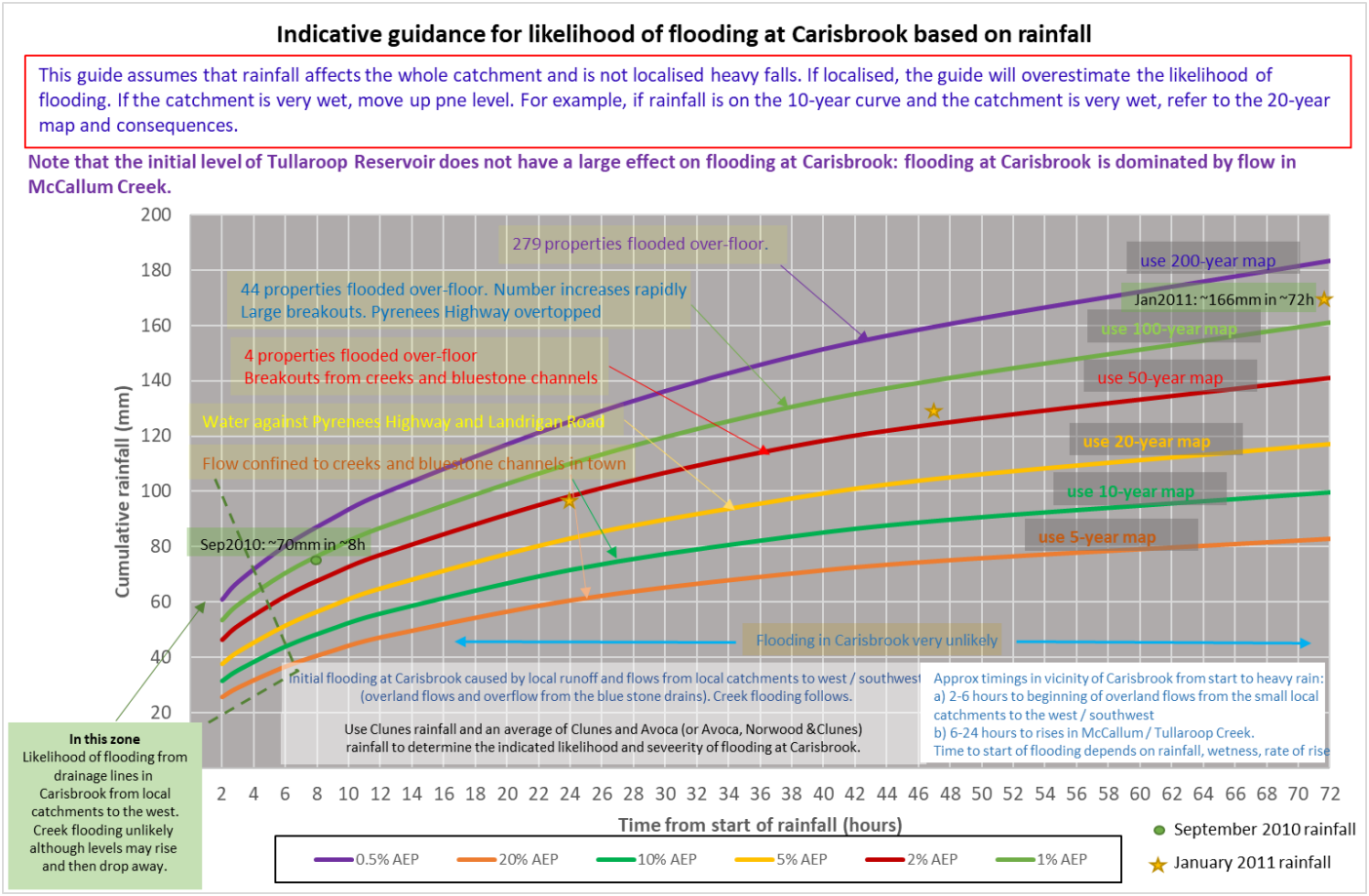
Approach 1: Using the total rainfall depth obtained from the start of the event (discount early drizzle or very light rain), plot the rainfall depth against elapsed time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates that flooding of around that severity is likely.

Approach 2: Discount the early lighter rain from consideration (i.e. begin calculating rainfall depth from start of heavy rain) and plot rainfall depth against time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates that flooding is likely.

CAUTION. While a strength of the tool is that it does provide a quick ball-park answer to questions such as “will we flood” and “how bad will it be”, it is based on a number of gross assumptions and generalisations. It is therefore indicative only. It is not property specific and does not enable accurate predictions of expected flooding, peak flood heights, the time of flood peak, the severity of expected flooding or specific likely consequences. Further, it will not always indicate the expected severity of flooding correctly although it will usually give a heads-up to severe flooding and thus of an indication of likely consequences.

After a flood event

After a flood event, plot the event rainfall depth (with date) on the tool and include an overview of the event, including antecedent conditions, in Appendix A of this MFEP. Relevant information should also be added to this Appendix.



Appendix C2 – Dunolly community flood emergency plan

1. Overview

Dunolly is a small rural township of 899 residents (2021 Census) situated within Central Goldfields approximately 178km north west of Melbourne, 20km north of Maryborough and less than 50km south west of Bendigo. It is within the Loddon River catchment.

Burnt Creek flows around the edge of Dunolly. It has a catchment area upstream of Dunolly of around 177km^2 and rises to the north west of town near Painswick on the southern slopes of Mt Moliagul and includes the eastern slopes of the Bealiba Ranges (see Figure C2-1). Burnt Creek flows into Bet Bet Creek near Betley approximately 10km to the south east. Bet Bet Creek flows into Laanecoorie Reservoir a further 8km downstream.

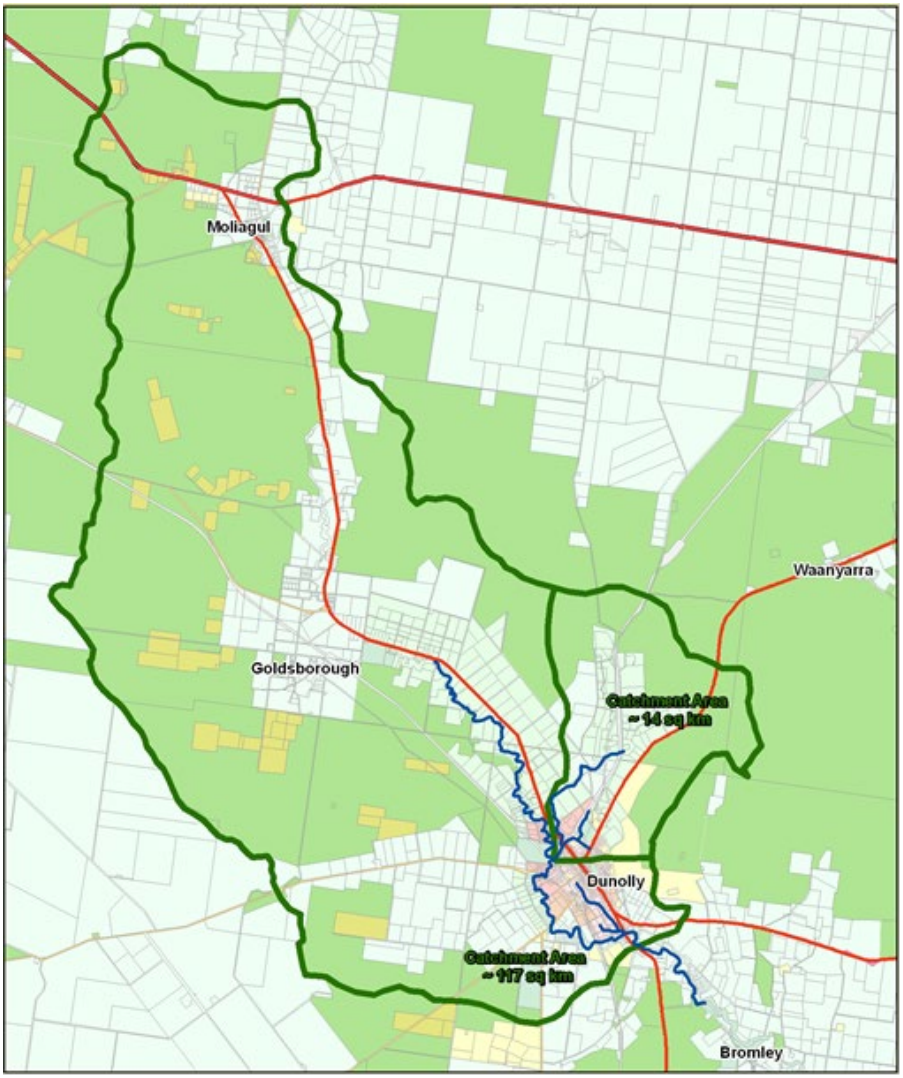


Figure C2-1: Burnt Creek catchment to Dunolly

A small tributary (Old Lead Creek) with a catchment area of around 14km^2 flows from north east of Dunolly and joins Burnt Creek to the north west of town.

Old Lead Reservoir, a former water supply reservoir now managed by Loddon Shire, is located north of Dunolly near the intersection of Dunolly – Rheola Road and Dunolly – Orville Road. It is the only appreciable dam in the Burnt Creek catchment and is fed by contour channels (rather than a watercourse) that divert runoff from adjacent catchments. These contour channels are currently in poor condition. With a capacity of only 120ML, the Old Lead Reservoir has negligible impact on the extent and timing of flood peaks at Dunolly. For example, it would have filled 4.5 times during the January 2011 event and had filled before the first peak occurred at Dunolly on 12 January 2011.

On the other hand, a dambreak from the reservoir is considered likely to have some impact on flooding in Dunolly but, as at the date of this MFEP, the extent of that impact has not been assessed. Further, it is understood that Loddon Shire are investigating options for the reservoir's future.

A contour drain runs approximately north to south along the eastern side of Dunolly (see Figure C2-2). The infrastructure has been upgraded with a levelled channel bank along the drain, as well as the addition of inflow and outflow structures to a reservoir basin. The drain captures the over-land flows from the higher ground to the north and east and channels it through a reservoir basin and into Burnt Creek to the south of town thereby providing flood protection for the town.

There are no stream gauges in the Burnt Creek catchment. The Burnt Creek catchment upstream of Dunolly is quite flat with high loss / infiltration rates. Floods therefore usually only occur following very heavy rainfall or after heavy rain on a wet catchment when the natural floodplain storage has been filled.

General rain of around 50mm or more over a 12 hour period or so across a wet catchment will cause significant rises with some flooding at Dunolly within 6 to 8 hours or so of rain starting. More substantial rainfall (of order 80mm or more in 12 hours or so or around 90mm in 24 hours or so), again on a wet catchment, will cause more severe flooding within 7 to 9 hours or so of rain.

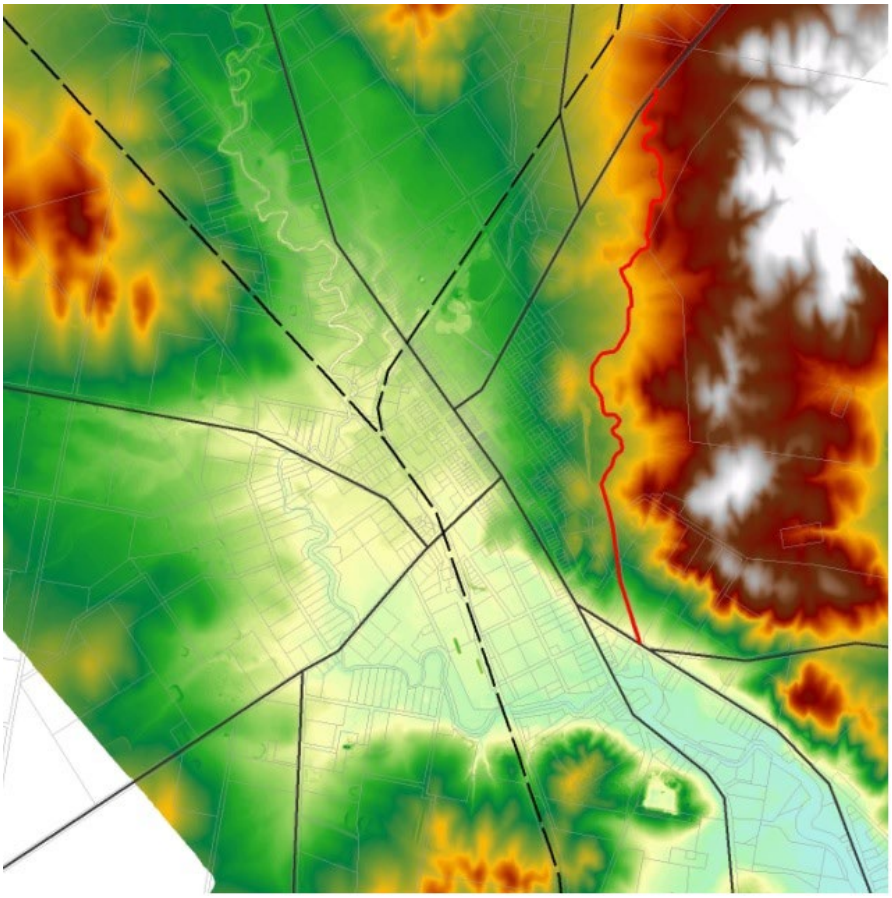


Figure C2-2: Contour drain (red line) to the east of Dunolly

2. Flood behaviour

Dunolly has been flooded a number of times, most notably in February 1873, November 1893, April 1959, September 1983, September 2010 and January 2011.

Large flood events at Dunolly result from high flows in Burnt Creek and in the tributary creeks. Flows from the local creeks cause the initial rise at Dunolly. The recently upgraded drain redirects the overland flow from the east to the south towards Burnt Creek and protects the township. Flooding from Burnt Creek mainly affects the area upstream of the Inglewood – Dunolly railway line, areas to the west of town and the main access roads.

The Inglewood – Dunolly railway line acts as a flow barrier, which protects the town from more frequent and severe flooding. Water ponds upstream (to the north) of the railway line but does not overtop it. This results in an area of deep flooding to the north of the railway line and south of Raglan Street. A number of properties in this area are flooded to depth with a number of houses flooded over floor.

Large floods have washed the ballast from under the line in the past but this did not happen in January 2011.

Water also ponds upstream of road crossings and many roads do get overtopped, creating access issues.

It is worth noting that:

- There are a number of shrinking islands immediately upstream of Dunolly and also to the west of town that are occupied by houses. A comparison between successive flood inundation maps at Appendix H and consideration of the list of properties flooded at Section 7.4 will provide guidance on appropriate response. Early evacuation will be essential during large floods.
- While Betley Road is first wetted at around the 5% AEP event and is impassable from around the 2% AEP event, the bridge is unlikely to be overtopped: it is the low section of the road on the town side of the bridge that is affected.

- The capacity of all rail structures (bridges and culverts) is sufficient for all floods up to and including the 0.5% AEP event.
- In very general terms, flood extents do not change dramatically between the 20% and 0.5% AEP events but depths do increase.
- Access and egress to the town is maintained for all design events through Bridgewater-Dunolly Road (protected from floodwaters by the railway line and the contour drain).
- The Hospital is not affected by flooding but access for emergency cases, staff and visitors is maintained through Breakwater-Dunolly Road only during floods bigger than about the 5%AEP event.
- Floodwaters outside the main creek channels flow relatively slowly at around 1m/s, even during very large floods.

During the 20% AEP event:

- The causeway at Burnt Creek is overtopped by around 400mm
- Raglan Street is overtopped by around 20mm
- The area between the Inglewood – Dunolly railway line and Raglan Street begins to flood as water backs up against the railway line
- Some water (up to 50mm deep) is conveyed to the south along the Maryborough – Dunolly Road
- No buildings are flooded over floor, water is impacting the exterior or subfloor of buildings and water is flowing across further properties.

During the 10% AEP event:

- The causeway at Burnt Creek is overtopped by around 400mm
- Raglan Street is overtopped by around 30mm
- Short Street (to the north of town) and the Dunolly - Stuart Mill near the creek are wet
- No buildings are flooded over floor, water is impacting the exterior or subfloor of buildings and water is flowing across further properties.

During the 5% AEP event:

- Around 200m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 20mm and 70mm
- Water (up to 150mm deep) is conveyed along the Maryborough – Dunolly Road
- Floodwater, up to around 100mm deep, is breaking out across Dunolly Road at the low point north of Raglan Street
- Short Street (to the north of town) and the Dunolly - Stuart Mill near the creek are flooded
- The Dunolly – Avoca Road is not wetted by floodwater
- 1 building is flooded over floor (at 1787 Dunolly-Maryborough Road), water is impacting the exterior or subfloor of 12 other buildings and water is flowing across a further 59 properties.

During the 2% AEP event:

- Around 500m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 100mm and 300mm
- Water (up to 200mm deep) is conveyed along the Maryborough – Dunolly Road
- Floodwater, up to around 250mm deep, is continuing to break out across Dunolly Road at the low point north of Raglan Street
- The Dunolly – Avoca Road is wetted by floodwater in the vicinity of the creek crossing: all main access roads are flood affected except Bridgewater-Dunolly Rd (Elgin St)
- If flooding is regional rather than just local, properties to the west of the creek and between the Dunolly – Stuart Mill Road and the Dunolly Avoca Road are effectively isolated from town and from other centres
- 4 buildings are flooded over floor (1 in Broadway, 1 in Bently, 1 in Dunolly Moliagul Road and 1 in Dunolly-Maryborough Road), water is impacting the exterior or subfloor of 15 other buildings and water is flowing across a further 56 properties.

During the 1% AEP event:

- Around 600m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 400mm and 1100mm
- Water (up to 250mm deep) is conveyed along the Maryborough – Dunolly Road
- Floodwater, up to around 400mm deep, is continuing to break out across Dunolly Road at the low point north of Raglan Street
- 6 buildings are flooded over floor (see property table), water is impacting the exterior or subfloor of 19 other buildings and water is flowing across a further 52 properties.

2.1 Historical events

18 February 1873

Heavy rain with thunderstorms resulted in severe flooding in Dunolly.

12 November 1893

Overnight rain followed by a thunderstorm (a total of around 100mm in about 23 hours including 25mm in 25 minutes) led to severe flooding at Dunolly. Roads were impassable, the railway line was damaged (ballast washed away), houses were flooded, stock were drowned and crops were damaged.

1 April 1959

150mm of rain reportedly fell at Moliagul and 67mm at Dunolly within a sixty-five minute period. This led to significant flooding at Dunolly with some houses experiencing inundation to window height.

8 September 1983

Flooding in September 1983 resulted from 94mm of rain across the Burnt Creek catchment over a 6-day period from the 25th to 30th September. Information on flood extents and impacts is not available.

4 September 2010

The September 2010 flood event resulted from heavy rain falling over a 5-day period beginning on 4th September. Dunolly received 85mm of rain. The majority of this rain fell at the beginning of the period starting on the 4th. Maximum intensities (between 20% and 10% AEPI) were recorded in the early hours of the morning of the 4th. Arterial and local roads were closed for several days. Large areas of rural land was flooded.

14 January 2011 (see inundation map at Appendix H)

The flood of January 2011 was the largest flood in living memory at Dunolly and resulted from rainfall with a 12-hour duration AEP event of close to 2%. More than 200mm of rain fell over a 5-day period in three separate bursts. The first burst occurred on the morning of the 10th and only lasted a couple of hours. The second and third bursts, beginning on the 11th and 13th respectively, were more prolonged with rainfall occurring over periods of around 36 and 24 hours. The maximum daily total exceeded 90mm. Rainfall totals varied by up to 15mm across the catchment with the highest totals on the eastern side.

The Old Lead Reservoir would have filled 4.5 times during the event and had filled before the first peak occurred at Dunolly on 12th January.

Floodwaters began impacting the town during the early hours of Friday 14th January. The peak occurred around 9:30am, approximately 12 hours after the start of the third rainfall burst. Water receded quickly and residents returned to their homes during the afternoon.

Dunolly was isolated with only air or rail access. The town also lost power. Twenty (20) homes were inundated and areas along Burnt Creek and Broadway were seriously impacted. A relief centre was opened at the Dunolly Bowls Club during the event, with approx.. 40 residents attending

September/October 2016 – Road closures and some property affected.

3. Overview of flooding consequences

3.1 Warning times

The Burnt Creek catchment responds very quickly to rain if the catchment is wet or rain is very heavy. Thus, the flood warning time for Dunolly is short: of order 4 hours or less for the creek to rise (to peak takes longer) - see Appendix B.

3.2 Areas affected

The northern end of Broadway is a flooding hot spot, and particularly the area between the Inglewood – Dunolly railway line and Raglan Street.

Maps at Appendix H provide guidance on where flooding is likely to occur within Dunolly for flood events ranging from the 20% AEP event up to the 0.5% event. Flooding to the extent and depths shown for each event may not occur simultaneously as the maps display the outer envelope of expected flooding.

3.3 Roads affected

The main access roads for Dunolly except Bridgewater-Dunolly Road (Dunolly – Moliagul Road, Maryborough – Dunolly Road, Dunolly – Eddington Road, Betley Road, Dunolly – Avoca Road and Dunolly – Stuart Mill Road) as well as a number of streets in the vicinity of the township are affected by flooding. Roads are not inundated for extended periods (generally less than 24 hours even in big floods).

3.4 Properties affected

A summary of the number of properties likely to be flooded and the number likely to be inundated over floor is provided in Section 7.3. Around 20 buildings in Dunolly were flooded over floor during the January 2011 event.

3.4.1 Detailed list

A list of properties likely to be flooded for a range of floods along with the expected depth of over-ground flooding adjacent to the building and the likely depth of over floor inundation is provided in Section 7.4. Properties within 100mm of over floor flooding are also identified.

It is strongly recommended that the list is used in conjunction with the flood inundation maps (Appendix H) and the indicative flood guidance tool provided in Section 7.5.

3.5 Isolation

The main access roads for Dunolly (Dunolly-Moliagul Road, Maryborough-Dunolly Road, Dunolly-Eddington Road, Betley Road, Dunolly-Avoca Road and Dunolly-Stuart Mill Road) are affected by flooding. The Bridgewater-Dunolly Road (Elgin St) is the only access road that remains free of floodwaters. The Dunolly-Avoca Road not wetted at the 5% AEP event. At the 2% AEP event, all roads west of the railway line and south of the township are wetted. Access & Egress to and from Dunolly is only possible through Bridgewater-Dunolly Road. While these roads do not remain inundated for an extended period (i.e. generally less than 24 hours even in big floods), road surfaces can be damaged which extends the period of isolation.

There are a number of shrinking islands immediately upstream of Dunolly and to the west of town that are occupied by houses. A comparison between successive flood inundation maps at Appendix H and consideration of the list of properties flooded at Section 7.4 will provide more accurate guidance on properties likely to be affected, isolated and/or require evacuation.

The Castlemaine-Dunolly, Dunolly-St Arnaud and Inglewood-Dunolly railway lines are not overtopped by floods up to at least the 0.5% AEP event. However, floodwater does pond on their upstream sides and it

is possible that ballast may be shifted or washed out. This did not happen during the January 2011 event but is reported to have happened during earlier floods.

3.6 Essential infrastructure

There is no known essential infrastructure affected by flooding at Dunolly other than main access roads and the pre-school. The hospital, police station, CFA brigade, Telstra exchange, school and Council offices all remain dry.

4. Flood mitigation

Flood intelligence MUST have regard for changes within the catchment that modify likely flood behaviour (e.g. mitigation works that reduce the severity of flood risk).

4.1 Flood protection levees

There are no formal flood mitigation works in place at Dunolly although the railway line and roads do act to some extent as a barrier, as does the contour channel to the north-east of town.

4.2 Drainage works

There are no specific drainage works planned or required in Dunolly, other than the contour drain that runs approximately north to south along the eastern side of the town and redirects over-land flows from the higher ground to the north and east around the town and into Burnt Creek to the south (see Figure C2-2), that impact on flooding or vice versa.

5. Flood impacts and required actions

Refer to the following Flood Intelligence Card.

Note that users of the flood intelligence card should consider rainfall depth and rates at locations in the vicinity of Dunolly and across the upper catchment and use the indicative tool at Section 7.5 in order to better appreciate the likely severity of flooding and its impacts in the town. Local data and/or data from the BOM website (http://www.bom.gov.au/) should be used. It is suggested that the following sites, available from the BOM website, will provide useful indicative rainfall data:

- Archdale Junction (site number 408206)
- Bet Bet (site number 407211B)
- Norwood (site number 407220A).

6. Gauge information

There is no stream gauge information for the Burnt Creek catchment.

7. Flood intelligence card, property inundation list and flood / no flood guidance tool

7.1 Introduction

BOM does not currently provide flood forecasts for Burnt Creek or for Dunolly. All actions must therefore be driven by rainfall and/or river level observations.

There are no water level / flood gauges within the Burnt Creek catchment.

BOM collects and records rainfall at a number of locations within or close to the Burnt Creek catchment. Data from a number of these sites are available from the BOM website at intervals ranging from around 3 hours to daily. Daily-read rainfall data is available for a number of sites in the general vicinity of the Burnt Creek catchment including at Dunolly. Rainfall data is also available at around 3-hourly intervals during heavy rain events from the rain gauge at the Bet Bet Creek at the Bet Bet site and from Laanecoorie Reservoir. Similar data is available from the Archdale site on the Avoca river. Rainfall data will also become available from the Bet Bet Creek at the Norwood site.

Users of the flood intelligence card should consider rainfall depth and rates at locations in the vicinity of Dunolly and across the upper catchment (if available) and use the indicative flood / no flood guidance tool at Section 7.5 in order to better appreciate the likely severity of flooding and its impacts in the town.

Notes:

1. While flood intelligence cards provide guidance on the relationship between flood magnitude and flood consequences, flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Further, the hydrologic and hydraulic modelling that underpins much of the intel detailed below is informed by a number of assumptions and approximations that are unlikely to be replicated exactly during a flood event. Actual impacts under similar rainfall conditions are therefore expected to be similar but may not be exactly the same: there are likely to be some differences.
2. All levels, impacts and actions listed in the following flood intelligence card and graph may need to be adjusted to better reflect experience.

7.2 Flood intelligence card

Observed Rainfall (see graph)	AEP	Water level / flow at Dunolly (mAHD / m^3/s)	Consequence / Impact	Actions (may include, but not limited to, evacuation, closure of roads, sandbagging, issue of warnings and who is responsible)
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
Heavy rain on wet catchment			Overflows from the contour drain to the east of town will cause initial shallow flooding in town streets and at the northern end of Broadway. The status of this drain is therefore an indicator of imminent flooding. Water also begins to back up against the Inglewood – Dunolly railway line downstream from Raglan Street.	◦ Check the contour drain for flow and capacity immediately to the south of the Bridgewater – Dunolly Road and in the section to the east of the Hospital. ◦ Monitor rainfall and water levels. ◦ Use the indicative flood / no flood tool to develop an appreciation of the likely scale of the flood event.
~50mm in 9 hours to ~60mm in 18 hours	20% AEP	20 m^3/s	Burnt Creek causeway overtopped by around 400mm. Raglan Street overtopped by around 20mm. The area between the Inglewood – Dunolly railway line and Raglan Street begins to flood as water backs up against the railway line. Some water (up to 50mm deep) runs south along the Maryborough - Dunolly Road. No buildings are flooded over floor, water is up against 6 buildings and water is flowing across a further 45 properties.	◦ Monitor rainfall and water levels. ◦ Use the indicative flood / no flood tool to develop an appreciation of the likely scale of the flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions. This may include organising necessary resources and/or evacuations, sandbagging at key locations (see maps), the removal of furniture etc from buildings likely to be flooded over floor and/or sandbagging buildings.
~55mm in 9 hours to ~70mm in 18 hours	10% AEP	42 m^3/s	Burnt Creek causeway overtopped by around 400mm. Raglan Street overtopped by around 30mm. Short Street (to the north of town) and the Dunolly – Stuart Mill in the vicinity of the creek crossing are wet. Some water (up to 100mm deep) running along the Maryborough – Dunolly Road.	◦ Continue to monitor rainfall and water levels. ◦ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ◦ Refer to indicated maps and impacts.

Observed Rainfall (see graph)	AEP	Water level / flow at Dunolly (mAHD / m^3/s)	Consequence / Impact	Actions (may include, but not limited to, evacuation, closure of roads, sandbagging, issue of warnings and who is responsible)
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
			No buildings are flooded over floor, water is up against 8 other buildings and water is flowing across a further 56 properties.	◦ Implement appropriate response actions and secure necessary resourcing. Deploy "water over road" and other signs. ◦ If flood is likely to be bigger than the 5% AEP event, plan for access roads to the town, other than Bridgewater-Dunolly Rd, to be impassable for up to 24 hours. ◦ If flood likely to be bigger than a 2% AEP event, open the Relief Centre at the Bowls Club and start evacuation of identified properties.
	Sept 1983	45 m^3/s	Information on flood impacts not available.	◦
~65mm in 9 hours to ~80mm in 18 hours	5% AEP	71 m^3/s	Around 200m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 20mm and 70mm. Water (up to 150mm deep) is running along the Maryborough – Dunolly Road. Floodwater (up to 100mm deep) breaking out across Dunolly Road at the low point north of Raglan Street. Short Street (to the north of town) and the Dunolly – Stuart Mill near the creek crossing are flooded. The Dunolly – Avoca Road and Bridgewater-Dunolly Road are the only main access roads not wetted by floodwater. 1 building is flooded over floor (at 1787 Dunolly-Maryborough Road), water up against 12 other buildings and water is flowing across a further 59 properties.	◦ Continue to monitor rainfall and water levels. ◦ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions and secure necessary resourcing. Deploy "water over road", "road closed" and other signs. ◦ If flood likely to be bigger than a 2% AEP event, activate the Relief Centre at the Bowls Club and continue evacuation of identified properties.

Observed Rainfall (see graph)	AEP	Water level / flow at Dunolly (mAHD / m^3/s)	Consequence / Impact	Actions (may include, but not limited to, evacuation, closure of roads, sandbagging, issue of warnings and who is responsible)
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
~80mm in 9 hours to ~95mm in 18 hours	2% AEP	106 m^3/s	Around 500m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 100mm and 300mm. Water (up to 200mm deep) is running along the Maryborough – Dunolly Road. Floodwater (up to 250mm deep) is continuing to break out across Dunolly Road at the low point north of Raglan Street. The Dunolly – Avoca Road is wetted by floodwater in the vicinity of the creek crossing: all main access roads are flood affected; and If flooding is regional rather than just local, properties to the west of the creek and between the Dunolly – Stuart Mill Road and the Dunolly Avoca Road are effectively isolated from town and from other centres. 4 buildings are flooded over floor (1 in Broadway, 1 in Betley, 1 in Dunolly Moliagul Rd and 1 in Dunolly-Maryborough Road), water is up against 15 other buildings and water is flowing across a further 56 properties.	◦ Continue to monitor rainfall and water levels. ◦ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ◦ Refer to indicated maps and impacts. ◦ Implement appropriate response actions and as appropriate deploy “water over road”, “road closed” and other signs.
	Jan 2011	107 m^3/s	Dunolly isolated with only air or rail access and power was lost (contour drain was overtopped, flooding Bridgewater-Dunolly Road and all access roads to the town). 40 homes evacuated 20 homes flooded over floor and areas along Burnt Creek and Broadway seriously impacted. A relief centre was opened at the Dunolly Bowls Club.	

Observed Rainfall (see graph)	AEP	Water level / flow at Dunolly (mAHD / m^3/s)	Consequence / Impact	Actions (may include, but not limited to, evacuation, closure of roads, sandbagging, issue of warnings and who is responsible)
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
			The peak occurred around 9:30am, approximately 12 hours after the start of the third rainfall burst. Water receded quickly and residents returned to their homes during the afternoon during the event.	
~90mm in 9 hours to ~110mm in 18 hours	1% AEP	145 m^3/s	Around 600m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 400mm and 1100mm. Water (up to 250mm deep) is running along the Maryborough – Dunolly Road. Water is continuing to break out from the end of the contour drain across Dunolly Road with shallow flooding. Floodwater (up to 400mm deep) is continuing to break out across Dunolly Road at the low point north of Raglan Street. 15 buildings flooded over floor (see property table), water up against 54 other buildings and water flowing across a further 114 properties.	◦ Continue to monitor rainfall and water levels. ◦ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ◦ Refer to indicated maps and impacts. ◦ Continue to implement appropriate response actions.
	April 1959	160 m^3/s	Significant flooding at Dunolly. Some houses inundated to window height.	
A little above the 1% AEP line on the indicative flood / no flood tool	0.5% AEP	188 m^3/s	Around 600m of Betley Road is inundated on the town side of the Betley Road Bridge to depths between 600mm and 1300mm. Water (up to 300mm deep) is running along the Maryborough – Dunolly Road. Floodwater (up to 400mm deep) is continuing to break out across Dunolly Road at the low point north of Raglan Street.	◦ Continue to monitor rainfall and water levels. ◦ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ◦ Refer to indicated maps and impacts.

Observed Rainfall (see graph)	AEP	Water level / flow at Dunolly (mAHD / m^3/s)	Consequence / Impact	Actions (may include, but not limited to, evacuation, closure of roads, sandbagging, issue of warnings and who is responsible)
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
			15 buildings flooded over floor (see property table), water up against 19 other buildings and water flowing across a further 52 properties	○ Continue to implement appropriate response actions.

7.3 Summary of properties flooded

Summary of number of flood affected properties in Dunolly (WaterTech, December 2013) (EXISTING CONDITIONS)						
	Design Flood AEP (%)					
	20%	10%	5%	2%	1%	0.5%
Level at reference gauge						
Number of properties flooded above floor	0	0	1	4	15	23
Number of properties flooded below floor against building only	6	8	12	15	19	78
Number of properties flooded but water not against building	45	56	59	56	52	99
Total number of flooded properties	51	64	72	75	86	200

7.4 Detailed list of properties flooded

Dunolly (WaterTech, December 2013) (EXISTING CONDITIONS)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Dunolly

LEGEND		Flood waters affect the property but not up against the building – may be quite deep if in a flow path												
		Within ~100mm of flooding over floor					Depth of over floor flooding							
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments	
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%		
96 BETLEY ROAD													Residential	
171 BETLEY ROAD				0.25	0.54	0.73				0.05	0.34	0.53	Residential	
65 BIRKETTS LANE													Residential	
200 BROADWAY				0.30	0.57	0.92					0.24	0.59	Residential	
218 BROADWAY													Residential	
225 BROADWAY													Residential	
226 BROADWAY													Residential	
228 BROADWAY													Residential	
232 BROADWAY				0.08	0.20								Residential	
237 BROADWAY				0.12	0.27	0.41						0.07	Residential	
246 BROADWAY			0.19	0.30	0.43	0.56				0.04	0.17	0.30	Residential	
5 BURNT CREEK LANE													Residential	
19 BURROWS LANE													Residential	
70 BURNT CREEK LANE													Residential	
78 DERMOUNDY ROAD	0.49	0.49	0.49	0.49	0.49	0.49							Residential	
1787 DUNOLLY MARYBOROUGH ROAD			0.15	0.29	0.36	0.43			0.06	0.20	0.27	0.34	Commercial	
1798 DUNOLLY MARYBOROUGH ROAD						0.15							Residential	
1802 DUNOLLY MARYBOROUGH ROAD					0.08	0.10							Residential	
100 DUNOLLY-MOLIAGUL ROAD			0.09	0.11	0.14	0.15					0.03	0.04	Residential	
115 DUNOLLY-MOLIAGUL ROAD													Residential	
297 DUNOLLY-MOLIAGUL ROAD													Residential	

Dunolly (WaterTech, December 2013) (EXISTING CONDITIONS)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Dunolly

LEGEND		Flood waters affect the property but not up against the building – may be quite deep if in a flow path		
		Within ~100mm of flooding over floor		Depth of over floor flooding

Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
341 DUNOLLY-MOLIAGUL ROAD													Residential
345 DUNOLLY-MOLIAGUL ROAD													Residential
449 DUNOLLY-MOLIAGUL ROAD													Residential
15 GOOSEBERRY HILL ROAD			0.15	0.36	0.50	0.64							Residential
26 GOOSEBERRY HILL ROAD													Residential
14 LEA KURIBUR STREET						0.17							Residential
21 MCKINNON ROAD													Residential
25 MCKINNON ROAD													Residential
28 MCKINNON ROAD						0.05							Residential
35 MCKINNON ROAD					0.24	0.40					0.24	0.40	Residential
40 MCKINNON ROAD													Residential
36 MIDDLE ROAD													Residential
52 MIDDLE ROAD					0.20	0.39						0.19	Residential
54 MIDDLE ROAD													Residential
40 PIERCE HILL ROAD													Residential
54 PIERCE HILL ROAD													Residential
13 RAGLAN STREET													Residential
17 RAGLAN STREET			0.08	0.12	0.15	0.16							Residential
19 RAGLAN STREET		0.05	0.08	0.10	0.13	0.14							Residential
21 RAGLAN STREET													Residential
22 RAGLAN STREET		0.09	0.12	0.13	0.14	0.15							Residential
23 RAGLAN STREET	0.09	0.10	0.11	0.13	0.14	0.15							Residential
26 RAGLAN STREET													Residential

Dunolly (WaterTech, December 2013) (EXISTING CONDITIONS)

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Dunolly

LEGEND		Flood waters affect the property but not up against the building – may be quite deep if in a flow path												
		Within ~100mm of flooding over floor						Depth of over floor flooding						
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
12 RAILWAY FLATS ROAD													Residential
30 RAVENS LANE													Residential
2 RUSSEL STREET													Residential
4 RUSSEL STREET													Residential
9 RUSSEL STREET						0.30							Residential
14 SEPARATION ROAD													Residential
22 SEPARATION ROAD													Residential
28 SEPARATION ROAD													Residential
38 SEPARATION ROAD													Residential
40 SEPARATION ROAD													Residential
46 SEPARATION ROAD													Residential
70 SEPARATION ROAD													Residential
78 SEPARATION ROAD													Residential
140 SEPARATION ROAD													Commercial
29 SPORTING FLAT ROAD													Residential
4 THOMAS STREET													Residential
5 THOMAS STREET													Residential
9 THOMAS STREET													Residential
11 THOMAS STREET				0.07	0.08	0.09							Residential
12 THOMAS STREET													Residential
13 THOMAS STREET				0.03	0.03	0.12							Residential
15 THOMAS STREET			0.01	0.02	0.07	0.29							Residential
17 THOMAS STREET	0.02	0.05	0.07	0.10	0.11	0.26							Residential

Dunolly (WaterTech, December 2013) (EXISTING CONDITIONS) It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Dunolly													
LEGEND		Flood waters affect the property but not up against the building – may be quite deep if in a flow path											
		Within ~100mm of flooding over floor						Depth of over floor flooding					
Location (Number & Street)	Depth of flooding near building for each AEP						Depth of over floor flooding at property for each AEP						Comments
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%	
19 THOMAS STREET	0.13	0.17	0.21	0.23	0.26	0.32							Residential
21 THOMAS STREET													Residential
23 THOMAS STREET													Residential
25 THOMAS STREET													Residential

7.5 Indicative flood / no flood guidance tool for Dunolly

BOM does not currently provide flood forecasts for Burnt Creek or for the Dunolly area. All flood response actions must therefore be driven by rainfall and/or river level observations.

In very general terms, the approximate time between start of heavy rain and flooding at Dunolly is around 9.5 to 10.5 hours. Levels fall at around half the rate of rise – it generally takes almost twice as long to fall as it does to rise.

7.5.1 Using the indicative flood / no flood guidance tool

In the lead up to a flood event

An average of the rainfall recorded at the rain gauges at Archdale Junction, Norwood, Bet Bet and Laanecoorie (or if the catchment is wet and one gauge is consistently higher, the average of that gauge and the next highest) should be used to determine an appropriate rainfall depth for use in the Indicative Flood / No Flood guidance tool provided below, unless data from alternative locations closer to areas considered likely to experience the heaviest rainfall is available. Care should be exercised however, as it must be remembered that runoff from headwater as well as low land areas contribute to flooding.

If the catchment is very wet, it would be appropriate to step up one level. For example, the 3rd burst of rainfall in January 2011 occurred over a 12-hour period and was around the 2% AEP. However, the resulting flood extents and depths in and around Dunolly were similar to a 1% AEP event.

If the catchment is dry, this tool will tend to over-estimate the likelihood of flooding if the catchment is dry and / or rain extended over more than 24 hours

Two approaches can be used during a rainfall event to determine an indication of the likelihood and severity of flooding at Dunolly. Both approaches can be used

simultaneously using the same copy of the tool.

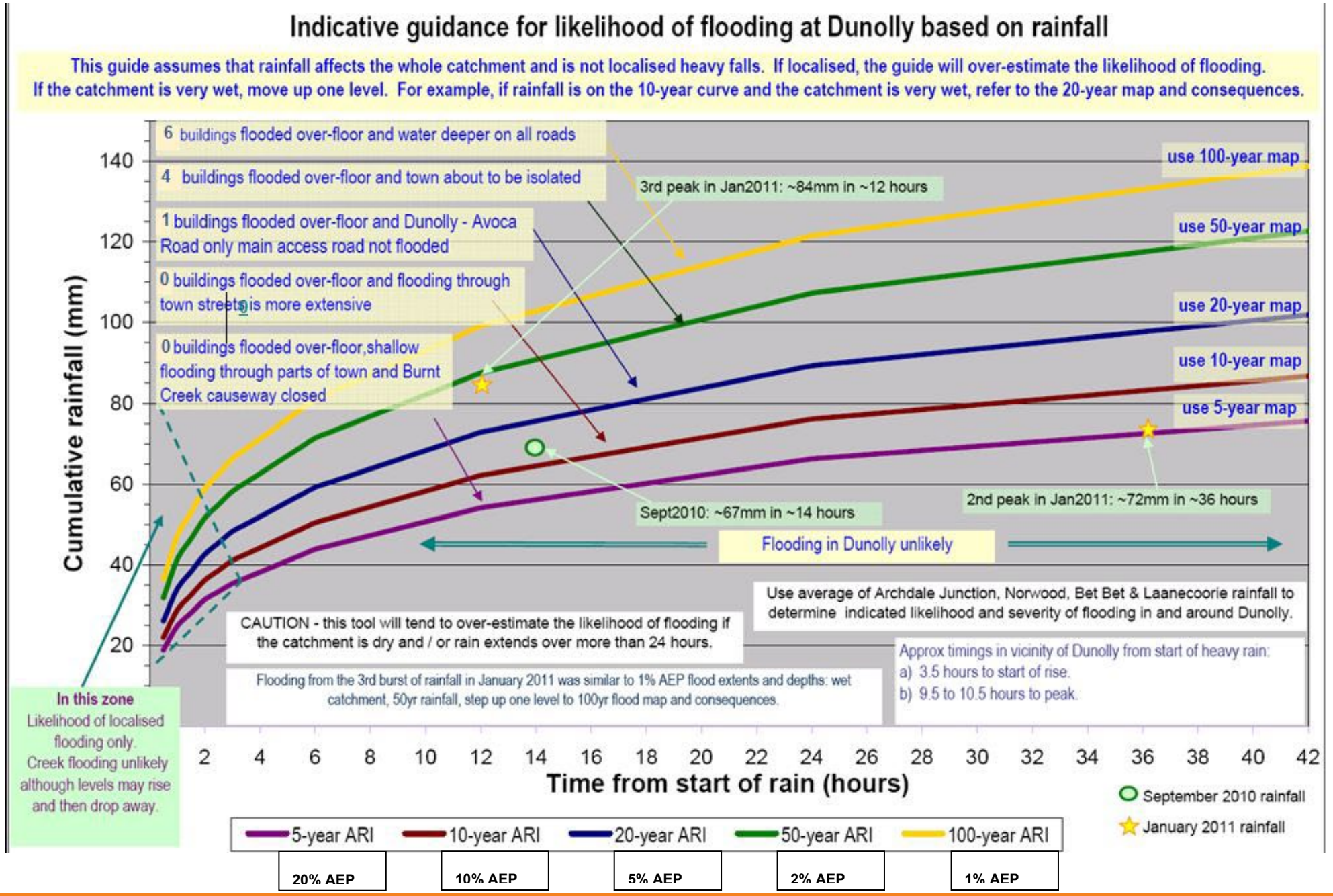
Approach 1: Using the total rainfall depth obtained from the start of the event (discount early drizzle or very light rain), plot the rainfall depth against elapsed time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates that flooding of around that severity is likely.

Approach 2: Discount the early lighter rain from consideration (i.e. begin calculating rainfall depth from start of heavy rain) and plot rainfall depth against time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates that flooding is likely.

CAUTION: While a strength of the tool is that it does provide a quick ball-park answer to questions such as “will we flood” and “how bad will it be”, it is based on a number of gross assumptions and generalisations. It is therefore indicative only. It is not property specific and does not enable accurate predictions of expected flooding, peak flood heights, the time of flood peak, the severity of expected flooding or specific likely consequences. Further, it will not always indicate the expected severity of flooding correctly although it will usually give a heads-up to severe flooding and thus of likely consequences. Note also that the tool will tend to over-estimate the likelihood of flooding if the catchment is dry and / or rain extends over more than 24 hours. On the other hand, it will tend to underestimate the likelihood of flooding if the catchment is wet. In such circumstances, it would be appropriate to step up one curve.

After a flood event

After a flood event, plot the event rainfall depth (with date) on the tool and include an overview of the event, including antecedent conditions, in Appendix A. Relevant information should also be added to this Appendix.


Indicative guidance for likelihood of flooding at Dunolly based on rainfall
This guide assumes that rainfall affects the whole catchment and is not localised heavy falls. If localised, the guide will over-estimate the likelihood of flooding.
If the catchment is very wet, move up one level. For example, if rainfall is on the 10-year curve and the catchment is very wet, refer to the 20-year map and consequences.
6 buildings flooded over-floor and water deeper on all roads
4 buildings flooded over-floor and town about to be isolated
1 buildings flooded over-floor and Dunolly - Avoca Road only main access road not flooded
0 buildings flooded over-floor and flooding through town streets is more extensive
0 buildings flooded over-floor,shallow flooding through parts of town and Burnt Creek causeway closed
3rd peak in Jan2011: ~84mm in ~12 hours
use 100-year map
use 50-year map
use 20-year map
use 10-year map
use 5-year map
Sept2010: ~67mm in ~14 hours
2nd peak in Jan2011: ~72mm in ~36 hours
Flooding in Dunolly unlikely
Use average of Archdale Junction, Norwood, Bet Bet & Laanecoorie rainfall to determine indicated likelihood and severity of flooding in and around Dunolly.
CAUTION - this tool will tend to over-estimate the likelihood of flooding if the catchment is dry and / or rain extends over more than 24 hours.
Flooding from the 3rd burst of rainfall in January 2011 was similar to 1% AEP flood extents and depths: wet catchment, 50yr rainfall, step up one level to 100yr flood map and consequences.
Approx timings in vicinity of Dunolly from start of heavy rain:
a) 3.5 hours to start of rise.
b) 9.5 to 10.5 hours to peak.
In this zone
Likelihood of localised flooding only. Creek flooding unlikely although levels may rise and then drop away.
Cumulative rainfall (mm)
20
40
60
80
100
120
140
Time from start of rain (hours)
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
September 2010 rainfall
January 2011 rainfall
5-year ARI
10-year ARI
20-year ARI
50-year ARI
100-year ARI
20% AEP
10% AEP
5% AEP
2% AEP
1% AEP

Appendix C3 – DRAFT Maryborough community flood emergency plan

Please note: The following information in this Appendix is based on the draft Maryborough Flood Study (November 2022). The data has not yet been accepted by Central Goldfields Shire Council or North Central CMA and therefore is subject to change.

1. Overview

Maryborough is a large rural township (around 8000 residents) approximately 60km north from Ballarat and 180km northwest from Melbourne and less than 58km south west of Bendigo. It is within the Four Mile Creek catchment.

Four Mile Creek is the primary waterway in Maryborough traversing the township from south to north. It has a catchment area encompassing Maryborough of around 34km^2 and rises to the southwest of town near on the southern slopes of Maryborough Regional Park and includes the eastern slopes of the Paddys Ranges State Park.

Centenary Reservoir, a former water supply reservoir now managed by Goldfields Shire, is located 3km south of Maryborough, east of Ballarat-Maryborough Road. Centenary Reservoir feeds into Goldfields Reservoir 1km north-west of centenary reservoir and are the only appreciable dams in the Four Mile Creek catchment and is fed by contour channels and pipes (rather than a watercourse) that diverts flow from Tullaroop Reservoir. With a capacity of only 180 and 150 ML, the Centenary Reservoir and Goldfields reservoir respectively has negligible impact on the extent and timing of flood peaks at Maryborough. On the other hand, a dam break from Goldfields reservoir is considered likely to have some impact on flooding in Maryborough but, as at the date of this MFEP, the extent of that impact has not been assessed.

There are no stream gauges in the Four Mile creek catchment.

The Four Mile Creek catchment upstream of Maryborough is quite steep with high loss / infiltration rates. Floods therefore usually only occur following very heavy rainfall or after heavy rain on a wet catchment when the natural floodplain storage has been filled.

The results of the design modelling show that flooding within the township has a critical duration of 1 -1.5 hours, where the predominant influence is stormwater flooding, and downstream of the township the critical duration increases to 6 hours, where the predominant influence is riverine flooding. Further, the 1% AEP event design flows are typically much greater than those estimated for the 2011 and 1999 events.

Although flood peaks in Maryborough will generally occur within 1 to 2 hours of the most intense rainfall, the underlying risk of flooding is also strongly linked to catchment wetness. Catchment wetness will be influenced by rain that has already fallen during an event ahead of the most intense rain burst as well as seasonal conditions. For example, the January 2011 flood occurred during La Nina conditions and, although the December 2010 rainfall was “above average”, the previous 3 months were the “highest on record for the upper Loddon River catchment, where Maryborough is located.

2. Flood behaviour

Maryborough township is located in the upper catchment and runoff typically travels from south to north. The main waterway is Four Mile Creek and this waterway has a number of formalised and informal tributaries, which feed into the main channel from both the east and the west of the catchment.

Within the township, there are two major bluestone lined channels that are approximately 5.5m wide by 1.5m deep. Typically, the flooding is contained within the two channels, however there are a number of locations that the channel overtops. In addition, the township experiences shallow sheet flows in some locations due to local rainfall.

A detailed description of the 1% AEP design flood behaviour, extracted from the Maryborough Flood Study, is provided below. Details of flood behaviour in other design events are provided in the Flood Intelligence Card – refer Section 16.

1% AEP flood behaviour

Modelling of the 1% AEP design flood event found that the critical duration is predominantly 2 Hours throughout the catchment. In the upper part of the township, around Majorca Road and at the areas between Railway Street and Loch Street, the critical duration tends towards 45 minutes. In addition, some of the catchment storages display alternative durations, however the 2-hour duration is clearly the catchment-wide critical duration for the 1% AEP event.

At the top of the catchment, south of the township, flow travels through forested areas to Centenary Dam and Goldfields Reservoir. In the 1% AEP design event, Goldfields Reservoir overtops the spillway, flowing down the spillway where it breaks out and ponds behind Derby Road to over 1m depth, but flows do not overtop Derby Road. The reservoir was assumed to be at spillway level at the start of the event for design modelling which is a typical conservative modelling approach. Derby Road is overtopped to a maximum depth of 175mm by flows from a catchment to the south west that travels towards the reservoir.

Upstream of Churchill Road, west of Derby Road, flow is generally contained within the creek, however there are approximately 3-5 residences that experience flooding greater than 100mm depth, either side of the creek, i.e. on Derby Road and Brown Street

Further downstream, Redpath tyre and battery service is flooded to a depth of approximately 165mm and the Mitsubishi Dealer is flooded to a depth of over 365mm. These results are in-line with the additional targeted community consultation.

Numbers 2-8 Derby Street may experience flooding of depths up to 200mm due to the creek breaking its banks in a 1% AEP storm event.

On the east side of the catchment, a number of commercial and residential properties are flooded near Nelson Street (upstream and downstream) and then again between Loch Street and Railway Street where flow is breaking out from the channel. Flooding on Gillies Street at this location is up to 350mm deep on the road crown and up to 600mm in the kerb and channel. Number 3 Roger Street may experience flooding of over 600mm in a 1% AEP event due to Four Mile Creek breaking its banks and numbers 21 and 23 Gillies Street and number 154 – 158 Railway Street may also experience significant flooding greater than 350mm depth.

Flows may overtop Inkerman Street to a depth of approximately 200mm.

Around the Council offices, flow overtops the channel and pools in the car park to a depth of approximately 750 – 800mm with some flows potentially entering the Council offices.

Parts of Burns Street may experience flood depths of over 350mm and there is some flooding around the Kmart site.

The depth of flooding under the Sutton Road Rail overpass is over 1.5m and there are a number of properties that are flooded in the block between Sutton Road and Sutton Lane adjacent to Fraser Street and in the rear of properties near the Napier Street Children's Playground.

In the 1% AEP event, there are a number of properties that are impacted between Kennedy Lane and Gillies Street to depths of approximately 250mm.

The flow under the railway line culvert at the corner of Golden Wattle Drive and Fraser Street causes backwatering, impacting two properties on Golden Wattle Drive, before travelling north through Goldfields Landscaping and across Burns Street flooding two residences on the corner of Burns Street and Christian Street and a number of residences along both sides of Christian Street as flood waters are not contained within the road reserve. Flood waters crosses residential properties from south-east to north west through Christian Street to Napier Street and water also travels west along Christian Street and North along Napier Street where Napier Street floods to a depth of approximately 250 - 300mm. Flow travels north west

through the Woolworth parking lot, which floods to a depth of approximately 150mm. Flow returns to the main Four Mile Creek channel at the corner of Napier Street and Lake Road.

At the corner of Alma Street and Tuaggra Street there is ponding to a depth of approximately 200 - 250mm and flows from the corner of Alma and Tuaggra Streets may continue to flow towards the Sushi Shop at the corner of High Street, potentially causing flooding of up to 100mm depth.

A number of residences adjacent to the Salvation Army headquarters on Wills Street experience flooding to a depth of approximately 200 - 250mm, but the headquarters itself is unlikely to experience above-floor flooding from the 1% AEP event.

Parts of the Havilah Hostel site may be flooded to approximately 100mm depth, which may make roads unpassable and there is ponding within the carpark on Harkness Street that is over 1m deep where flows break away from the channel.

There are residences likely to be flooded in the Holyrood Street / Gladstone Street vicinity, some greater than 500mm depth.

Much of the Golf Course experiences shallow sheet overland flows and the drain adjacent to Park Road fills and overtops Park Road.

The residential areas adjacent to the golf course, from Tullaroop Road to Dooleys Road are likely to experience significant flooding with depths over 500 – 600mm in parts.

Flooding within Whirrakee Rise is predominantly contained within the road reserves, although there are noticeably greater depths adjacent to the central detention basin at the junction of Quinn Street and Whirrakee Drive. With depths of over 500mm, this may make this junction unpassable. At the Sonac Blood Processing Facility flow is mainly contained within the driveway and hardstand areas, but to a depth of approximately 300.

The flooding at Tullaroop Road is impacting the industrial facility and Tullaroop Road to depths of up to 300mm and Tullaroop Road is overtopping but only to very shallow depths.

Between Tullaroop Road and Simson Road, the creek breaks its banks significantly, however there are no residential properties impacted.

Flood waters break out of the channel at Simson Road and the floodplain at this location is likely to be approximately 400 - 450m wide – covering the north-western portion to the railway line.

2.1 Historical events

December 1999

The December 1999 flood event resulted from heavy rain falling over a 3-day period consisting of approximately 2 rainfall bursts. 99.2mm fell in Maryborough the 27th of December, which was the highest on record daily rainfall for any December with an AEP between 2% and 1%. This followed a month of “average” rainfall, so conditions were not as saturated as for the 2011 event.

January 2011

During the January 2011 flood Maryborough recorded 90.4mm in the 24 hours to 9am Friday 14th, which was the highest January daily total since the station opened in 1878. This 24-hour total has an annual exceedance probability (AEP) between 5% and 2%. For the whole event a total of 229mm fell from the 10th to 16th January, and this came after “above average” monthly rainfall in December.

3. Overview of flooding consequences

3.1 Warning times

The Four Mile Creek catchment responds very quickly to rain if the catchment is wet or rain is very heavy. Thus, the flood warning time for Maryborough is short due its small size: of order 2 hours or less for the creek to peak.

3.2 Areas affected

Maps at Appendix H provide guidance on where flooding is likely to occur within Maryborough for flood events ranging from the 20% AEP event up to the 0.5% event. Flooding to the extent and depths shown for each event may not occur simultaneously as the maps display the outer envelope of expected flooding.

3.3 Roads affected

The main access roads for Maryborough except Park Road, Ballarat-Maryborough Road and a number of streets inside the main township are not affected by flooding. Roads are not inundated for extended periods (generally less than 24 hours even in big floods).

3.4 Properties affected

A summary of the number of properties likely to be flooded and the number likely to be inundated over-floor is provided in Section 7.2 of this Appendix. No buildings in Maryborough were reported flooded over-floor during the January 2011 or 1999 event.

3.4.1 Detailed list

A list of properties likely to be flooded for a range of floods along with the expected depth of over-ground flooding and the likely depth of over-floor inundation is provided in Section 7.3 of this Appendix. Properties within 100mm of over-floor flooding are also identified.

It is strongly recommended that the list is used in conjunction with the flood inundation maps (Appendix H) and the indicative flood guidance tool provided in Section 7.4.

3.4.2 Update of list of properties likely to be flooded

The list of properties likely to be flooded (with corresponding levels and indication of over-floor flood depth) should be updated within twelve (12) weeks of a flood. Update should occur with information collected as part of post-flood information recording activities and may be collected as a consequence of the event debrief. Information on the collective experience of the IMT should also be gathered and utilised.

3.5 Isolation

The main access roads for Maryborough (Ballarat-Maryborough Road, Park Road and Pyrenees Highway) are affected by flooding. Pyrenees Highway, Ballarat-Maryborough and Road Majora Road are not wetted at the 2% AEP event. Most road inundations occur onwards from the 1% AEPs. While these roads do not remain inundated for an extended period (i.e. generally less than 24 hours even in big floods), road surfaces can be damaged which extends the period of isolation.

Maryborough-Ballarat railway lines are not overtopped by floods up to at least the 1% AEP event. However, floodwater does pond on their upstream sides, and it is possible that ballast may be shifted or washed out.

3.6 Essential infrastructure

There is some essential infrastructure such as fire stations and community centres affected by flooding at Maryborough other than main access roads and the Pre-School.

4. Flood mitigation

Flood intelligence MUST have regard for changes within the catchment that modify likely flood behaviour (e.g. mitigation works that reduce the severity of flood risk).

4.1 Flood protection levees

There are no formal flood mitigation works in place at Maryborough although the railway line and roads do act to some extent as a barrier.

4.2 Drainage works

There is a proposed drainage upgrade to be constructed between Wills Street and Dundas Road. The proposed drainage improvements did not form part of the 'existing conditions' design modelling for the Maryborough Flood Study as they had not been constructed at the time of writing. However the upgrade was modelled for the 1% AEP 2-hour duration event as part of the project and the assessment results have been provided to Council in a separate memo. The results indicated that the works would cause a local reduction in peak flood levels adjacent to the new drainage line, with several properties being subject to shallower peak flood depths. However, the total number of properties flooded above floor level in the 1% AEP event is not reduced.

5. Flood impacts and required actions

Refer to the following Flood Intelligence Card.

Note that users of the flood intelligence card should consider rainfall depth and rates at locations in the vicinity of Maryborough and across the upper catchment (if available) and use the indicative tool at Section 7.4 to better appreciate the likely severity of flooding and its impacts in the town. Local data and/or data from the BOM (http://www.bom.gov.au/) should be used. It is suggested that the following sites, available from the BOM website, will provide useful indicative rainfall data:

- Maryborough (site number 088043)
- Tullaroop Reservoir (site number 088052)
- Talbot (Post Office) (site number 088056).

6. Stream gauge information

There are no water level or flood gauges within the Four Mile Creek catchment.

7. Flood intelligence card, property inundation list and flood / no flood guidance tool

BOM does not currently provide flood forecasts for Four Mile Creek or for Maryborough. All actions must therefore be driven by rainfall and/or river level observations.

BOM collects and records rainfall at several locations within or close to the Four Mile Creek catchment. Data from a number of these sites are available from the BoM website at intervals ranging from around 3 hours to daily. Daily-read rainfall data is available for a number of sites in the general vicinity of the Four Mile Creek catchment at Maryborough. Rainfall data is also available at around 3-hourly intervals during heavy rain events from the rain gauge at the Talbot and from Avoca.

Notes:

- While flood intelligence cards provide guidance on the relationship between flood magnitude and flood consequences, flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, will have identical impacts. Further, the hydrologic and hydraulic modelling that underpins much of the intel detailed below is informed by a number of assumptions and approximations that are unlikely to be replicated exactly during a flood event. Actual impacts under similar rainfall conditions are therefore expected to be similar but may not be exactly the same: there are likely to be some differences.
- All levels, impacts and actions listed in the following flood intelligence card and graph may need to be adjusted to better reflect experience.

7.1 Flood intelligence card

Observed Rainfall (see graph)	AEP	Consequence / Impact	Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.			
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.			
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.			
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table			
26.1mm in 2 hours 37.4mm in 6 hours 47.6mm in 12 hours 60.3mm in 24 hours	20% AEP	• Several isolated areas of inundation located upstream of township at location of low elevations in rural areas. • Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas. • Overland flows generally contained within drainage assets throughout the Maryborough township. • Above floor flooding to 7 properties, and water is flowing across a further 58 properties. • Key roadways inundated: ○ Dooleys Road ○ Ormond Avenue ○ Quinn Street ○ Sutton Road	○ Monitor rainfall and water levels. ○ Use the indicative flood / no flood tool to develop an appreciation of the likely scale of the flood event. ○ Refer to indicated maps and impacts. ○ Implement appropriate response actions. This may include organising necessary resources and / or evacuations, sandbagging at key locations, the removal of furniture etc from buildings likely to be flooded over-floor and / or sandbagging buildings.
31.9mm in 2 hours 44.8mm in 6 hours 56.6mm in 12 hours 71.6mm in 24 hours	10% AEP	• Several isolated areas of inundation located upstream of township at location of low elevations in rural areas. • Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas. • Overland flows generally contained within drainage assets throughout the Maryborough township. • Above floor flooding to 13 properties, and water is flowing across a further 83 properties. • Key roadways inundated: ○ Dooleys Road ○ Ormond Avenue ○ Quinn Street ○ Sutton Road	○ Continue to monitor rainfall and water levels. ○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ○ Refer to indicated maps and impacts. ○ Implement appropriate response actions and secure necessary resourcing. Deploy “water over road” and other signs.

Observed Rainfall (see graph)	AEP	Consequence / Impact		Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				

38.1mm in 2 hours
52.5mm in 6 hours
65.7mm 12 hours
83.0mm in 24 hours
	5% AEP	• Several flow paths forming upstream of the golf course, converging at the intersection of Ormond Avenue and Park Road creating localised flooding of the residential development at this location.
		• Overland flows ponding at low point located at corner of Gilles Street and Roger Street inundating several properties.
		• Drainage channel crossing railway corridor adjacent to Golden Wattle Drive discharging to downstream industrial property causing inundation of properties.
		• Several isolated areas of inundation located upstream of township at location of low elevations in rural areas.
			• Inundation at residential dwellings adjacent to Park Road
			• Inundation downstream of Golden Wattle Drive drain
			• Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas.
			• Above floor flooding to 31 properties, and water is flowing across a further 107 properties.
			• Key roadways inundated:
			  ○ Burns Street
			  ○ Dooleys Road
			  ○ North Street
			  ○ Ormond Avenue
			  ○ Quinn Street
			  ○ Sutton Road
			  ○ Gilles Street
			  ○ Rogers Street
				○ Continue to monitor rainfall and water levels.
				○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event.
				○ Refer to indicated maps and impacts.
				○ Implement appropriate response actions and secure necessary resourcing. Deploy “water over road”, “road closed” and other signs.

47mm in 2 hours 63.2mm in 6 hours 78mm 12 hours 98.1mm in 24 hours	2% AEP	• Further inundation at the intersection of Ormond Avenue and Park Road due to breaching upstream of the channel crossing the rail corridor south of Alexandra Avenue. Overland flows	• Inundation at residential dwellings adjacent to Park Road • Inundation downstream of Golden Wattle Drive drain	○ Continue to monitor rainfall and water levels. ○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ○ Refer to indicated maps and impacts.

Observed Rainfall (see graph)	AEP	Consequence / Impact		Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
		at this location flow North contributing to increased flood extents and causing inundation of residential properties between Alexander Street and North Street. • Further inundation of residential properties bounded by Gilles Street, Rogers Street and Railway Street due to a topographical low point at this location. • Inundation of properties on western side of Burns Street in addition to industrial property located downstream of Golden Wattle Drive drain due to increased flow rates. • Several isolated areas of inundation located upstream of township at location of low elevations in rural areas.	• Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas. • Above floor flooding to 58 properties, and water is flowing across a further 165 properties. • Key roadways inundated: ○ Alexander Avenue ○ Burns Street ○ Dooleys Road ○ Forest View Drive ○ Gilles Street ○ Golden Wattle Drive ○ North Street ○ Ormond Avenue ○ Quinn Street ○ Railway Street ○ Sutton Road ○ Rogers Street	○ Implement appropriate response actions and as appropriate deploy “water over road”, “road closed” and other signs.
54.6mm in 2 hours 72.0mm in 6 hours 87.8mm 12 hours 110mm in 24 hours	1% AEP	• Inundation at residential dwellings adjacent to Park Road • A significant number of residential properties located on the eastern side of Park Street between Alexander	• Inundation downstream of Golden Wattle Drive drain • Inundation increased downstream of Railway Street from Gilles Street.	○ Continue to monitor rainfall and water levels. ○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ○ Refer to indicated maps and impacts. ○ Continue to implement appropriate response actions.

Observed Rainfall (see graph)	AEP	Consequence / Impact	Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.			
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.			
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.			
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table			
		Avenue and Dooley Road are further inundated due to breaching of Four Mile Creek, south of Alexander Avenue. • Inundation of properties on the western side of Burns Street in addition to industrial property located downstream of Golden Wattle Drive drain due to increased flow rates. • Slight increase to flood extent between Burns Street and Golden Wattle Drive drain. • Overtopping of the detention basin on the corner of Whirakee Drive and Quinn Street resulting in localised inundation of the Whirakee Rise Estate, predominantly contained to the road network. • Isolated properties inundated at 46 Alma Street, 115 Clarendon Street, three properties bounded by Holyrood Street, Gertrude Street and Franklin Street, several properties located between Dundas Road and Clarendon Street as well as the Central • Several isolated areas of inundation located upstream of township at location of low elevations in rural areas. • Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas. • Above floor flooding to 79 properties, and water is flowing across a further 178 properties. • Key roadways inundated: ○ Alexander Avenue ○ Burns Street ○ Dooleys Road ○ Forest View Drive ○ Gilles Street ○ Golden Wattle Drive ○ Napier Street ○ North Street ○ Ormond Avenue ○ Park Road ○ Quinn Street ○ Railway Street ○ Sutton Road ○ Derby Road	

Observed Rainfall (see graph)	AEP	Consequence / Impact	Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.			
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.			
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.			
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table			
		Goldfields Shire Council building on Nolan Street.	

54.6mm in 2 hours
79.3mm in 6 hours
88.6mm 12 hours
121mm in 24 hours
	0.5% AEP	• Inundation at residential dwellings adjacent to Park Road
		• A significant number of residential properties located on the eastern side of Park Street between Alexander Avenue and Dooley Road are further inundated.
		• Additionally Flooding along Dundas Road between Harrison Street and Palmerson Street.
		• Inundation increased downstream of Railway Street from Gilles Street.
		• Inundation of properties on the western side of Burns Street in addition to industrial property located downstream of Golden Wattle Drive drain due to increased flow rates.
		• Slight increase to flood extent between Burns Street and Golden Wattle Drive drain.
		• Inundation downstream of Golden Wattle Drive drain
		• Several isolated areas of inundation located upstream of township at location of low elevations in rural areas.
		• Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas
		• Single dwelling inundated along Alma Street due to overtopping of 4 mile-creek between Kars Street and Inkerman Street.
		• Above floor flooding to 94 properties, and water is flowing across a further 276 properties.
		• Key roadways inundated:
		  ○ Alexander Avenue
		  ○ Alma Street
		  ○ Burns Street
		  ○ Dooleys Road
			○ Continue to monitor rainfall and water levels.
			○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event.
			○ Refer to indicated maps and impacts.
			○ Continue to implement appropriate response actions.

Observed Rainfall (see graph)	AEP	Consequence / Impact		Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
		• Overtopping of the detention basin on the corner of Whirakee Drive and Quinn Street resulting in localised inundation of the Whirakee Rise Estate, predominantly contained to the road network. • Isolated properties inundated at 46 Alma Street, 115 Clarendon Street, three properties bounded by Holyrood Street, Gertrude Street and Franklin Street, several properties located between Dundas Road and Clarendon Street as well as the Central Goldfields Shire Council building on Nolan Street.	○ Dundas Road ○ Forest View Drive ○ Gilles Street ○ Golden Wattle Drive ○ Loch Street ○ Napier Street ○ North Street ○ Ormond Avenue ○ Park Road ○ Quinn Street ○ Railway Street ○ Sutton Road	
68.4mm in 2 hours 89.6mm in 6 hours 109mm 12 hours 137mm in 24 hours	0.2% AEP	• A significant number of residential properties located on the eastern side of Park Street between Alexander Avenue and Dooley Road are further inundated. • Additionally Flooding along Dundas Road between Harrison Street and Palmerson Street. • Inundation increased downstream of Railway Street from Gilles Street.	• Large scale breakout of Four Mile Creek downstream of the township adjacent to Dooleys Road, inundating surrounding rural areas • Single dwelling inundated along Alma Street due to overtopping of 4 mile-creek between Kars Street and Inkerman Street • Residential building inundated on Layton Road	○ Continue to monitor rainfall and water levels. ○ Maintain plot on indicative flood / no flood tool in order to further develop appreciation of likely scale of flood event. ○ Refer to indicated maps and impacts. ○ Continue to implement appropriate response actions.

Observed Rainfall (see graph)	AEP	Consequence / Impact		Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.				
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.				
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.				
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table				
		• Inundation of properties on the western side of Burns Street in addition to industrial property located downstream of Golden Wattle Drive drain due to increased flow rates. • Slight increase to flood extent between Burns Street and Golden Wattle Drive drain. • Overtopping of the detention basin on the corner of Whirakee Drive and Quinn Street resulting in localised inundation of the Whirakee Rise Estate, predominantly contained to the road network. • Isolated properties inundated at 46 Alma Street, 115 Clarendon Street, three properties bounded by Holyrood Street, Gertrude Street and Franklin Street, several properties located between Dundas Road and Clarendon Street as well as the Central Goldfields Shire Council building on Nolan Street. • Several isolated areas of inundation located upstream of township at	• Residential building inundated on Franklin Street. • Key roadways inundated: ○ Alexander Avenue ○ Alma Street ○ Burns Street ○ Derby Road ○ Dooleys Road ○ Dundas Road ○ Forest View Drive ○ Franklin Street ○ Gilles Street ○ Golden Wattle Drive ○ Layton Road ○ Loch Street ○ Napier Street ○ Nolan Street ○ North Street ○ Ormond Avenue ○ Park Road ○ Quinn Street ○ Railway Street ○ Rogers Street ○ Sutton Road ○ Tuaggra Street	

Observed Rainfall (see graph)	AEP	Consequence / Impact	Action Actions may include (but not limited to) evacuation, road closures, sandbagging and community warnings
USING THIS INTELLIGENCE CARD. Obtain rainfall data and use the indicative flood guidance tool to determine the approximate flood severity. Consider the appropriate flood inundation map. Review all consequences and actions in this table, from the first row down to the approximate expected severity of flooding. Initiate all actions in a logical sequence. Note that some actions may need to be initiated in an order that is different from their relative placement in this table.			
If response has been initiated locally, the first action should be a call to VICSES, followed by a call to the MERC and MERO at Central Goldfields Shire. Note time available – see below.			
It is important that the decision to Evacuate is made early based on available intelligence and local knowledge.			
Due to existing flow paths, water will flow across a number of properties but not up against the side of the building – these are indicated with blue shading in the following property table			
		location of low elevations in rural areas.	

7.2 Summary of properties flooded

The design flood extents used to identify the flooded properties listed below were filtered to remove flood depths < 50mm.

Summary of number of flood affected properties in Maryborough (WMS, 2022) (Existing conditions)						
	Design Flood AEP (%)					
	20%	10%	5%	2%	1%	0.5%
Level at reference gauge						
Number of properties flooded above floor	7	13	31	58	79	94
Number of properties flooded below floor against building only						
Number of properties flooded but water not against building						
Total number of flooded properties	65	96	138	223	257	276

7.3 Detailed list of properties flooded

Maryborough (WMS Engineering, 2022) (Existing conditions) *It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card for Maryborough*													
LEGEND		Flood waters affect the property but not up against the building – may be quite deep if in a flow path											
		Within ~100mm of flooding over-floor						Depth of over-floor flooding					
Location	**Depth of flooding near building for each AEP**						**Depth of over-floor flooding at property for each AEP**						**Comments**
(Number & Street)	**20%**	**10%**	**5%**	**2%**	**1%**	**0.50%**	**20%**	**10%**	**5%**	**2%**	**1%**	**0.50%**	
1 ALEXANDER AVENUE			0.294	0.510	0.545	0.566			0.144	0.352	0.385	0.405	DWELLING
1 NAPIER STREET				0.164	0.216	0.244							DWELLING
1 NAPIER STREET				0.164	0.216	0.244							DWELLING
1 ORMOND AVENUE	0.298	0.409	0.479	0.657	0.718	0.755					0.018	0.054	DWELLING
1 ROWLES DRIVE				0.024	0.034	0.044							DWELLING
1/10 CHRISTIAN STREET	0.146	0.174	0.198	0.219	0.235	0.246	0.087	0.114	0.136	0.156	0.171	0.181	UNIT
1/22 HOLYROOD STREET				0.146	0.185	0.214							UNIT
1/294 GLADSTONE STREET				0.127	0.139	0.148							UNIT
1/296 GLADSTONE STREET	0.089	0.100	0.116	0.134	0.144	0.151							UNIT
1/4 HARKNESS STREET					0.109	0.122							UNIT
1/4 ORMOND AVENUE			0.220	0.436	0.483	0.513			0.096	0.309	0.356	0.386	UNIT
1/5 EARL STREET				0.116	0.154	0.182							UNIT
1/8 CHRISTIAN STREET	0.056	0.077	0.095	0.113	0.128	0.138							UNIT
1/8 MCKEAN STREET	0.090	0.103	0.115	0.126	0.134	0.141							UNIT
10 BARR STREET	0.104	0.188	0.247	0.296	0.328	0.352							DWELLING
10 BROUGHAM STREET					0.040	0.045							DWELLING
10 BROWN STREET				0.124	0.136	0.144							DWELLING
10 HUBBLE STREET		0.004	0.012	0.023	0.034	0.040							DWELLING
100 GRIFFITHS STREET				0.162	0.267	0.336							DWELLING
103 PARK ROAD					0.088	0.097							DWELLING
11 CARRICK STREET			0.132	0.144	0.153	0.161							DWELLING
11 GEARING STREET	0.132	0.244	0.324	0.399	0.450	0.488							DWELLING
11 HARKNESS STREET (HAVILAH HOSTEL)					0.063	0.084							AGED CARE FACILITY

11 HARKNESS STREET (HAVILAH HOSTEL)		0.087	0.121	0.161	0.179	0.192							AGED CARE FACILITY
11 HARKNESS STREET (HAVILAH HOSTEL)									0.026	0.066	0.084	0.098	AGED CARE FACILITY
11 MARSHALL STREET													DWELLING
11 SUTTON ROAD		0.148	0.173	0.193	0.211	0.224							DWELLING
110 GILLIES STREET	0.190	0.220	0.250	0.285	0.304	0.319							DWELLING
112 GILLIES STREET MARYBROUGH 3465		0.147	0.159	0.173	0.187	0.195							DWELLING
112 GOLDEN WATTLE DRIVE		0.091	0.112	0.136	0.153	0.168							DWELLING
113 PARK ROAD				0.062	0.085	0.091							DWELLING
114 GOLDEN WATTLE DRIVE	0.160	0.191	0.226	0.253	0.271	0.288							DWELLING
115 CLARENDON STREET													DWELLING
117 PARK ROAD													DWELLING
119 PARK ROAD				0.132	0.154	0.169							DWELLING
12 BACKWAY COURT	0.187	0.204	0.226	0.269	0.299	0.318							DWELLING
12 BARR STREET		0.124	0.171	0.213	0.239	0.256							DWELLING
12 GEARING STREET					0.079	0.096							DWELLING
12 GOLDEN WATTLE DRIVE								0.025	0.049	0.077	0.092	0.103	DWELLING
12 NOLAN STREET				0.134	0.301	0.375				0.095	0.262	0.335	HALL
12 NOLAN STREET - COUNCIL OFFICES	0.114	0.114	0.114	0.114	0.447	0.525							OFFICE BUILDING
12 RAGLAN STREET			0.082	0.098	0.102	0.106							DWELLING
122 HIGH STREET													SHOP
122 PARK ROAD				0.026	0.129	0.173							DWELLING
124 HIGH STREET													SHOP
124 PARK ROAD				0.126	0.222	0.266							DWELLING
126 PARK ROAD				0.079	0.170	0.211							DWELLING
128 PARK ROAD					0.088	0.121					0.088	0.121	DWELLING
13 MARSHALL STREET			0.015	0.034	0.047	0.062							DWELLING
131 GILLIES STREET		0.114	0.133	0.155	0.171	0.182			0.030	0.069	0.093	0.108	DWELLING
132 PARK ROAD				0.101	0.183	0.218							DWELLING
137 DOOLEYS ROAD				0.098	0.116	0.126							DWELLING
14 BACKWAY COURT	0.147	0.162	0.181	0.220	0.248	0.265					0.001	0.017	DWELLING
14 BARR STREET					0.043	0.057							DWELLING
14 CHRISTIAN STREET									0.036	0.064	0.084	0.098	BUILDING

14 GEARING STREET				0.100	0.118	0.129							DWELLING
14 NOLAN STREET - RECREATION CENTRE					0.296	0.375							TILT PANEL BUILDING
14 SUTTON ROAD			0.098	0.121	0.143	0.163							DWELLING
140 PARK ROAD			0.164	0.230	0.286	0.318							DWELLING
142 PARK ROAD						0.167							DWELLING
146 PARK ROAD				0.106	0.137	0.155							DWELLING
148 PARK ROAD				0.165	0.181	0.193				0.079	0.101	0.114	DWELLING
15 ANIMAL HAVEN ROAD					0.015	0.028					0.015	0.028	DWELLING
15 MARSHALL STREET				0.061	0.070	0.081							DWELLING
15 NAPIER STREET				0.240	0.358	0.420							DWELLING
150 PARK ROAD				0.133	0.201	0.245					0.015	0.055	DWELLING
15-17 FULLER STREET												0.018	DWELLING
152 PARK ROAD	0.200	0.308	0.379	0.560	0.621	0.659	0.066	0.173	0.245	0.427	0.488	0.526	DWELLING
154 PARK ROAD			0.326	0.485	0.550	0.592		0.183	0.244	0.402	0.456	0.491	DWELLING
154 RAILWAY STREET				0.100	0.235	0.275					0.081	0.126	DWELLING
156 RAILWAY STREET	0.065	0.088	0.112	0.221	0.340	0.377							DWELLING
158 PARK ROAD				0.554	0.602	0.634				0.116	0.166	0.197	DWELLING
158 RAILWAY STREET		0.108	0.128	0.225	0.328	0.362						0.017	DWELLING
16 CHRISTIAN STREET	0.057	0.063	0.067	0.081	0.102	0.131							SCOUT HALL
16 GEARING STREET	0.086	0.110	0.144	0.187	0.218	0.239							DWELLING
16 HOLYROOD STREET					0.042	0.086	0.069	0.076	0.089	0.101	0.113	0.143	DWELLING
16 SUTTON ROAD	0.221	0.248	0.284	0.317	0.346	0.372							DWELLING
160 PARK ROAD													DWELLING
160 RAILWAY STREET				0.018	0.084	0.112							DWELLING
162 PARK ROAD				0.315	0.374	0.420				0.290	0.339	0.380	DWELLING
162 RAILWAY STREET			0.101	0.199	0.295	0.328						0.024	DWELLING
164 PARK ROAD		0.186	0.221	0.320	0.367	0.407			0.141	0.237	0.283	0.321	DWELLING
166 PARK ROAD		0.176	0.207	0.290	0.336	0.374							DWELLING
167 RAILWAY STREET	0.135	0.198	0.259	0.416	0.507	0.555					0.080	0.130	SHOP
167 RAILWAY ST - MARYBOROUGH ENTERPISE CENTRE				0.183	0.270	0.316				0.091	0.182	0.229	WAREHOUSE
168 RAILWAY STREET					0.038	0.087							DWELLING
17 MARYBOROUGH-DUNOLLY ROAD				0.151	0.160	0.167				0.033	0.039	0.045	OFFICE & CB WAREHOUSE

1-7 MCCLURE STREET				0.177	0.294	0.357							OFFICE BUILDING (APIARIST)
17 NAPIER STREET					0.125	0.149							DWELLING
170 PARK ROAD			0.078	0.222	0.299	0.349				0.101	0.198	0.263	TYRE STORE
172 PARK ROAD			0.075	0.250	0.327	0.375				0.096	0.157	0.203	DWELLING
174 PARK ROAD		0.114	0.119	0.198	0.258	0.299						0.022	DWELLING
178 PARK ROAD						0.100				0.161	0.221	0.263	DWELLING
18 BARKLY STREET													DWELLING
18 ROGERS STREET	0.217	0.247	0.287	0.323	0.354	0.383							DWELLING
18 SUTTON ROAD				0.150	0.233	0.285							DWELLING
180 PARK ROAD				0.202	0.283	0.335							DWELLING
182 PARK ROAD				0.242	0.327	0.380							DWELLING
184 PARK ROAD			0.040	0.210	0.292	0.342							DWELLING
186 PARK ROAD	0.118	0.128	0.140	0.210	0.286	0.332							DWELLING
187 PARK ROAD		0.021	0.054	0.210	0.289	0.337							DWELLING
188 PARK ROAD			0.065	0.159	0.220	0.258							DWELLING
189 PARK ROAD				0.236	0.356	0.419							DWELLING
190 HIGH STREET		0.170	0.200	0.337	0.409	0.453							SHOP
192 HIGH STREET				0.095	0.154	0.192							SHOP
194 HIGH STREET				0.069	0.141	0.185							SHOP
195 PARK ROAD													DWELLING
196-198 HIGH STREET				0.165	0.236	0.278							SHOP
198 PARK ROAD					0.080	0.098							DWELLING
2 DERBY ROAD		0.022	0.149	0.282	0.390	0.450							DWELLING
2 GOLDEN WATTLE DRIVE	0.190	0.257	0.384	0.516	0.624	0.684							DWELLING
2 GOLDEN WATTLE DRIVE										0.027	0.135	0.196	DWELLING
2 HOPE STREET	0.156	0.177	0.198	0.223	0.240	0.253							DWELLING
2 LOWENSTEIN STREET	0.260	0.370	0.441	0.619	0.680	0.718				0.001	0.018	0.031	DWELLING
2 ORMOND AVENUE				0.089	0.165	0.223		0.181	0.260	0.454	0.513	0.549	DWELLING
2 ROGERS STREET				0.136	0.215	0.239							DWELLING
2 TULLAROOP ROAD		0.104	0.119	0.148	0.161	0.173							DWELLING
2 WHITTAKER STREET	0.118	0.142	0.162	0.180	0.194	0.204							DWELLING
2/10 CHRISTIAN STREET			0.262	0.294	0.305	0.313		0.021	0.043	0.061	0.075	0.085	UNIT

2/10 VIRTUE STREET										0.033	0.048	0.059	UNIT
2/169 PARK ROAD				0.093	0.151	0.192							DWELLING
2/176 PARK ROAD				0.130	0.150	0.171						0.022	UNIT
2/29 PALMERSTON STREET	0.157	0.166	0.178	0.196	0.206	0.213							DWELLING
2/294 GLADSTONE STREET	0.091	0.098	0.109	0.124	0.133	0.139							UNIT
2/296 GLADSTONE STREET						0.045							UNIT
2/4 HARKNESS STREET			0.089	0.308	0.350	0.377							UNIT
2/4 ORMOND AVENUE				0.101	0.145	0.173				0.169	0.210	0.237	UNIT
2\LP148869 PALMER ROAD				0.143	0.182	0.214							DWELLING
20 HOLYROOD STREET				0.013	0.032	0.051					0.047	0.082	DWELLING
20 MARSHALL STREET				0.014	0.027	0.038					0.005	0.026	DWELLING
20 PALMERSTON STREET					0.027	0.050							CORNER SHOP
20 ROGERS STREET				0.242	0.305	0.344							DWELLING
200 PARK ROAD		0.112	0.153	0.293	0.361	0.402				0.107	0.162	0.197	DWELLING
202 PARK ROAD	0.115	0.149	0.186	0.243	0.268	0.282							DWELLING
20-24 DERBY RD (A& G Leech Car Dealership)			0.146	0.286	0.355	0.401			0.193	0.242	0.268	0.283	CAR SHOWROOM
204 PARK ROAD			0.146	0.286	0.355	0.401							DWELLING
206 PARK ROAD		0.183	0.234	0.364	0.424	0.465							DWELLING
208 PARK ROAD						0.138				0.310	0.368	0.408	DWELLING
208 RAILWAY STREET													DWELLING
21 ELGIN ROAD				0.140	0.317	0.370							DWELLING
21 GILLIES STREET				0.134	0.247	0.306					0.075	0.129	DWELLING
21 NAPIER STREET						0.111							DWELLING
21 TULLAROOP ROAD (Crameri's Chafff Mill)			0.253	0.398	0.469	0.517						0.030	OFFICE & GI WAREHOUSE
210 PARK ROAD			0.247	0.404	0.490	0.539					0.057	0.102	DWELLING
212 PARK ROAD		0.236	0.297	0.466	0.559	0.608							DWELLING
214 PARK ROAD				0.393	0.466	0.515					0.003	0.053	DWELLING
216 PARK ROAD			0.285	0.432	0.491	0.529				0.060	0.128	0.176	DWELLING
218 PARK ROAD	0.132	0.138	0.149	0.161	0.170	0.180			0.030	0.175	0.231	0.269	DWELLING
22 MARINERS REEF ROAD													DWELLING
22 PALMERSTON STREET				0.075	0.116	0.133							DWELLING
22 ROGERS STREET				0.363	0.412	0.461							DWELLING

220 PARK ROAD			0.259	0.355	0.413	0.463						0.032	DWELLING
222 PARK ROAD			0.255	0.344	0.428	0.495						0.026	DWELLING
224 PARK ROAD						0.109					0.002	0.075	DWELLING
226 GLADSTONE STREET		0.223	0.272	0.372	0.464	0.530							DWELLING
226 PARK ROAD	0.216	0.257	0.306	0.395	0.479	0.538							DWELLING
228 PARK ROAD												0.028	DWELLING
23 ALBERT STREET				0.121	0.139	0.158			0.003	0.016	0.027	0.034	DWELLING
23 DUNDAS ROAD											0.001	0.022	DWELLING
23 FRANKLIN STREET (JARDINE CABINETS)				0.209	0.387	0.442							OFFICE & WORKSHOP
23 GILLIES STREET											0.012	0.066	DWELLING
23 MARYBOROUGH-DUNOLLY RD (HOOPERS STEEL)				0.159	0.270	0.326							OFFICE & CB WAREHOUSE
23 PARK ROAD				0.074	0.085	0.090							DWELLING
238 HIGH STREET				0.168	0.198	0.222							ACCOMODATION
24 MARSHALL STREET					0.114	0.129							DWELLING
242 HIGH STREET													DWELLING
24-26 TUAGGRA STREET			0.019	0.034	0.043	0.050						0.060	PETROL STATION
244 HIGH STREET				0.044	0.065	0.087							DWELLING
25 FRANKLIN STREET													DWELLING
25 MARYBOROUGH-DUNOLLY ROAD				0.148	0.262	0.318							DWELLING
25 NAPIER STREET										0.020	0.132	0.186	DWELLING
25 ROWLES DRIVE				0.204	0.230	0.248							DWELLING
2-6 ALEXANDER AVENUE				0.196	0.233	0.264			0.227	0.443	0.478	0.499	DWELLING
26 HOLYROOD STREET						0.009							DWELLING
26-28 DERBY RD (Redpath Tyre & Batteries)					0.133	0.138							WAREHOUSE
27 DUNDAS ROAD													DWELLING
27 FRANKLIN STREET				0.061	0.162	0.218							DWELLING
27 NAPIER STREET				0.271	0.319	0.359					0.036	0.089	DWELLING
28 HOLYROOD STREET	0.101	0.128	0.150	0.173	0.194	0.206							DWELLING
280 GLADSTONE STREET				0.122	0.157	0.179							DWELLING
281 MARYBOROUGH-DUNOLLY RD, HAVELOCK		0.182	0.202	0.227	0.251	0.264						0.009	WAREHOUSE
282-284 GLADSTONE STREET	0.140	0.171	0.198	0.225	0.246	0.259							DWELLING
286 GLADSTONE STREET	0.045	0.073	0.098	0.124	0.145	0.157							DWELLING

286A GLADSTONE STREET	0.032	0.047	0.061	0.076	0.089	0.096							DWELLING
286B GLADSTONE STREET							0.005	0.023	0.040	0.057	0.072	0.080	DWELLING
29 PEEL STREET			0.319	0.536	0.571	0.592							DWELLING
3 ALEXANDER AVENUE			0.127	0.146	0.163	0.178			0.174	0.381	0.414	0.434	DWELLING
3 BARR STREET													DWELLING
3 CAMILLE COURT													DWELLING
3 CAMPBELL STREET			0.087	0.120	0.161	0.184							DWELLING
3 LINTON DRIVE				0.174	0.234	0.265							DWELLING
3 NAPIER STREET	0.281	0.392	0.460	0.637	0.698	0.735							DWELLING
3 PALMERSTON STREET					0.138	0.201							DWELLING
3 ROGERS STREET					0.187	0.252					0.140	0.196	DWELLING
3 TULLAROOP ROAD						0.193							DWELLING
3/10 VIRTUE STREET						0.108							UNIT
3/112-114 PARK ROAD				0.073	0.129	0.169							UNIT
3/176 PARK ROAD			0.157	0.162	0.168	0.171						0.017	UNIT
3/22 ELGIN ROAD					0.094	0.119	0.179	0.198	0.217	0.230	0.244	0.252	UNIT
3/29 PALMERSTON STREET			0.171	0.409	0.450	0.475							DWELLING
3/4 ORMOND AVENUE									0.065	0.305	0.345	0.371	UNIT
3\LP148869 PALMER ROAD	0.046	0.054	0.062	0.077	0.116	0.197							DWELLING
30 ALMA STREET	0.109	0.118	0.128	0.146	0.155	0.162							DWELLING
30 BURNS STREET	0.165	0.178	0.188	0.200	0.206	0.210							DWELLING
306 GLADSTONE STREET	0.158	0.176	0.190	0.203	0.210	0.215							DWELLING
308 GLADSTONE STREET		0.110	0.132	0.161	0.177	0.193			0.014	0.023	0.028	0.032	DWELLING
31 WILLS STREET			0.062	0.092	0.114	0.134							KINDERGARTEN
315 GLADSTONE STREET				0.023	0.050	0.073							DWELLING
317 GLADSTONE STREET					0.093	0.169							DWELLING
32 ALMA STREET			0.118	0.141	0.153	0.163							DWELLING
320 GLADSTONE STREET		0.126	0.145	0.172	0.184	0.193							DWELLING
322 GLADSTONE STREET	0.201	0.256	0.297	0.357	0.387	0.413					0.002	0.013	DWELLING
33 WILLS STREET					0.073	0.135							DWELLING
34 ALMA STREET				0.102	0.173	0.219							DWELLING
34-36 TUAGGRA STREET (WOOLWORTHS)													SHOPPING CENTRE

35 DRIVE IN COURT			0.075	0.139	0.174	0.203							WAREHOUSE
35 WILLS STREET	0.086	0.100	0.116	0.146	0.166	0.182							DWELLING
35-37 MAJORCA ROAD			0.049	0.127	0.158	0.180							DWELLING
36 DODD LANE													DWELLING
36 NOLAN STREET				0.051	0.071	0.086							DWELLING
36 POOLE STREET						0.132							DWELLING
37 HOLYROOD STREET	0.178	0.222	0.272	0.334	0.370	0.394							DWELLING
37 SUTTON ROAD						0.112				0.015	0.049	0.072	DWELLING
38 ALMA STREET			0.120	0.146	0.158	0.168							DWELLING
4 CUTTLE CLOSE	0.071	0.078	0.085	0.092	0.094	0.096							DWELLING
4 HOLYROOD STREET				0.117	0.133	0.144							DWELLING
4 HOPE STREET		0.153	0.162	0.173	0.181	0.186							DWELLING
4 LUKE COURT													DWELLING
4 NEILL ST – Maryborough Medical Centre				0.154	0.225	0.273							OFFICE
4 NORTH STREET					0.056	0.066							DWELLING
4 WHITTAKER STREET				0.033	0.049	0.063							DWELLING
4 WILLS STREET					0.107	0.156							DWELLING
4/112-114 PARK ROAD				0.073	0.126	0.165					2.711	2.762	UNIT
4/176 PARK ROAD													UNIT
4/29 PALMERSTON STREET		0.086	0.261	0.481	0.524	0.551							DWELLING
4/4 ORMOND AVENUE				0.085	0.097	0.102			0.125	0.340	0.384	0.412	UNIT
4/8 MCKEAN STREET				0.060	0.066	0.073	0.012	0.025	0.038	0.058	0.067	0.074	UNIT
4\LP148869 PALMER ROAD			0.065	0.117	0.165	0.190							DWELLING
41 PARK ROAD						0.178							DWELLING
44 TULLAROOP ROAD					0.162	0.217							OFFICE & WAREHOUSE
45 KARS STREET	0.137	0.180	0.220	0.261	0.332	0.400							DWELLING
46 ALMA STREET												0.035	DWELLING
46 GILLIES STREET				0.037	0.111	0.161							LARGE SHED
465 Maryborough Dunolly Road				0.109	0.133	0.144							DWELLING
47 LAYTON ROAD					0.142	0.202							DWELLING
48 ALMA STREET					0.154	0.235							DWELLING
48 TUAGGRA STREET			0.260	0.494	0.532	0.554							PUBLIC TOILETS

5 ALEXANDER AVENUE	0.065	0.073	0.090	0.120	0.146	0.172			0.048	0.273	0.309	0.330	DWELLING
5 BARR STREET	0.207	0.247	0.285	0.337	0.371	0.397							DWELLING
5 CAMILLE COURT	0.202	0.213	0.230	0.252	0.263	0.272							DWELLING
5 LINTON DRIVE	0.103	0.115	0.129	0.170	0.196	0.222							DWELLING
5 MCCANN STREET				0.194	0.240	0.262							DWELLING
5 PALMERSTON STREET					0.261	0.304							DWELLING
5/22 ELGIN ROAD						0.155			0.136	0.149	0.161	0.169	UNIT
50 ALMA STREET					0.050	0.113							DWELLING
5-7 FULLER STREET		0.124	0.138	0.153	0.164	0.175							DWELLING
58 DUNDAS ROAD			0.069	0.079	0.084	0.088							DWELLING
6 DERBY ROAD	0.103	0.120	0.139	0.173	0.246	0.303							DWELLING
6 GOLDEN WATTLE DRIVE	0.185	0.210	0.234	0.250	0.271	0.284							DWELLING
6 LAKE ROAD - TENNIS CLUB						0.113							CLUBROOMS
6/112-114 PARK ROAD			0.193	0.234	0.251	0.258						0.028	UNIT
62 PARK ROAD MARYBROUGH 3465	0.157	0.173	0.185	0.202	0.215	0.232		0.005	0.044	0.085	0.102	0.109	DWELLING
62 RAGLAN STREET	0.102	0.115	0.125	0.151	0.170	0.187							DWELLING
67 Loch Street													OFFICE AND WAREHOUSE
68 PARK ROAD	0.095	0.124	0.150	0.180	0.200	0.219							DWELLING
69 DUNDAS ROAD			0.014	0.071	0.101	0.132							DWELLING
6A HARRISON STREET										0.011	0.041	0.072	DWELLING
6B HARRISON STREET				0.088	0.094	0.098							DWELLING
7 BARR STREET			0.036	0.073	0.104	0.124							DWELLING
7 BROWN STREET				0.232	0.259	0.282							DWELLING
7 CAMILLE COURT	0.106	0.128	0.148	0.177	0.193	0.209							DWELLING
7 MCCANN STREET				0.137	0.214	0.267				0.028	0.047	0.062	DWELLING
7 NAPIER STREET					0.132	0.185							DWELLING
7 ROGERS STREET					0.108	0.133							DWELLING
7/112-114 PARK ROAD		0.085	0.104	0.143	0.173	0.216							UNIT
70 NOLAN ST - MAIN BUILDING (PAINTRIGHT)		0.126	0.140	0.162	0.178	0.193				0.130	0.160	0.203	SHOP
71 DUNDAS ROAD	0.071	0.090	0.109	0.127	0.142	0.149							DWELLING
72-84 BURNS STREET (COUNCIL DEPOT)		0.112	0.128	0.145	0.154	0.164		0.014	0.033	0.052	0.068	0.076	OFFICE
73 HOLYROOD STREET				0.008	0.013	0.020							DWELLING

75 CLARENDON ST - MARYBORUGH HOSPITAL		0.056	0.063	0.081	0.087	0.093							HOSPITAL
77 DUNDAS ROAD													DWELLING
78 BARKLY STREET	0.152	0.182	0.208	0.231	0.251	0.258							DWELLING
7-9 JOHNSON STREET													WAREHOUSE
8 BARR STREET				0.169	0.206	0.235							DWELLING
8 CAMILLE COURT						0.091				0.030	0.064	0.090	DWELLING
8 DERBY ROAD				0.024	0.045	0.064							DWELLING
8 GOLDEN WATTLE DRIVE	0.141	0.163	0.184	0.198	0.213	0.222							DWELLING
8 HOPE STREET					0.047	0.070							DWELLING
8 ROGERS STREET		0.154	0.183	0.239	0.264	0.283							DWELLING
8 WOODLANDS COURT	0.079	0.101	0.123	0.143	0.160	0.167					0.002	0.022	DWELLING
8-10 GRIFFIN STREET										0.112	0.124	0.134	BUS DEPOT
85 INKERMAN STREET						0.081							UNIT
86 ALMA STREET						0.013							DWELLING
88 BURNS STREET	0.067	0.079	0.097	0.117	0.130	0.139							WAREHOUSE
88 NELSON STREET					0.017	0.060							DWELLING
89 LOCH STREET													DWELLING
9 BARR STREET	0.084	0.109	0.125	0.138	0.149	0.159							DWELLING
9 BROWN STREET	0.087	0.108	0.124	0.140	0.149	0.157							DWELLING
9 CARRICK STREET	0.046	0.062	0.077	0.105	0.123	0.139							DWELLING
9 MARSHALL STREET	0.173	0.180	0.193	0.208	0.217	0.222							DWELLING
9 ROWLES DRIVE				0.119	0.145	0.166				0.063	0.070	0.075	DWELLING
9 WOODLANDS COURT					0.038	0.094			0.084	0.112	0.126	0.136	DWELLING
90 MARYBOROUGH-DUNOLLY RD, HAVELOCK						0.175							DWELLING
90 NAPIER STREET (GIRL GUIDES)	0.075	0.089	0.108	0.130	0.145	0.155							CHURCH
90 NELSON STREET													DWELLING
91 NELSON STREET						0.086				0.020	0.046	0.067	DWELLING
93 ALMA STREET													SHED
93 DUNDAS ROAD	0.076	0.083	0.090	0.098	0.111	0.170							DWELLING
94 NAPIER STREET												0.061	NEWSPAPER
96 BURKE ST				0.161	0.173	0.183							Goldfield Shopping Centre
97 MAJORCA ROAD	0.101	0.111	0.123	0.144	0.154	0.165							DWELLING

97 NELSON STREET							0.047	0.056	0.068	0.088	0.097	0.107	DWELLING
Corner of Dooleys Road and Forrest Road					0.118	0.159							DWELLING
Golden Country Motel & Caravan Park		0.192	0.203	0.217	0.227	0.233							OFFICE - Main Building
HOLYROOD STREET (CARAVAN PARK)			0.095	0.121	0.139	0.152							TOILET BLOCK
Jack Pascoe Reserve - MARYBOROUGH SPORTS AND LEISURE CENTRE			0.227	0.443	0.478	0.499							
OLD RAILWAY STATION -				0.091	0.118	0.136							BUILDING
Outbuildings of 2 Alexander Ave			0.084	0.141	0.229	0.275			0.199	0.392	0.424	0.444	SHED
PARK ROAD										0.072	0.101	0.123	TOILETS
PARK ROAD - GOLF CLUB											0.206	0.259	CLUBHOUSE
PARK ROAD - PRINCES PARK CLUBROOMS										0.131	0.205	0.259	CLUBROOMS

7.4 Indicative flood / no flood guidance tool

BOM does not currently provide flood forecasts for Four Mile Creek or for the Maryborough area. All flood response actions must therefore be driven by rainfall and/or river level observations.

In very general terms, the approximate time between start of heavy rain and flooding at Maryborough is around 1.5 to 2 hours.

7.5 Using the indicative flood / no flood guidance tool

In the lead up to a flood event

An average of the rainfall recorded at the rain gauges at Maryborough Majorca, Tullaroop Reservoir and Talbot (Post Office) (or if the catchment is wet and one gauge is consistently higher, the average of that gauge and the next highest) should be used to determine an appropriate rainfall depth for use in the Indicative Flood / No Flood guidance tool provided below, unless data from alternative locations closer to areas considered likely to experience the heaviest rainfall is available. Care should be exercised however, as it must be remembered that runoff from headwater as well as low land areas contribute to flooding.

If the catchment is very wet, it would be appropriate to step up one level. For example, rainfall approaching the 5% AEP curve on a very wet catchment may result in flood extents and depths in and around Maryborough similar to a 2% AEP event. If the catchment is dry, this tool will tend to over-estimate the likelihood of flooding if the catchment is dry and/or rain extended over more than 24 hours. Two approaches can be used during a rainfall event to determine an indication of the likelihood and severity of flooding at Maryborough. Both approaches can be used simultaneously using the same copy of the tool.

Unless there are unusual circumstances, actions as per the Flood Intelligence Card should be initiated as soon as the tool suggests flooding is likely. Response can be escalated if the tool indicates an increase in the expected severity of flooding.

Approach 1: Using the total rainfall depth obtained from the start of the event (discount early drizzle or very light rain), plot the rainfall depth against elapsed time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates

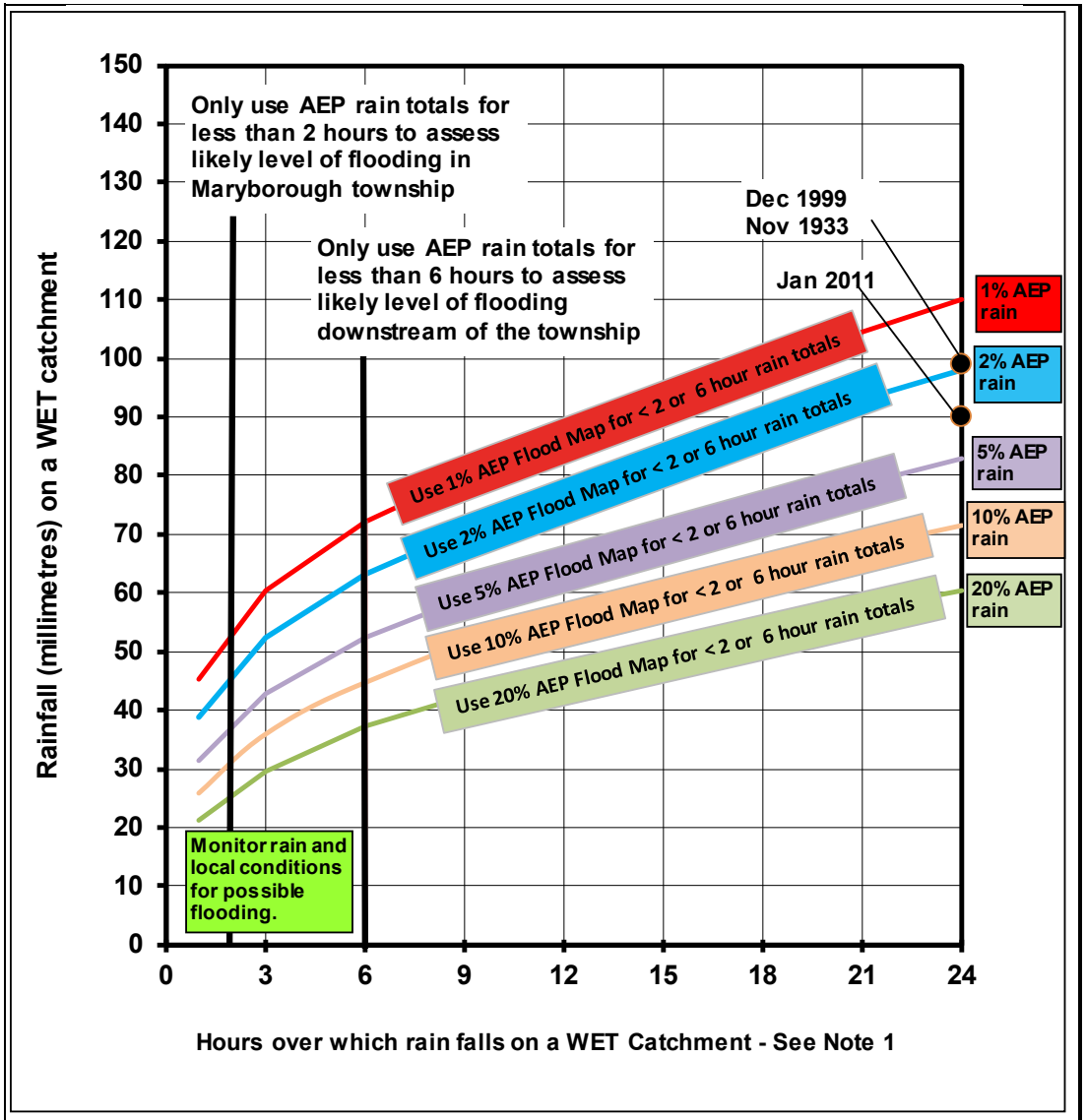
that flooding of around that severity is likely.

Approach 2: Discount the early lighter rain from consideration (i.e. begin calculating rainfall depth from start of heavy rain) and plot rainfall depth against time on a copy of the tool. A new plot should be started on receipt of data for each new time step and existing plots should be extended using the new data. Assess the likelihood and expected severity of flooding from the curves with due regard for included notes. A crossing of the curves by any of the plots indicates that flooding is likely.

CAUTION: While a strength of the tool is that it does provide a quick ball-park answer to questions such as “will we flood” and “how bad will it be”, it is based on a number of gross assumptions and generalisations. It is therefore indicative only. It is not property specific and does not enable accurate predictions of expected flooding, peak flood heights, the time of flood peak, the severity of expected flooding or specific likely consequences. Further, it will not always indicate the expected severity of flooding correctly although it will usually give a heads-up to severe flooding and thus of likely consequences. Note also that the tool will tend to over-estimate the likelihood of flooding if the catchment is dry and / or rain extends over more than 24 hours. On the other hand, it will tend to underestimate the likelihood of flooding if the catchment is wet. In such circumstances, it would be appropriate to step up one curve.

After a flood event

After a flood event, plot the event rainfall depth (with date) on the tool and include an overview of the event, including antecedent conditions, in Appendix A of this MFEP. Relevant information should also be added to this Appendix.



This figure is an approximate guide only

1 Measure the rain once the catchment is "WET" i.e. - when local creeks or drains have just started to flow or you recently have had good rainfall and the ground is wet underfoot

2 Use rainfall values based upon Melbourne radar rainfall estimates or from local rain gauges

Rainfall Intensity Likely to Cause Flooding at Maryborough

Appendix C4 – Bealiba community flood emergency plan

1. Overview of flooding consequences

Bealiba has a population of approximately 300 and is located approximately 70km west of Bendigo. Cochranes creek runs through the centre of the town. The upstream catchment area is 127km². The creek flows into the Avoca River and the channel is relatively well defined with no significant tributaries joining within the study area. Figure 32 shows the location.

1.1 Warning times

Flooding in Bealiba can be caused by either overland flooding from the local catchment, or from riverine flooding from Cochranes Creek. Stormwater runoff will begin within minutes of intense rainfall over the town. Flood waters in Cochranes Creek will begin to rise within a few hours of heavy rainfall commencing. Flooding occurs rapidly with floods peaking approximately 15 hours after stream levels begin to rise. Figure 33 shows typical response and times to rise for a number of design floods. Figure 32 shows the location of the hydrographs.

1.2 Areas affected

Floodwaters break out of Cochranes Creek and inundate St Arnaud-Dunolly Road and Logan Road in a 20% AEP event. Buildings being to be inundated in a 2% AEP event. A summary of flooding for a number of design events is given in Table 37. Details of individual properties and buildings inundated are provided in Table 39.

Figure 32: Map of Bealiba study area with reporting location

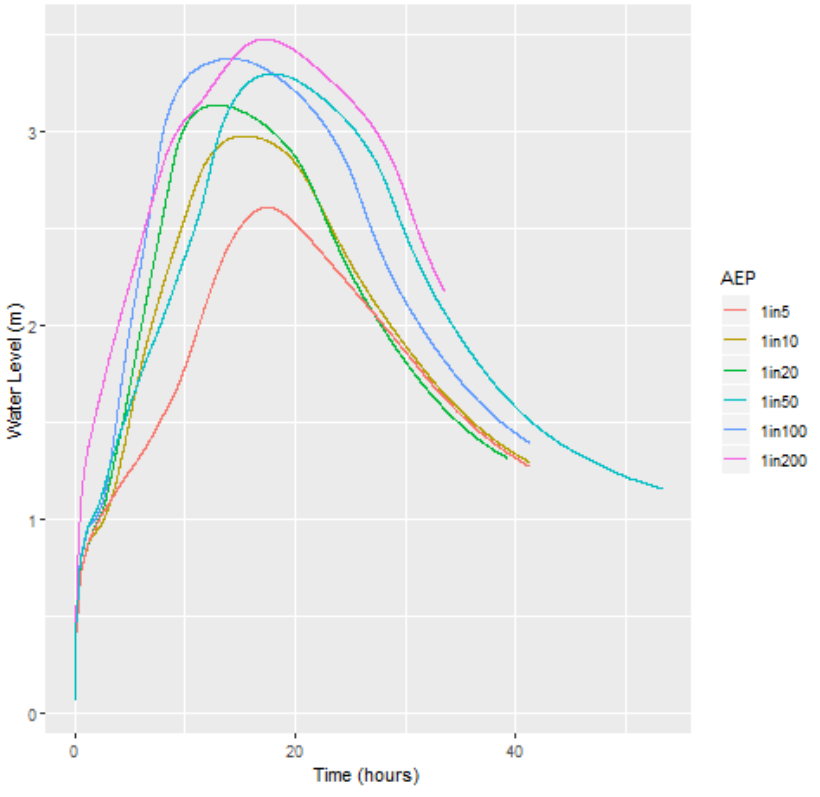


Figure 33: Design Event Hydrographs (HARC, 2020)

Table 37: Summary of impacts of flooding	
AEP	Impact
20%	St Arnaud-Dunolly Road overtops. No properties are flooded
10%	Logan Road overtops. No properties are flooded
5%	No properties are flooded
2%	One property is flooded downstream of Logan Road near Main Road. Two properties are flooded just upstream of Davies Street
1%	Three properties are flooded as above
0.5%	Three properties are flooded as above

1.3 Properties affected

A summary of the number of properties likely to be flooded at Bealiba is provided in Table 38.

Table 38: Summary of properties affected						
AEP	20%	10%	5%	2%	1%	0.5%
Buildings Flooded Above Floor	0	0	0	0	0	0
Properties Flooded but Below Floor Level	0	0	0	3	3	3
Total Properties Flooded	0	0	0	3	3	3

1.4 List of properties likely to be flooded

Table 39: Detailed list of properties flooded												
Address	Depth of flooding near building for each AEP						Depth of over floor flooding for each AEP					
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%
1 Lovel Street				0.1	0.1	0.3						
1 Lovel Street				0.1	0.1	0.3						
31 Main Street				< 0.1	0.1	0.3						

1.5 Isolation

The main access roads for Bealiba are the:

- Logan Road
- St Arnaud-Dunolly Road.

St Arnaud-Dunolly Road overtops in a 20% AEP event and Logan Road overtops in a 10% AEP. Events larger than the 0.5% AEP event haven't been modelled. Table 40 summarises the main road inundation. Along with the main roads there are several local roads which also become inundated during a 20% AEP event.

Table 40: Summary of road inundation			
AEP	Roads impacted by flooding	Maximum depth over road (m)	Duration of inundation (hours)
20%	Logan Road	0.0	0
	St Arnaud-Dunolly Road	0.3	21
10%	Logan Road	0.1	9
	St Arnaud-Dunolly Road	0.4	25
5%	Logan Road	0.2	13

	St Arnaud-Dunolly Road	0.6	25
2%	Logan Road	0.3	17
	St Arnaud-Dunolly Road	0.8	30
1%	Logan Road	0.4	18
	St Arnaud-Dunolly Road	1.0	30
0.5%	Logan Road	0.4	22
	St Arnaud-Dunolly Road	1.2	35

2. Flood intelligence card

Table 41: Flood intelligence card

AEP	Rainfall depth (mm)	Consequence / Impacts	Actions
-	Heavy rain on wet catchment	The capacity of the town stormwater drainage system maybe exceeded. Local nuisance flooding will occur along the side of roads and within some properties. No over-floor flooding expected.	▪ Consider deploying “water over road signs” at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.
20%	~20mm in 1hr to ~30mm in 3hr	▪ Flows out onto the floodplain with extensive flooding ▪ Several local roads inundated ▪ St Arnaud-Dunolly Road overtopped by 300mm	▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for St Arnaud-Dunolly Road
10%	~25mm in 1hr to ~35mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 20% AEP with increased depths and additional flooding upstream of Logan Road ▪ Several local roads inundated ▪ St Arnaud-Dunolly Road overtopped by 400mm and Logan Road overtopped by 100mm	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for St Arnaud-Dunolly Road and Logan Road
5%	~30mm in 1hr to ~40mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 10% AEP with increased depths ▪ St Arnaud-Dunolly Road overtopped by 600mm and Logan Road overtopped by 200mm ▪ Several local roads inundated	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for St Arnaud-Dunolly Road and Logan Road
2%	~35mm in 1hr to ~45mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 5% AEP with increased depths ▪ 3 properties flooded but not above floor. Refer to Table 39 ▪ St Arnaud-Dunolly Road overtopped by 800mm and Logan Road overtopped by 300mm ▪ Several local roads inundated	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 39). ▪ Implement appropriate response actions that may include deploying “water over road” signs

Table 41: Flood intelligence card			
AEP	**Rainfall depth (mm)**	**Consequence / Impacts**	**Actions**
			▪ Put out “road closed” signs for St Arnaud-Dunolly Road and Logan Road
1%	~40mm in 1hr to ~50mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 2% AEP with increased depths ▪ 3 properties flooded but not above floor. Refer to Table 39 ▪ St Arnaud-Dunolly Road overtopped by 1000mm and Logan Road overtopped by 400mm ▪ Several local roads inundated	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 39). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for St Arnaud-Dunolly Road and Logan Road
0.5%	A little above the 1% AEP line on the quick look flood / no flood tool	▪ Flows out onto the floodplain. ▪ Extent is fairly similar to the 1% AEP with increased depths ▪ 3 properties flooded but not above floor. Refer to Table 39 ▪ St Arnaud-Dunolly Road overtopped by 1200mm and Logan Road overtopped by 400mm ▪ Several local roads inundated	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 39). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for St Arnaud-Dunolly Road and Logan Road

2.1 Indicative quick look flood / no flood tool

The tool is aimed at providing a rapid indication of whether flooding is likely with some lead time. It is intended to be indicative only and will not provide a forecast of expected flood depth. The tool is designed to be linked to the mapping and intelligence produced by this project and in that way provides an indication of likely consequences.

The tool is driven by rainfall recorded at Avoca River at Archdale Junction (408206). IFD data from this location has been compared to the study area specific IFD data. Adjusted rainfall depths were then plotted against time to produce the tool as shown in Figure 35.

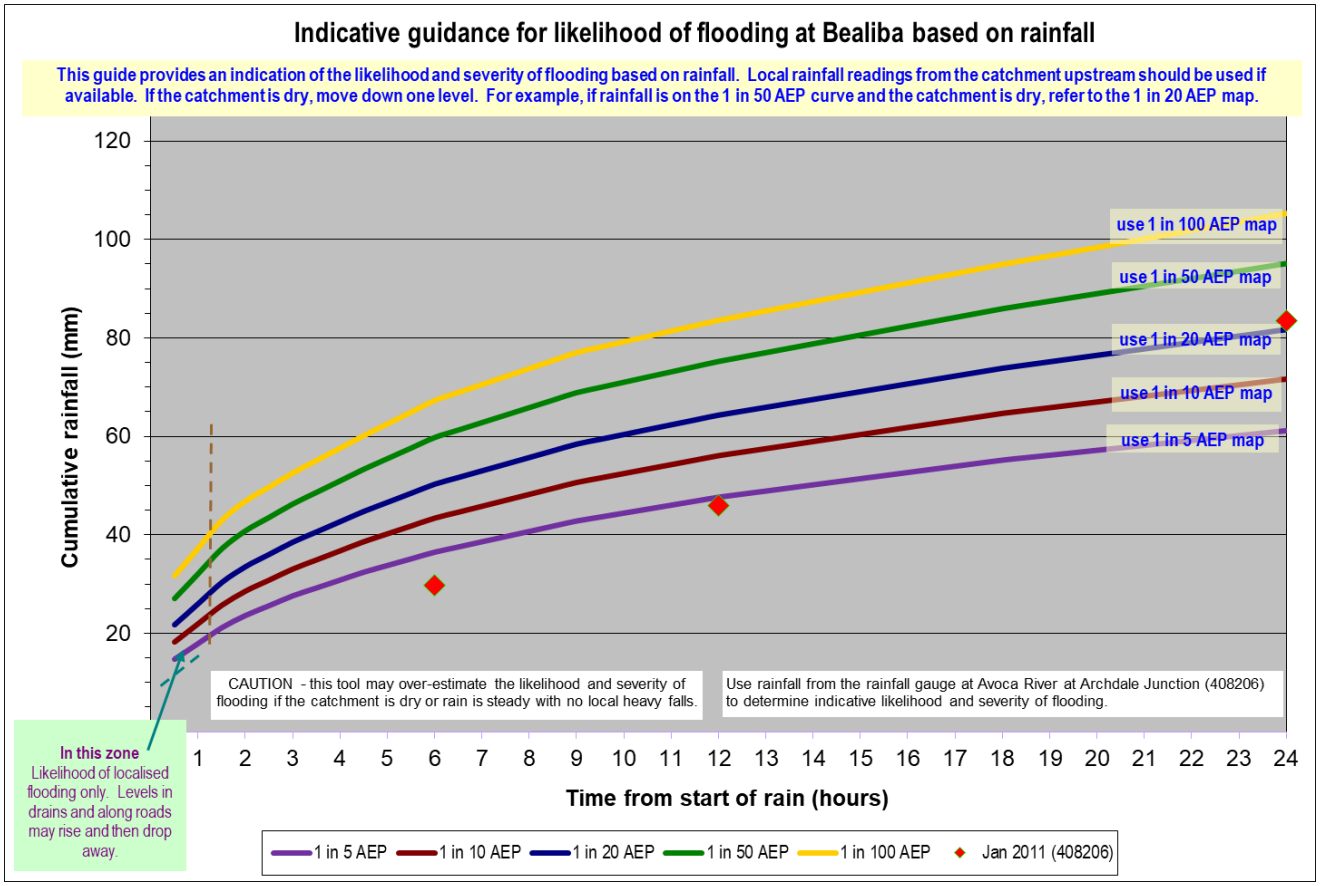


Figure 35: Quick look tool

2.2 Guidance on the use of the quick look flood / no flood tool

In the lead up to a flood

The quick look indicative flood / no flood tool provided in Figure 35 gives guidance on the likelihood and severity of expected flooding at Bealiba.

Rainfall recorded at Avoca River at Archdale Junction (408206) was used to develop the quick look tool. As the data being used comes from a rain gauge that is outside the Bealiba catchment, the tool may not perform to expectations in severe thunderstorm situations and / or when there is locally heavy rainfall embedded in more general rain. In such situations, rainfalls recorded more locally are likely to drive a more accurate indication of flooding and likely severity.

Appendix C5 – Bet Bet community flood emergency plan

1. Overview of flooding consequences

Bet Bet has a population of approximately 501 and is approximately 50 km south-west of Bendigo. Bet Bet Creek runs through the centre of the town. The creek has an upstream catchment area of 647 km². The creek channel is relatively well defined with no significant tributaries joining within the study area. Figure 24 shows the location.

1.1 Warning times

Flooding in Bet Bet can be caused by either overland flooding from the local catchment, or from riverine flooding from Bet Bet Creek. Stormwater runoff will begin within minutes of intense rainfall over the town. Flood waters in Bet Bet Creek will begin to rise within a few hours of heavy rainfall commencing. Flooding occurs rapidly with floods peaking approximately 10 - 30 hours after stream levels begin to rise.

Figure 23 shows typical response and times to rise for a number of design floods. Figure 24 shows the location of the hydrographs.

1.2 Areas affected

Floodwaters break out of Bet Bet Creek and overtop the Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road in a 20% AEP. A number of buildings are impacted from the 5% AEP and above. A summary of flooding for a number of design events is given in Table 25. Details of individual properties and buildings inundated are provided in Table 27.

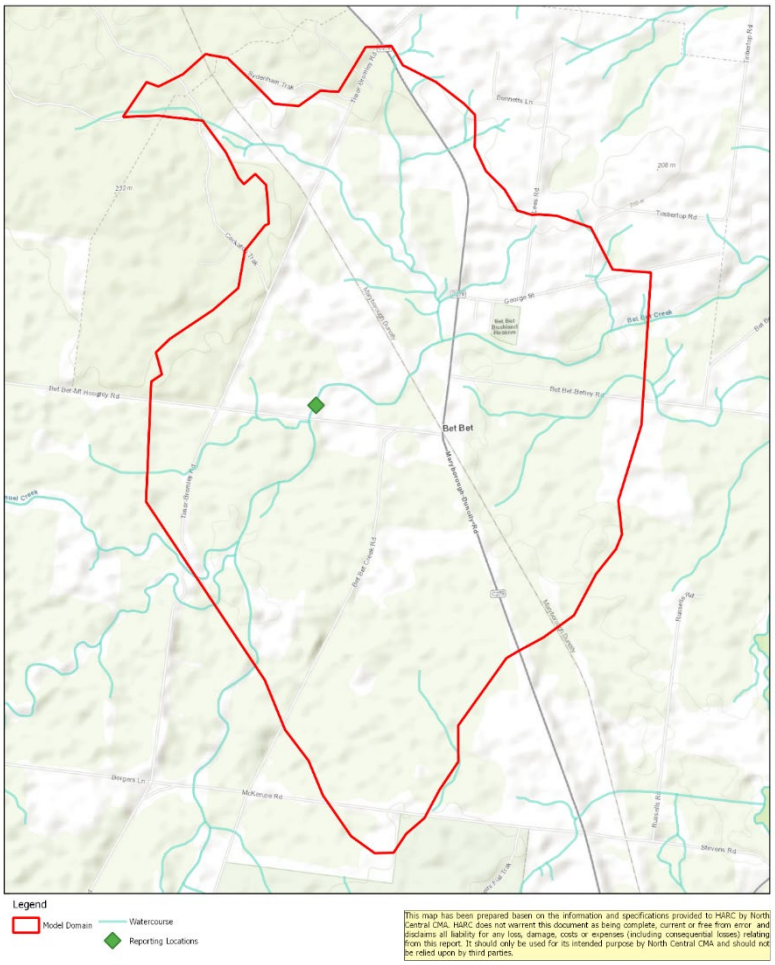


Figure 24: Map of Bet Bet study area with reporting location

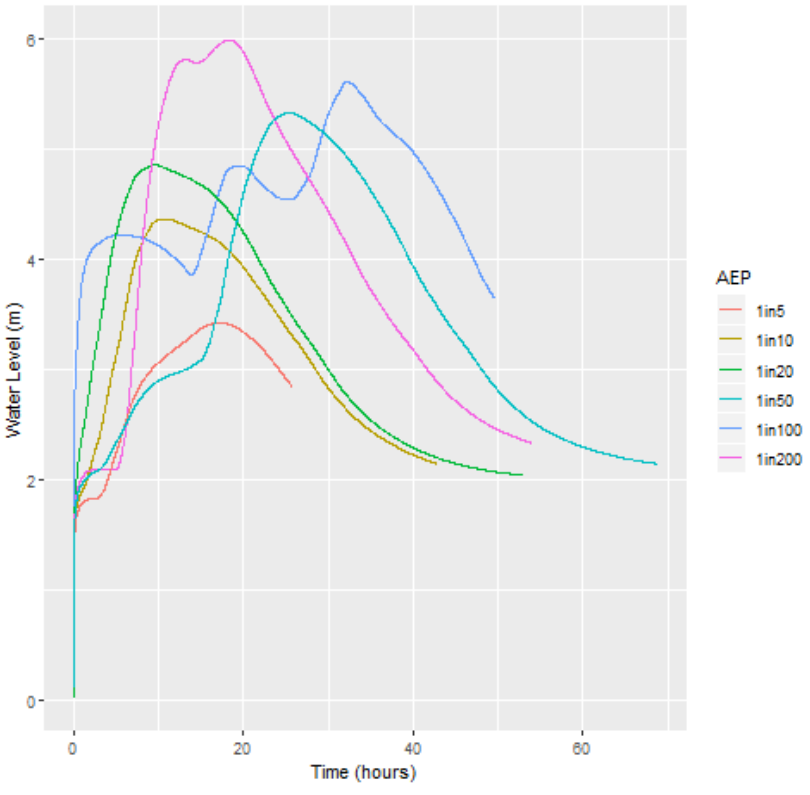


Figure 23: Design event hydrographs (HARC, 2020)

Table 25: Summary of impacts of flooding	
AEP	Impact
20%	Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road overtopped. No buildings are inundated
10%	Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road overtopped. No buildings are inundated
5%	One property is flooded near the downstream modelling boundary
2%	Three additional properties are flooded at upstream of Bet Bet-Mt Hooghly Road and the intersection of Bet Bet-Mt Hooghly Road and Bet Bet Creek Road
1%	Bet Bet Creek Road overtopped. One additional property is inundated in the township
0.5%	Twelve additional properties are flooded in the township

1.3 Properties affected

A summary of the number of properties likely to be flooded at Bet Bet is provided in Table 26.

Table 26: Summary of properties affected						
AEP	20%	10%	5%	2%	1%	0.5%
Buildings flooded above floor	0	0	0	2	2	4
Properties flooded but below floor level	0	0	1	2	3	13
Total properties flooded	0	0	1	4	5	17

1.4 List of properties likely to be flooded

Table 27: Detailed list of properties flooded												
Address	Depth of flooding near building for each AEP						Depth of over floor flooding for each AEP					
	20%	10%	5%	2%	1%	0.5%	20%	10%	5%	2%	1%	0.5%
1065 Bet Bet Creek Rd						< 0.1						
89 Bet Bet-Mt Hooghly Rd				0.2	0.4	0.7						
43 Bet Bet-Mt Hooghly Rd				0.2	0.3	0.7				0.2	0.3	0.6
40 Bet Bet-Mt Hooghly Rd				0.2	0.5	0.9						
1176 Bet Bet Creek Rd						0.4						
1168 Bet Bet Creek Rd						< 0.1						
20 Bet Bet-Mt Hooghly Rd						0.3						
20 Bet Bet-Mt Hooghly Rd						0.4						0.2
20 Bet Bet-Mt Hooghly Rd						0.4						
9 Bet Bet-Mt Hooghly Rd						0.2						
1065 Maryborough-Dunolly Rd						0.2						
1116 Maryborough-Dunolly Rd						0.1						
1115 Maryborough-Dunolly Rd						0.1						
1085 Maryborough-Dunolly Rd						0.3						
2 Bet Bet-Betley Rd					0.2	0.5						0.2
34 Bet Bet-Betley Rd						0.1						
110 George St			0.2	0.7	1.0	1.4				0.4	0.7	1.1

1.5 Isolation

The main access roads for Bet Bet are the:

- Bet Bet – Mt Hooghly Road
- Maryborough-Dunolly Road
- Bet Bet Creek Road.

Bet Bet – Mt Hooghly Road and Maryborough-Dunolly Road overtops in a 20% AEP event. Bet Bet Creek Road only overtops in a 0.5% AEP. Events larger than the 0.5% AEP event haven't been modelled. Table 28 summarises the main road inundation.

Table 28: Summary of road inundation

AEP	Roads impacted by flooding	Maximum depth over road (m)	Duration of inundation (hours)
20%	Bet Bet-Mt Hooghly Road	0.1	5
	Maryborough-Dunolly Road	0.5	18
	Bet Bet Creek Road	0.0	0
10%	Bet Bet-Mt Hooghly Road	0.6	20
	Maryborough-Dunolly Road	1.4	31
	Bet Bet Creek Road	0.0	0
5%	Bet Bet-Mt Hooghly Road	1.0	24
	Maryborough-Dunolly Road	1.9	39
	Bet Bet Creek Road	0.0	0
2%	Bet Bet-Mt Hooghly Road	1.4	29
	Maryborough-Dunolly Road	2.5	49
	Bet Bet Creek Road	0.0	0
1%	Bet Bet-Mt Hooghly Road	1.6	49
	Maryborough-Dunolly Road	2.8	49
	Bet Bet Creek Road	0.0	0
0.5%	Bet Bet-Mt Hooghly Road	2.0	31
	Maryborough-Dunolly Road	3.1	49
	Bet Bet Creek Road	0.9	42

2. Flood intelligence card

The gauge location where river heights are reported is at Bet Bet Ck @ Bet Bet (407211).

Table 29: Flood intelligence card

AEP	River height^	Rainfall depth (mm)	Consequence / Impacts	Actions
-	-	Heavy rain on wet catchment	The capacity of the town stormwater drainage system maybe exceeded. Local nuisance flooding will occur along the side of roads and within some properties. No over-floor flooding expected.	▪ Consider deploying "water over road signs" at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.
> 20%	4.0 (Minor Flood Level)			▪ Consider deploying "water over road signs" at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.

Table 29: Flood intelligence card				
AEP	**River height^**	**Rainfall depth (mm)**	**Consequence / Impacts**	**Actions**
20%	4.7	~15mm in 1hr to ~20mm in 3hr	▪ Flows out onto the floodplain but fairly confined ▪ Maryborough-Dunolly Road overtopped by 500mm. Bet Bet-Mt Hooghly Road overtopped by 100mm	▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Put out “road closed” signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
12.5%	5.0 (Moderate Flood Level)			▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Put out “road closed” signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
10%	5.3	~20mm in 1hr to ~25mm in 3hr	▪ Flows out onto the floodplain. Extent is increased a reasonable amount compared to the 1 in 5 AEP with increased depths ▪ Maryborough-Dunolly Road overtopped by 1400mm. Bet Bet-Mt Hooghly Road overtopped by 600mm	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Put out “road closed” signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
5%	5.8	~25mm in 1hr to ~30mm in 3hr	▪ Flows out onto the floodplain Extent is fairly similar to the 1 in 10 AEP with increased depths ▪ 1 property flooded but below floor level. Refer to Table 27 ▪ Maryborough-Dunolly Road overtopped by 1900mm. Bet Bet-Mt Hooghly Road overtopped by 1000mm	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 27). ▪ Put out “road closed” signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
3.33%	6.0 (Major Flood Level)			▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 27). ▪ Put out “road closed” signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
2%	6.4	~30mm in 1hr to ~35mm in 3hr	▪ Flows out onto the floodplain. Extent is increased by a reasonable amount compared to the 1 in 20 AEP with increased depths ▪ 4 properties flooded with 2 buildings flooded above floor. Refer to Table 27 ▪ Maryborough-Dunolly Road overtopped by	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 27).

Table 29: Flood intelligence card				
AEP	**River height^**	**Rainfall depth (mm)**	**Consequence / Impacts**	**Actions**
			2500mm. Bet Bet-Mt Hooghly Road overtopped by 1400mm.	▪ Implement appropriate response actions that may include deploying "water over road" signs ▪ Put out "road closed" signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road
1%	6.7	~35mm in 1hr to ~40mm in 3hr	▪ Flows out onto the floodplain. Extent is increased by a reasonable amount compared to the 1 in 50 AEP with increased depths ▪ 5 properties flooded with 2 buildings flooded above floor. Refer to Table 27 ▪ Maryborough-Dunolly Road overtopped by 2800mm. Bet Bet-Mt Hooghly Road overtopped by 1600mm	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 27). ▪ Implement appropriate response actions that may include deploying "water over road" signs ▪ Put out "road closed" signs for Bet Bet-Mt Hooghly Road and Maryborough-Dunolly Road.
0.5%	7.1*	A little above the 1 in 100 AEP line on the quick look flood / no flood tool	▪ Flows out onto the floodplain. Extent is increased by a significant amount compared to the 1 in 100 AEP with increased depths ▪ 17 properties flooded with 4 buildings flooded above floor. Refer to Table 27 ▪ Maryborough-Dunolly Road overtopped by 3100mm. Bet Bet-Mt Hooghly Road overtopped by 2000mm. Bet Bet Creek Road overtopped by 900mm ▪ Several local roads inundated	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 27). ▪ Implement appropriate response actions that may include deploying "water over road" signs ▪ Put out "road closed" signs for Bet Bet-Mt Hooghly Road, Maryborough-Dunolly Road and Bet-Bet Creek Road.

^River heights are reported at Bet Bet Ck @ Bet Bet (407211). River heights based on current rating curve (June 2020)

** Beyond rating curve therefore less accurate*

2.1 Indicative quick look flood / no flood tool

The tool is aimed at providing a rapid indication of whether flooding is likely with some lead time. It is intended to be indicative only and will not provide a forecast of expected flood depth. The tool is designed to be linked to the mapping and intelligence produced by this project and in that way provides an indication of likely consequences.

The tool is driven by rainfall recorded at Bet Bet Creek at Lillicur (407288). IFD data from this location has been compared to the study area specific IFD data. Adjusted rainfall depths were then plotted against time to produce the tool as shown in Figure 25.

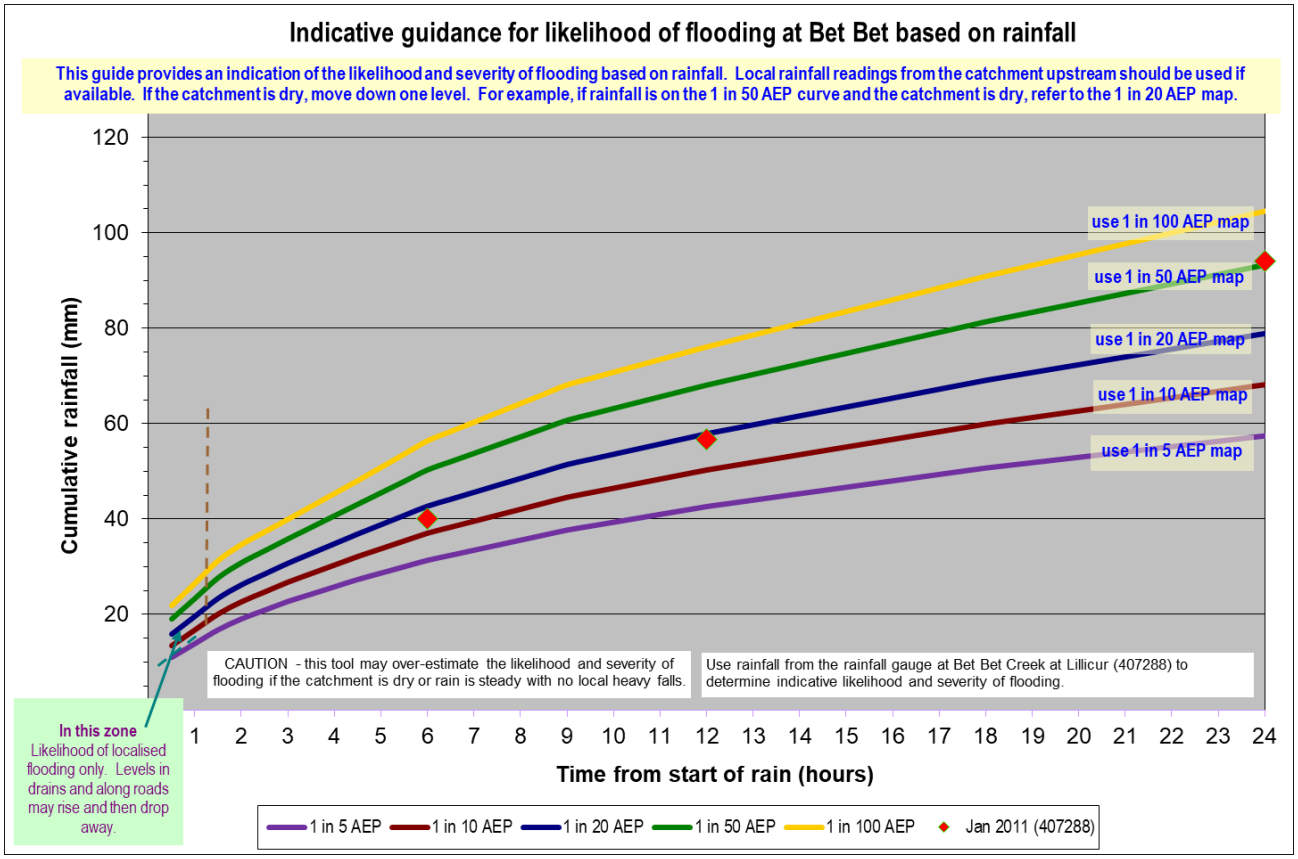


Figure 25: Quick look tool

2.2 Guidance on the use of the quick look flood / no flood tool

In the lead up to a flood

The quick look indicative flood / no flood tool provided in Figure 25 gives guidance on the likelihood and severity of expected flooding at Bet Bet. Rainfall recorded at Bet Bet Creek at Lillicur (407288) was used to develop the quick look tool. The tool may not perform to expectations in severe thunderstorm situations and/or when there is locally heavy rainfall embedded in more general rain.

During a flood - using the quick look tool

Plot cumulative rainfall depth against elapsed time on a copy of the tool. Do not start using the tool until rainfall exceeds approximately 2mm an hour (i.e. ignore early drizzle or very light rain).

At each time step, after plotting the cumulative rainfall, assess the likelihood and expected severity of flooding from the curves. Some degree of judgement is required to determine if the quick look tool is providing an answer that is in line with expected outcomes. When plotted rainfall data crosses a curve on Figure 25 this indicates that flooding of around that severity is possible.

If the catchment is dry, it would generally be appropriate to step down one level. For example, if the rainfall plot is on the 2% AEP curve and the catchment is dry, refer to the 5% AEP map and associated consequences listed in the flood intelligence card available in the MFEP. The exception to this would be if there was very heavy rain on a dry catchment. In that circumstance, adopt a cautious approach and do not step down a level.

If the catchment is dry and/or rain extends over more than 12 hours, the quick look tool will tend to over-estimate the likelihood of flooding.

Appendix C6 – Moliagul community flood emergency plan

1. Overview of flooding consequences

Moliagul has a population of approximately 80 is located approximately 60km west of Bendigo. Burnt Creek runs through the centre of the town. The creek has an upstream catchment area of 13km². The creek channel is relatively well defined with no significant tributaries joining within the study area. Figure 19 shows the location.

Figure 18: Map of Moliagul study area with reporting location

1.1 Warning times

Flooding in Moliagul can be caused by either overland flooding from the local catchment, or from riverine flooding from Burnt Creek. Stormwater runoff will begin within minutes of intense rainfall over the town. Flood waters in Burnt Creek will begin to rise within a few hours of heavy rainfall commencing. Flooding occurs rapidly with floods peaking approximately 2 to 4 hours after stream levels begin to rise. Figure 19 shows typical response and times to rise for a number of design floods. Figure 18 shows the location of the hydrographs.

1.2 Areas affected

Floodwaters break out of Burnt Creek and inundate Monument and Dunolly-Moliagul Road in a 10% AEP. Buildings become inundated in a 5% AEP event. A summary of flooding for a number of design events is given in Table 19. Details of individual properties and buildings inundated are provided in Table 21.

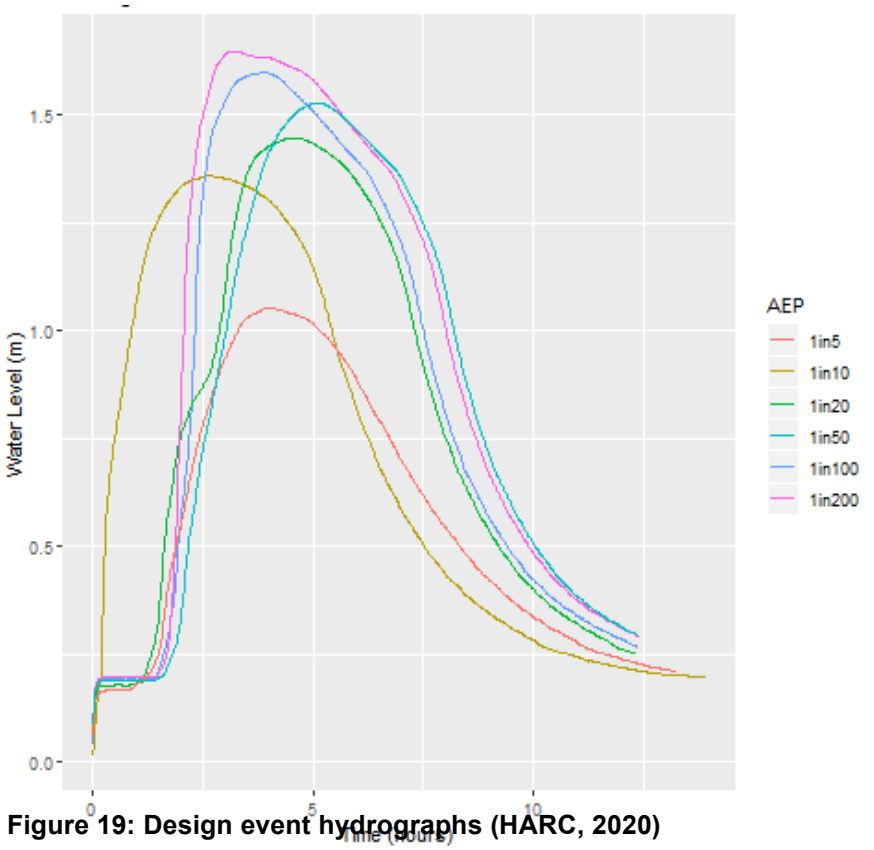


Figure 19: Design event hydrographs (HARC, 2020)

Table 19: Summary of impacts of flooding	
AEP (1 in Y)	**Impact**
5	No properties are flooded
10	Monument Road and Dunolly-Moliagul Road overtopped and no properties are flooded
20	Wedderburn-Dunolly Road overtopped. Five properties are flooded near Dunolly-Moliagul Road
50	Two additional agricultural properties are flooded upstream of Dunolly-Moliagul Road
100	Seven properties are flooded as above
200	Seven properties are flooded as above

1.3 Properties affected

A summary of the number of properties likely to be flooded at Moliagul is provided in Table 20.

Table 20: Summary of properties affected						
AEP	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
Buildings flooded above floor	0	0	0	3	4	4
Properties flooded but below floor level	0	0	5	4	3	3
Total properties flooded	0	0	5	7	7	7

1.4 List of properties likely to be flooded

Table 21: Detailed list of properties flooded												
Address	**Depth of flooding near building for each AEP**						**Depth of over floor flooding for each AEP**					
	20%	**10%**	**5%**	**2%**	**1%**	**0.5%**	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
1446 Dunolly-Moliagul Rd			0.1	0.1	0.1	0.1				0.1	0.1	0.2
1457 Dunolly-Moliagul Rd				0.2	0.2	0.3				0.3	0.3	0.4
1457 Dunolly-Moliagul Rd*				0.1	0.1	0.2				0.1	0.2	0.2
1443 Dunolly-Moliagul Rd			<0.1	0.1	0.1	0.1						
1443 Dunolly-Moliagul Rd*			< 0.1	0.1	0.2	0.2						
1433 Dunolly-Moliagul Rd			0.1	0.1	0.2	0.3					< 0.1	0.1
1436 Dunolly-Moliagul Rd			< 0.1	0.0	0.0	0.0						

** Two buildings on the same property*

1.5 Isolation

The main access roads for Moliagul are the:

- Dunolly-Moliagul Road
- Monument Road
- Wedderburn-Dunolly Road.

Each one of these roads is overtopped in a 5% AEP event. Events larger than the 0.5% AEP event haven't been modelled. Table 22 summarises the main road inundation. Along with the main roads there are a number of local roads which also being to become inundated during a 5% AEP event.

Table 22: Summary of road inundation			
AEP	Roads impacted by flooding	Maximum depth over road (m)	Duration of inundation (hours)
20%	Dunolly-Moliagul Road	0	0
	Monument Road	0	0
	Dunolly-Moliagul Road at Monument Road	0	0
	Wedderburn-Dunolly Road	0	0
10%	Dunolly-Moliagul Road	0	0
	Monument Road	< 0.1	4
	Dunolly-Moliagul Road at Monument Road	0.1	5
	Wedderburn-Dunolly Road	0	0
5%	Dunolly-Moliagul Road	< 0.1	1
	Monument Road	0.1	4
	Dunolly-Moliagul Road at Monument Road	0.2	8
	Wedderburn-Dunolly Road	0.2	8
2%	Dunolly-Moliagul Road	0.1	2
	Monument Road	0.1	5
	Dunolly-Moliagul Road at Monument Road	0.2	8
	Wedderburn-Dunolly Road	0.3	8
1%	Dunolly-Moliagul Road	0.1	3
	Monument Road	0.2	5
	Dunolly-Moliagul Road at Monument Road	0.3	9
	Wedderburn-Dunolly Road	0.4	10
0.5%	Dunolly-Moliagul Road	0.1	4
	Monument Road	0.2	6
	Dunolly-Moliagul Road at Monument Road	0.3	10
	Wedderburn-Dunolly Road	0.4	10

1.6 Flood intelligence card

Table 23: Flood intelligence card			
AEP	Rainfall (mm)	Consequence / Impacts	Actions
-	Heavy rain on wet catchment	▪ The capacity of the town stormwater drainage system maybe exceeded. ▪ Local nuisance flooding will occur along the side of roads and within some properties. ▪ No over-floor flooding expected.	▪ Consider deploying “water over road signs” at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.
20%	~20mm in 1hr to ~30mm in 3hr	▪ Flows out onto the floodplain. ▪ Several local roads inundated.	▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs.

Table 23: Flood intelligence card			
AEP	**Rainfall (mm)**	**Consequence / Impacts**	**Actions**
10%	~25mm in 1hr to ~35mm in 3hr	▪ Flows out onto the floodplain. ▪ Flooding along Dunolly-Moliagul Road. ▪ Monument Road beginning to be inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Dunolly-Moliagul Road and Monument Road
5%	~30mm in 1hr to ~40mm in 3hr	▪ Flows out onto the floodplain with widespread flooding. ▪ Dunolly-Moliagul Road and several local roads inundated. ▪ 5 properties flooded. Refer to Table 21.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 21). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Dunolly-Moliagul Road, Monument Road and Wedderburn-Dunolly Road.
2%	~40mm in 1hr to ~50mm in 3hr	▪ Flows out onto the floodplain with widespread flooding. ▪ 7 properties flooded with 3 buildings flooded above floor. Refer to Table 21. ▪ Wedderburn-Dunolly Road overtopped by 300mm. ▪ Dunolly-Moliagul Road and several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 21). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Dunolly-Moliagul Road, Monument Road and Wedderburn-Dunolly Road..
1%	~45mm in 1hr to ~60mm in 3hr	▪ Flows out onto the floodplain with widespread flooding. ▪ 7 properties flooded with 4 buildings flooded above floor. Refer to Table 21. ▪ Wedderburn-Dunolly Road overtopped by 400mm. ▪ Dunolly-Moliagul Road overtopped by 300mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 21). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Dunolly-Moliagul Road, Monument Road and Wedderburn-Dunolly Road.
0.5%	A little above the 1% AEP line on the quick look flood / no flood tool	▪ Flows out onto the floodplain extent with widespread flooding. ▪ 7 properties flooded with 4 buildings flooded above floor. Refer to Table 21. ▪ Wedderburn-Dunolly Road overtopped by 400mm. ▪ Dunolly-Moliagul Road overtopped by 300mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 21). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Dunolly-Moliagul Road, Monument Road and Wedderburn-Dunolly Road.

1.7 Indicative quick look flood / no flood tool

The tool is aimed at providing a rapid indication of whether flooding is likely with some lead time. It is intended to be indicative only and will not provide a forecast of expected flood depth. The tool is designed to be linked to the mapping and intelligence produced by this project and in that way provides an indication of likely consequences.

The tool is driven by rainfall recorded at Avoca River at Archdale Junction (408206). IFD data from this location has been compared to the study area specific IFD data. Adjusted rainfall depths were then plotted against time to produce the tool as shown in Figure 20.

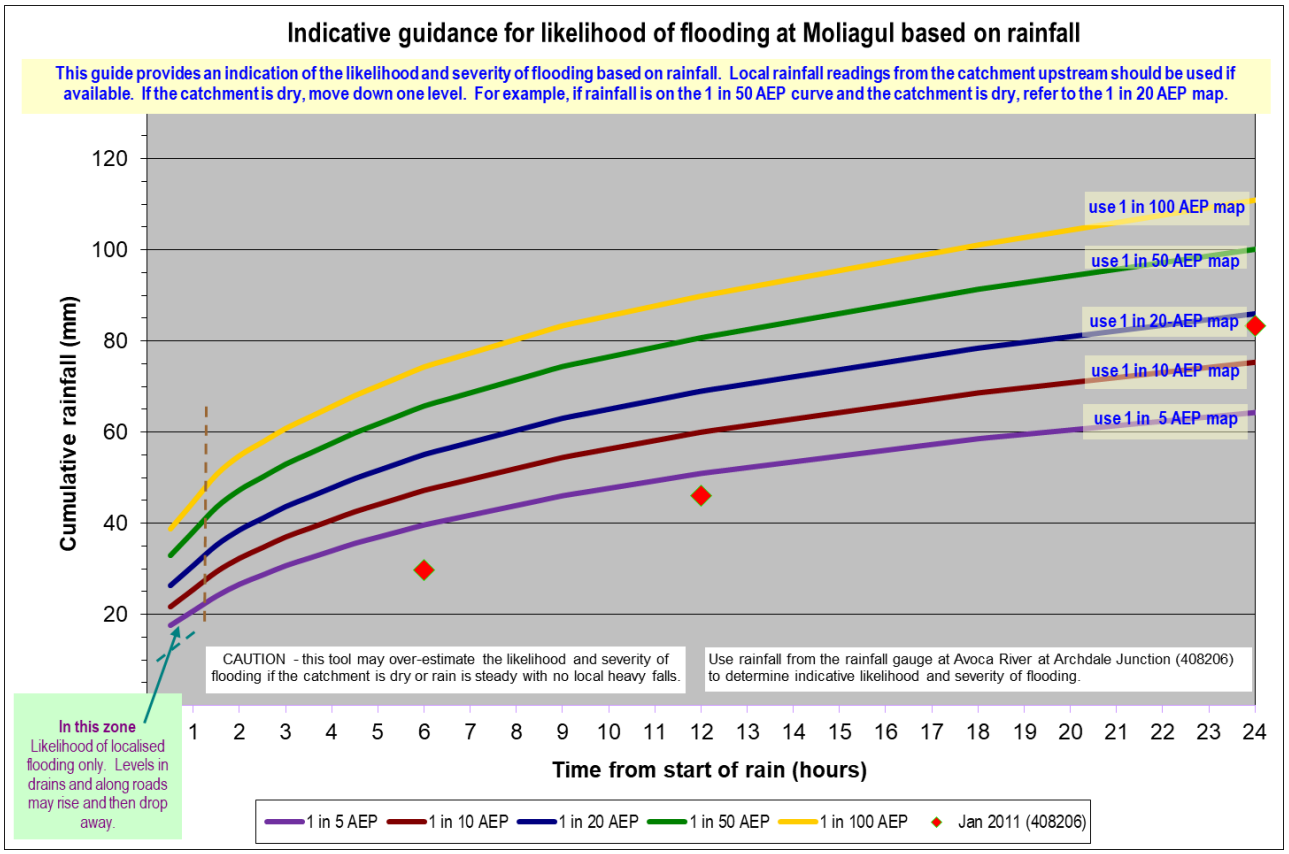


Figure 20: Quick look tool

1.8 Guidance on the use of the quick look flood / no flood tool

The quick look indicative flood / no flood tool provided in Figure 20 gives guidance on the likelihood and severity of expected flooding at Moliagul.

Rainfall recorded at Avoca River at Archdale Junction (408206) was used to develop the quick look tool. As the data being used comes from a rain gauge that is outside the Moliagul catchment, the tool may not perform to expectations in severe thunderstorm situations and/or when there is locally heavy rainfall embedded in more general rain. In such situations, rainfalls recorded more locally are likely to drive a more accurate indication of flooding and likely severity.

Appendix C7 – Talbot community flood emergency plan

1. Overview of flooding consequences

Talbot has a population of approximately 442 and is located approximately 43km north of Ballarat. Back Creek runs through the centre of the town. The creek has an upstream catchment area of 115km². The creek channel is relatively well defined with Mia Mia Creek joining Back Creek near the downstream boundary of the study area. Figure 27 shows the location.

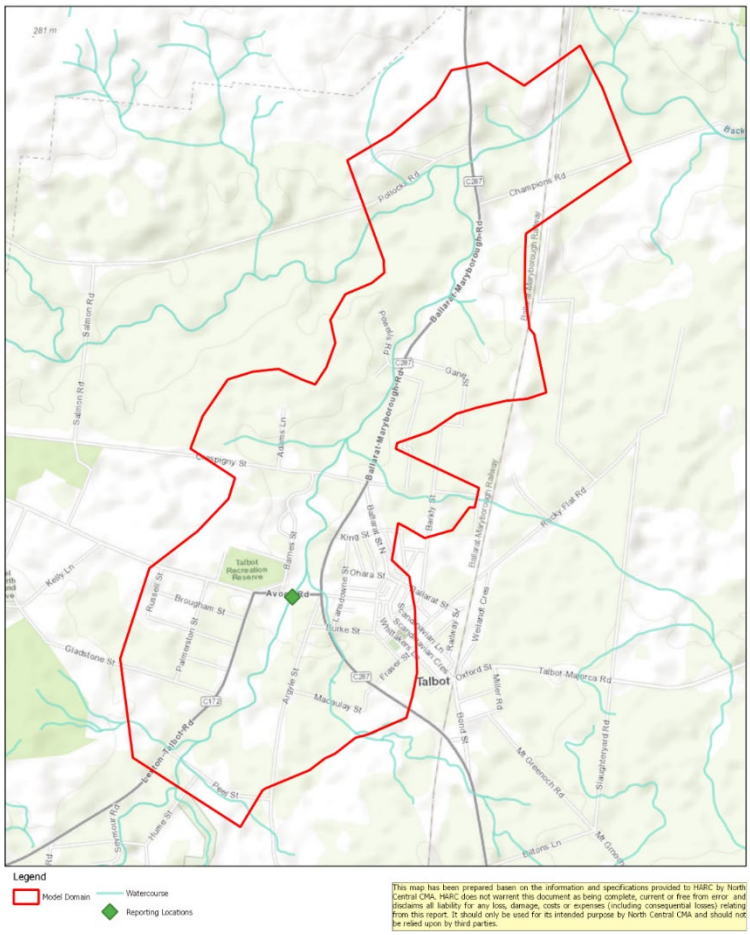


Figure 27: Map of Talbot study area with reporting location

1.1 Warning times

Flooding in Talbot can be caused by either overland flooding from the local catchment, or from riverine flooding from Mia Mia Creek. Stormwater runoff will begin within minutes of intense rainfall over the town. Flood waters in Mia Mia Creek will begin to rise within a few hours of heavy rainfall commencing. Flooding occurs rapidly with floods peaking approximately 5-15 hours after stream levels begin to rise. Figure 28 shows typical response and times to rise for a number of design floods. Figure 27 shows the location of the hydrographs.

1.2 Areas affected

Floodwaters break out of Mia Mia Creek and inundate Ballarat-Maryborough Road in a 1 in 5 AEP. Inundation of a number of properties begins to occur during a 1 in 10 AEP event. A summary of flooding for a number of design events is given in Table 31. Details of individual properties and buildings inundated are provided in Table 33.

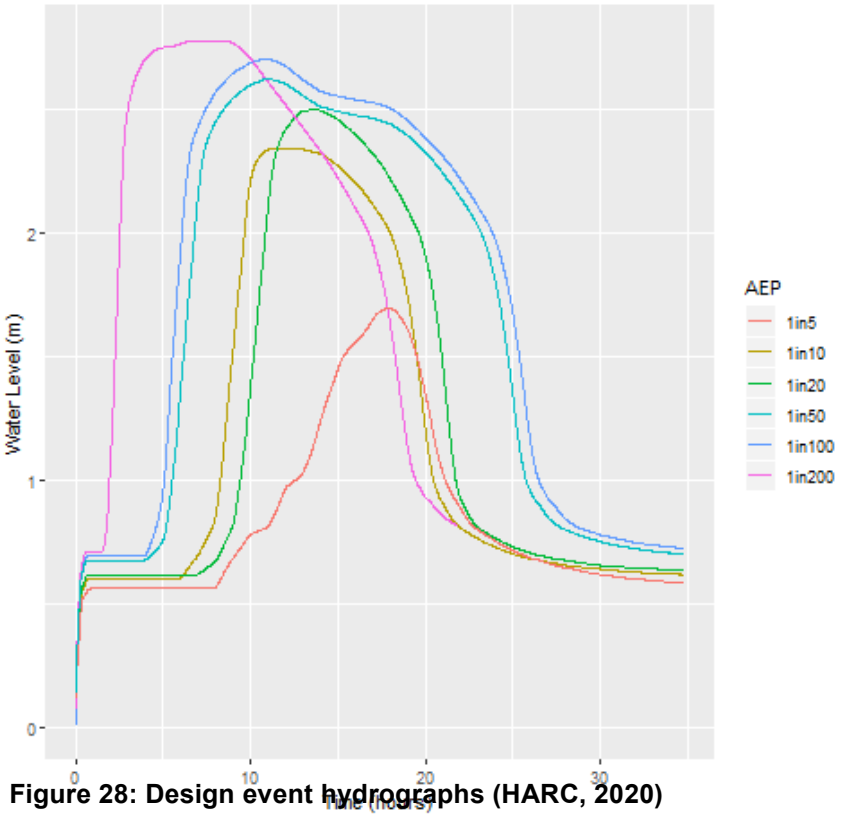


Figure 28: Design event hydrographs (HARC, 2020)

Table 31: Summary of impacts of flooding	
AEP	**Impact**
20%	Ballarat-Maryborough Road overtopped. No building is inundated
10%	Avoca Road overtopped. Three properties are flooded. One is at upstream of Avoca Road and two are at downstream of Back Creek near Ballarat-Maryborough Road
5%	Three properties are flooded as above
2%	Three properties are flooded as above
1%	Five additional properties are flooded. Four are at downstream of Avoca Road and one is near Powells Road
0.5%	Eight properties are flooded as above

1.3 Properties affected

A summary of the number of properties likely to be flooded at Talbot is provided in Table 32.

Table 32: Summary of properties affected						
AEP	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
Buildings flooded above floor	0	0	2	2	4	7
Properties flooded but below floor level	0	3	1	1	4	1
Total properties flooded	0	3	3	3	8	8

1.4 List of properties likely to be flooded

Table 33: Detailed list of properties flooded												
	Depth of flooding near building for each AEP						**Depth of over floor flooding for each AEP**					
Address	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
6 Argyle St		< 0.1	0.1	0.2	0.3	0.3			0.1	0.2	0.3	0.3
5 Barnes St					< 0.1	0.1					0.2	0.3
10 Barnes St					0.1	0.2					0.3	0.4
10 Barnes St					0.1	0.2						< 0.1
10 Barnes St*					0.1	0.2						0.1
15 Powells Rd					0.1	0.2						0.1
5335 Ballarat-Maryborough Rd		< 0.1	0.2	0.4	0.5	0.6						
5335 Ballarat-Maryborough Rd*		0.2	0.3	0.5	0.6	0.8			< 0.1	0.2	0.3	0.5

**A number of buildings on the same property*

1.5 Isolation

The main access roads for Talbot are the:

- Avoca Road
- Ballarat-Maryborough Road.

Ballarat-Maryborough Road overtops in a 20% AEP event and Avoca Road overtops in a 10% AEP event. Events larger than the 0.5% AEP event haven't been modelled. Table 34 summarises the main road inundation. Along with the main roads there are a number of local roads which also being to become inundated during a 20% AEP event.

Table 34: Summary of road inundation			
AEP	Roads impacted by flooding	Maximum depth over road (m)	Duration of inundation (hours)
20%	Avoca Road	0.0	0
	Ballarat-Maryborough Road	0.4	19
10%	Avoca Road	0.1	22
	Ballarat-Maryborough Road	0.6	22
5%	Avoca Road	0.2	22
	Ballarat-Maryborough Road	0.7	22
2%	Avoca Road	0.3	25
	Ballarat-Maryborough Road	0.8	26
1%	Avoca Road	0.4	26
	Ballarat-Maryborough Road	0.9	27
0.5%	Avoca Road	0.4	26
	Ballarat-Maryborough Road	1.3	27

1.6 Flood intelligence card

Table 35: Flood intelligence card			
AEP	Rainfall (mm)	Consequence / Impacts	Actions
-	Heavy rain on wet catchment	▪ The capacity of the town stormwater drainage system maybe exceeded. ▪ Local nuisance flooding will occur along the side of roads and within some properties. ▪ No over-floor flooding expected.	▪ Consider deploying “water over road signs” at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.
20%	~20mm in 1hr to ~25mm in 3hr	▪ Flows out onto the floodplain. ▪ Several local roads inundated. ▪ Ballarat-Maryborough Road overtopped by 400mm.	▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Ballarat-Maryborough Road.
10%	~25mm in 1hr to ~30mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 20% AEP with increased depths. ▪ Several local roads inundated. ▪ 3 properties flooded but below floor level. Refer to Table 33. ▪ Ballarat-Maryborough Road overtopped by 600mm and Avoca Road overtopped by 100mm.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Ballarat-Maryborough Road and Avoca Road. ▪ Sandbag buildings that are at risk (Refer to Table 4)

Table 35: Flood intelligence card			
AEP	**Rainfall (mm)**	**Consequence / Impacts**	**Actions**
5%	~30mm in 1hr to ~35mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 10% AEP with increased depths. ▪ 3 properties flooded with 2 above floor. Refer to Table 33. ▪ Ballarat-Maryborough Road overtopped by 700mm and Avoca Road overtopped by 200mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 33). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Ballarat-Maryborough Road and Avoca Road.
2%	~35mm in 1hr to ~40mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 5% AEP with increased depths. ▪ 3 properties flooded with 2 above floor. Refer to Table 33. ▪ Ballarat-Maryborough Road overtopped by 800mm and Avoca Road overtopped by 300mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 33). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Ballarat-Maryborough Road and Avoca Road.
1%	~40mm in 1hr to ~50mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 2% AEP with increased depths. ▪ 8 properties flooded with 4 above floor. Refer to Table 33. ▪ Ballarat-Maryborough Road overtopped by 900mm and Avoca Road overtopped by 400mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 33). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Ballarat-Maryborough Road and Avoca Road.
0.5%	A little above the 1% AEP line on the quick look flood / no flood tool	▪ Flows out onto the floodplain. Extent is fairly similar to the 1% AEP with increased depths. ▪ 8 properties flooded, 7 above floor. Refer Table 33. ▪ Ballarat-Maryborough Road overtopped by 1300mm and Avoca Road overtopped by 400mm. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 33). ▪ Implement appropriate response actions that may include deploying “water over road” signs ▪ Put out “road closed” signs for Ballarat-Maryborough Road and Avoca Road.

1.7 Indicative quick look flood / no flood tool

The tool is aimed at providing a rapid indication of whether flooding is likely with some lead time. It is intended to be indicative only and will not provide a forecast of expected flood depth. The tool is designed to be linked to the mapping and intelligence produced by this project and in that way provides an indication of likely consequences.

The tool is driven by rainfall recorded at Bet Bet Creek at Lillicur (407288). IFD data from this location has been compared to the study area specific IFD data. Adjusted rainfall depths were then plotted against time to produce the tool as shown in Figure 30.

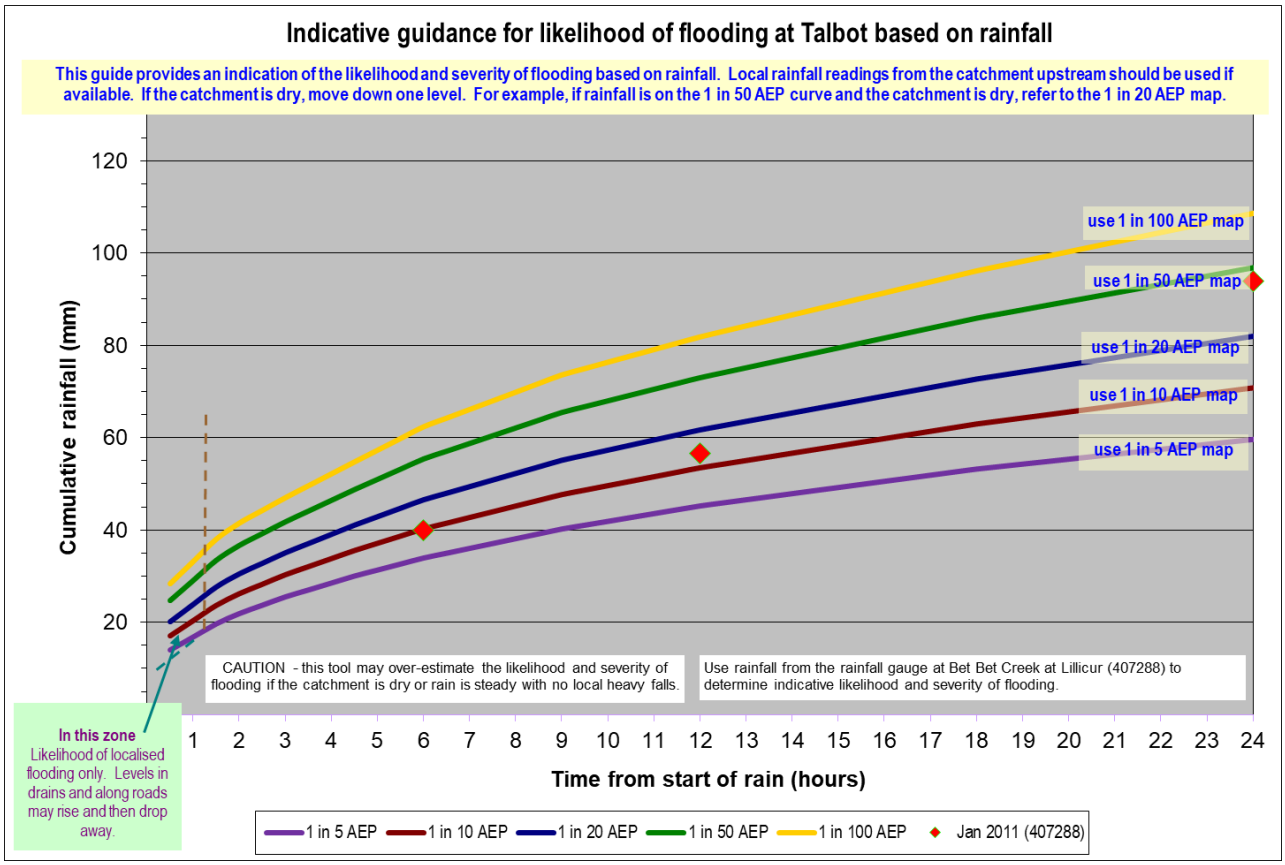


Figure 30: Quick look tool

1.8 Guidance on the use of the quick look flood / no flood tool

The quick look indicative flood / no flood tool provided in Figure 30 gives guidance on the likelihood and severity of expected flooding at Talbot.

Rainfall recorded at Bet Bet Creek at Lillicur (407288) was used to develop the quick look tool. As the data being used comes from a rain gauge that is outside the Talbot catchment, the tool may not perform to expectations in severe thunderstorm situations and/or when there is locally heavy rainfall embedded in more general rain. In such situations, rainfalls recorded more locally are likely to drive a more accurate indication of flooding and likely severity.

Appendix C8 – Timor-Bowenvale community flood emergency plan

1. Overview of flooding consequences

Timor and Bowenvale have a combined population of approximately 240 and are located approximately 58km south-west of Bendigo. Bet Bet Creek runs through the centre of Timor. The upstream catchment area is 485km². The creek channel is relatively well defined with two main tributaries, Timor Creek and Chinamans Billy Goat Creek joining within the study area. Figure 37 shows the location.

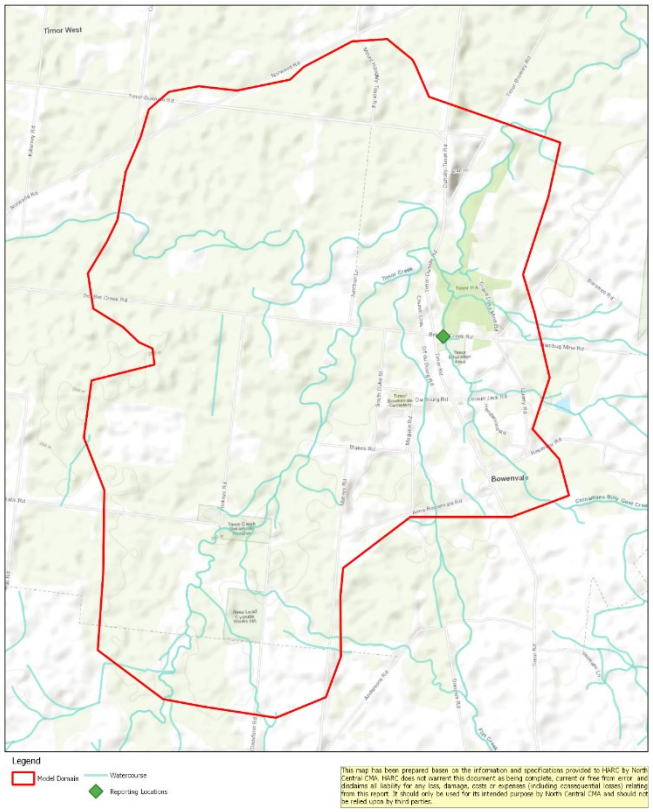


Figure 37: Map of Timor-Bowenvale study area with reporting location

1.1 Warning times

Flooding in Timor-Bowenvale can be caused by either overland flooding from the local catchment, or from riverine flooding from Bet Bet Creek, Timor Creek and/or Chinamans Billy Goat Creek. Stormwater runoff will begin within minutes of intense rainfall over the town. Flood waters in each of the creeks will begin to rise within a few hours of heavy rainfall commencing. Flooding occurs rapidly with floods peaking approximately 10 hours after stream levels begin to rise. Figure 38 shows typical response and times to rise for a number of design floods. Figure 37 shows the location of the hydrographs.

1.2 Areas affected

Floodwaters break out of Bet Bet Creek and inundate Timor-Dunolly Road in a 20% AEP event along with the inundation of a property. A summary of flooding for a number of design events is given in Table 43. Details of individual properties and buildings inundated are provided in Table 45.

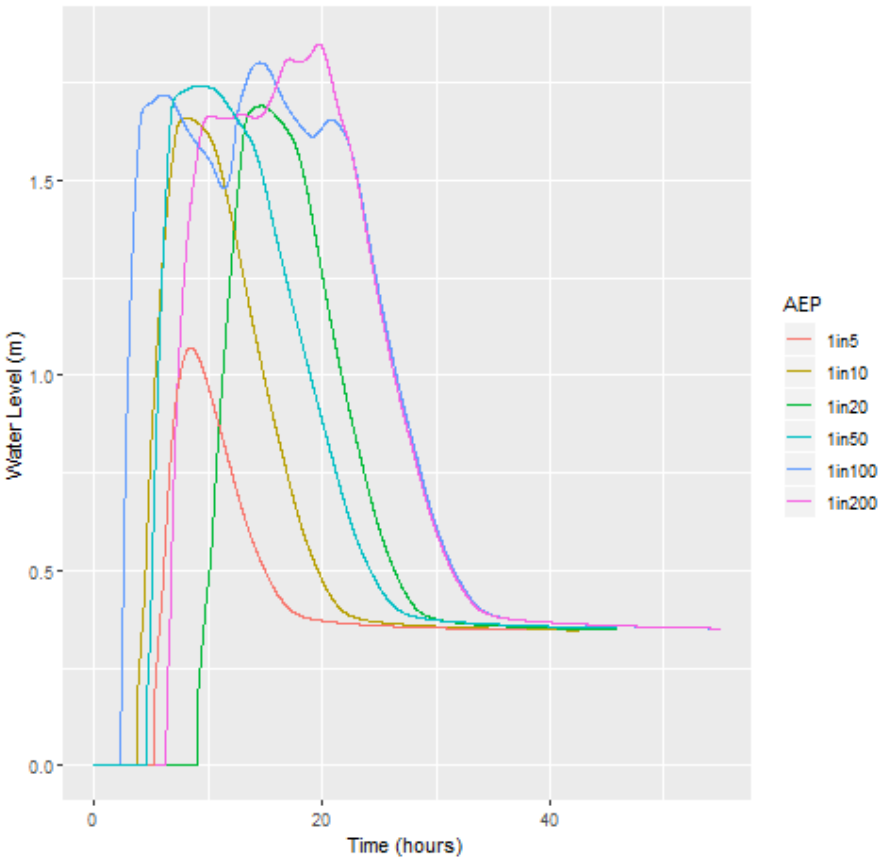


Figure 38: Design event hydrographs (HARC, 2020)

Table 43: Summary of impacts of flooding	
AEP	**Impact**
20%	Bet Bet Creek Road and Timor-Dunolly Road overtopped. One property is flooded just upstream of Bet Bet Creek Road
10%	Two additional properties are flooded upstream of Bet Bet Creek Road and upstream of Bet Bet Creek
5%	Three properties are flooded as above
2%	Two additional properties are flooded. One is at Timor township and one is near the intersection of Timor-Dunolly Road and Timor-Bromley Road
1%	Four additional properties are flooded. Three agricultural properties are flooded upstream of Bet Bet Creek and one is at Timor township
0.5%	Three additional properties are flooded. One agricultural property is flooded upstream of Bet Bet Creek and two residential properties are at Timor township

1.3 Properties affected

A summary of the number of properties likely to be flooded at Timor-Bowenvale is provided in Table 44.

Table 44: Summary of properties affected						
AEP	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
Buildings flooded above floor	0	0	0	1	1	2
Properties flooded but below floor level	1	3	3	4	8	10
Total properties flooded	1	3	3	5	9	12

1.4 List of properties likely to be flooded

Table 45: Detailed list of properties flooded												
	Depth of flooding near building for each AEP						**Depth of over floor flooding for each AEP**					
Address	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**	**20%**	**10%**	**5%**	**2%**	**1%**	**0.5%**
159 Bet Bet Creek Rd						0.2						
177 Bet Bet Creek Rd						0.1						< 0.1
177 Bet Bet Creek Rd					0.1	0.3						
177 Bet Bet Creek Rd		0.5	0.7	1.1	1.3	1.5						
398 Bet Bet Creek Rd	< 0.1	0.1	0.1	0.1	0.1	0.1						
396 Bet Bet Creek Rd		< 0.1	0.1	0.1	0.1	0.1						
20 Grand Duke Mine Rd						< 0.1						
105 Timor-Dunluce Rd					0.1	0.3						
63 Timor-Dunluce Rd					0.1	0.2						
1272 Dunolly-Timor Rd				0.3	0.6	0.8						
1281 Dunolly-Timor Rd					0.2	0.4						
1201 Dunolly-Timor Rd				0.2	0.3	0.4				0.2	0.3	0.4

1.5 Isolation

The main access roads for Timor-Bowenvale are the:

- Bet Bet Creek Road
- Timor-Dunolly Road
- Timor Road south of Bet Bet Creek Road.

Timor–Dunolly Road and Bet Bet Creek Road begin to overtop in a 20% AEP event. Timor Road south of Bet Bet Creek Road begins to overtop in a 5% AEP event. Events larger than the 0.5% AEP event haven't been modelled. Table 46 summarises the main road inundation. Along with the main roads there are a number of local roads which also being to become inundated during a 20% AEP event.

Table 46: Summary of road inundation

AEP	Roads impacted by flooding	Maximum depth over road (m)	Duration of inundation (hours)
20%	Bet Bet Creek Road at Chinamans Billy Goat Creek	0	0
	Timor-Dunolly Road	0.3	17
	Timor Road south of Bet Bet Creek Road	0	0
	Bet Bet Creek Road at Flat Creek	< 0.1	4
	Bet Bet Creek Road at Bet Bet Creek	0	0
10%	Bet Bet Creek Road at Chinamans Billy Goat Creek	0	0
	Timor-Dunolly Road	1.1	24
	Timor Road south of Bet Bet Creek Road	0	0
	Bet Bet Creek Road at Flat Creek	0.1	8
	Bet Bet Creek Road at Bet Bet Creek	0.1	5
5%	Bet Bet Creek Road at Chinamans Billy Goat Creek	0	0
	Timor-Dunolly Road	1.5	28
	Timor Road south of Bet Bet Creek Road	< 0.1	2
	Bet Bet Creek Road at Flat Creek	0.1	10
	Bet Bet Creek Road at Bet Bet Creek	0.1	7
2%	Bet Bet Creek Road at Chinamans Billy Goat Creek	0	0
	Timor-Dunolly Road	1.9	30
	Timor Road south of Bet Bet Creek Road	0.1	5
	Bet Bet Creek Road at Flat Creek	0.1	11
	Bet Bet Creek Road at Bet Bet Creek	0.2	10
1%	Bet Bet Creek Road at Chinamans Billy Goat Creek	< 0.1	19
	Timor-Dunolly Road	2.1	40
	Timor Road south of Bet Bet Creek Road	0.1	8
	Bet Bet Creek Road at Flat Creek	0.1	21
	Bet Bet Creek Road at Bet Bet Creek	0.3	21
0.5%	Bet Bet Creek Road at Chinamans Billy Goat Creek	0.1	19
	Timor-Dunolly Road	2.3	40
	Timor Road south of Bet Bet Creek Road	0.2	8
	Bet Bet Creek Road at Flat Creek	0.1	21
	Bet Bet Creek Road at Bet Bet Creek	0.4	21

1.6 Flood intelligence card

Table 47: Flood intelligence card

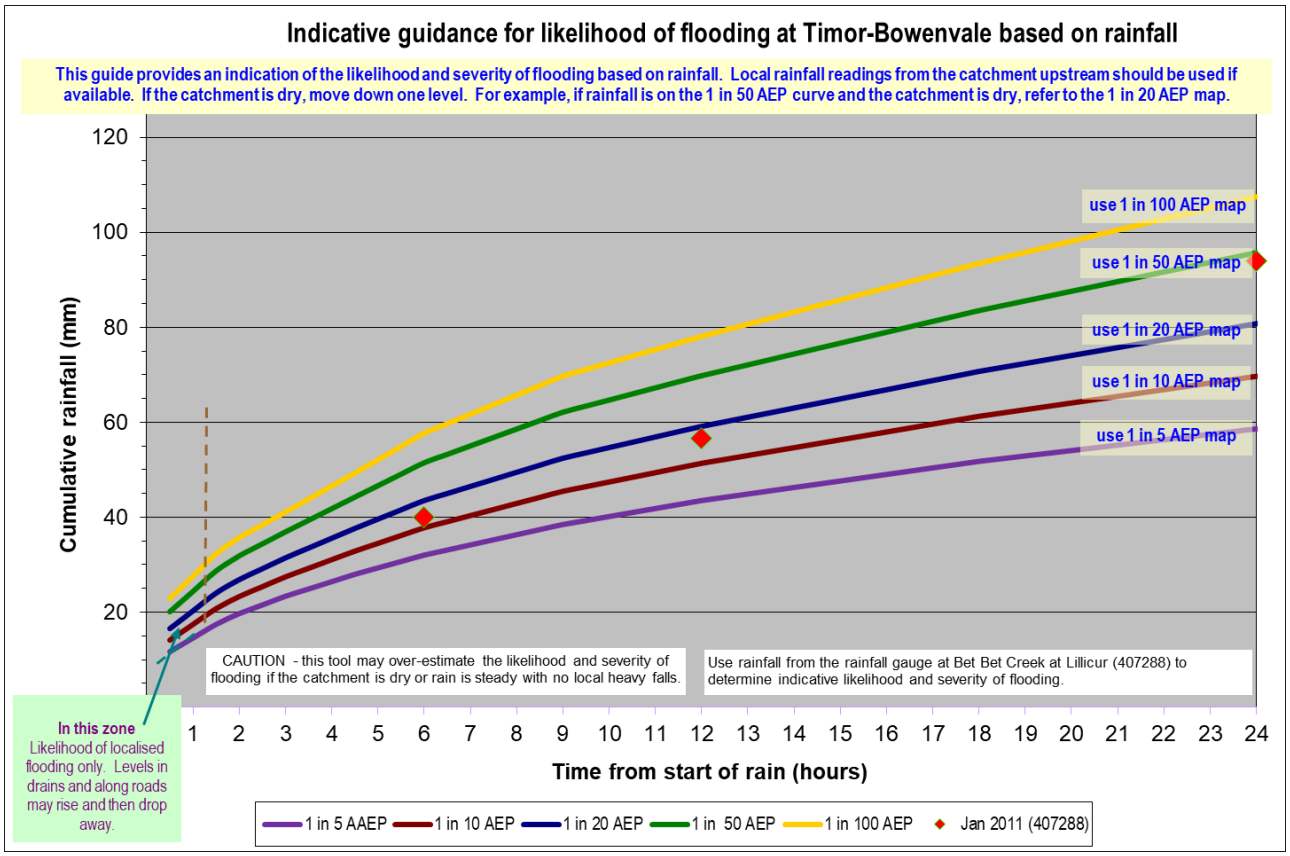
AEP	Rainfall depth (mm)	Consequence / Impacts	Actions
-	Heavy rain on wet catchment	▪ The capacity of the town stormwater drainage system maybe exceeded. ▪ Local nuisance flooding will occur along the side of roads and within some properties. ▪ No over-floor flooding expected.	▪ Consider deploying “water over road signs” at hot spots. ▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event.
20%	~15mm in 1hr to ~20mm in 3hr	▪ Flows out onto the floodplain. ▪ Several local roads inundated. ▪ 1 property flooded but below floor level. Refer to Table 45. ▪ Timor –Dunolly Road overtopped by 300mm and Bet Bet Creek Road just beginning to overtop.	▪ Monitor rainfall and water levels. ▪ Use the quick look flood / no flood tool to develop an appreciation of the likely scale of the flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Timor-Dunolly and Bet Bet Creek Road. ▪ Sandbag buildings that are at risk (Refer to Table 45).
10%	~20mm in 1hr to ~25mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 20% AEP with increased depths. ▪ Several local roads inundated. ▪ 3 properties flooded but below floor level. Refer to Table 45. ▪ Timor–Dunolly Road overtopped by 1100mm and Bet Bet Creek Road is beginning to be overtopped by 100mm.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Timor-Dunolly and Bet Bet Creek Road. ▪ Sandbag buildings that are at risk (Refer to Table 45).
5%	~25mm in 1hr to ~30mm in 3hr	▪ Flows out onto the floodplain. Extent is fairly similar to the 10% AEP with increased depths. ▪ 3 properties flooded but below floor level. Refer to Table 45. ▪ Timor–Dunolly Road overtopped by 1500mm, Bet Bet Creek Road is beginning to be overtopped by 100mm and Timor Road just starting to overtop. ▪ Several local roads inundated.	▪ Continue to monitor rainfall and water levels. ▪ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ▪ Refer to indicated maps for impacts. ▪ Sandbag buildings that are at risk (Refer to Table 45). ▪ Implement appropriate response actions that may include deploying “water over road” signs. ▪ Put out “road closed” signs for Timor-Dunolly, Bet Bet Creek Road and Timor Road south of Bet Bet Creek Road.
2%	~30mm in 1hr to	▪ Flows out onto the floodplain. Extent is fairly similar to the 5%	▪ Continue to monitor rainfall and water levels.

Table 47: Flood intelligence card			
AEP	**Rainfall depth (mm)**	**Consequence / Impacts**	**Actions**
	~35mm in 3hr	AEP but with increased flood extent downstream of town and increased depths overall. ■ 5 properties flooded with 1 above floor. Refer to Table 45. ■ Timor–Dunolly Road overtopped by 1900mm, Bet Bet Creek Road is beginning to be overtopped by 300mm and Timor Road is being overtopped by 100mm. ■ Several local roads inundated.	■ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ■ Refer to indicated maps for impacts. ■ Sandbag buildings that are at risk (Refer to Table 45). ■ Implement appropriate response actions that may include deploying “water over road” signs. ■ Put out “road closed” signs for Timor-Dunolly, Bet Bet Creek Road and Timor Road south of Bet Bet Creek Road.
1%	~35mm in 1hr to ~40mm in 3hr	■ Flows out onto the floodplain. ■ Extent is fairly similar to the 2% AEP but with increased flood extent downstream of town and increased depths overall. ■ 9 properties flooded with 1 above floor. Refer to Table 45. ■ Timor–Dunolly Road overtopped by 2100mm, Bet Bet Creek Road is beginning to be overtopped by 300mm and Timor Road is being overtopped by 100mm. ■ Several local roads inundated.	■ Continue to monitor rainfall and water levels. ■ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ■ Refer to indicated maps for impacts. ■ Sandbag buildings that are at risk (Refer to Table 45). ■ Implement appropriate response actions that may include deploying “water over road” signs. ■ Put out “road closed” signs for Timor-Dunolly, Bet Bet Creek Road and Timor Road south of Bet Bet Creek Road
0.5%	A little above the 1% AEP line on the quick look flood / no flood tool	■ Flows out onto the floodplain. Extent is fairly similar to the 1% AEP but with increased flood extent downstream of town and increased depths overall. ■ 12 properties flooded with 2 above floor. Refer to Table 45. ■ Timor–Dunolly Road overtopped by 2300mm, Bet Bet Creek Road is beginning to be overtopped by 400mm and Timor Road is being overtopped by 200mm. ■ Several local roads inundated.	■ Continue to monitor rainfall and water levels. ■ Continue to use / maintain plot on the quick look flood / no flood tool in order to further develop appreciation of likely scale of flood event. ■ Refer to indicated maps for impacts. ■ Sandbag buildings that are at risk (Refer to Table 45). ■ Implement appropriate response actions that may include deploying “water over road” signs. ■ Put out “road closed” signs for Timor-Dunolly, Bet Bet Creek Road and Timor Road south of Bet Bet Creek Road.

1.7 Indicative quick look flood / no flood tool

The tool is aimed at providing a rapid indication of whether flooding is likely with some lead time. It is intended to be indicative only and will not provide a forecast of expected flood depth. The tool is designed to be linked to the mapping and intelligence produced by this project and in that way provides an indication of likely consequences.

The tool is driven by rainfall recorded at Bet Bet Creek at Lillicur (407288). IFD data from this location has been compared to the study area specific IFD data. Adjusted rainfall depths were then plotted against time to produce the tool as shown in Figure 40.



1.8 Guidance on the use of the quick look flood / no flood tool

The quick look indicative flood / no flood tool provided in Figure 40 gives guidance on the likelihood and severity of expected flooding at Timor-Bowenvale.

Rainfall recorded at Bet Bet Creek at Lillicur (407288) was used to develop the quick look tool. The tool may not perform to expectations in severe thunderstorm situations and / or when there is locally heavy rainfall embedded in more general rain.

Appendix D – Flood warnings systems

1. Introduction

Flood Warning products and Flood Class Levels can be found on the BOM website. Flood Warning products include Severe Thunderstorm Warnings, Severe Weather Warnings, Flood Watches and Flood Warnings.

2. Severe Thunderstorm and Severe Weather Warnings

BOM can forecast the environment in which severe thunderstorms or small scale weather systems that are locally intense and slow moving may occur and provides a generalised service to that effect. However, it is not yet scientifically possible to predict individual flash flooding events except on time scales of tens of minutes at the very best.

BOM issues warnings of flash flooding when it becomes apparent that an event has commenced which may lead to flash flooding or when flash flooding has commenced.

3. Flood Watches

Flood watches are issued by BOM to notify communities and other stakeholders within broad areas (rather than specific catchments) of the potential flood threat from a developing weather situation. They provide a 'heads up' of likely flooding.

Flood watches are based on an assessment of the developing weather situation and indicators of current catchment wetness. They provide generalised statements about expected forecast rainfall totals, the current state of the catchments within the target area and the streams at risk from flooding. Instructions for obtaining rain and stream level observations and access to updated Watches and Warnings are also included.

Normally, BOM would issue a Flood Watch 24 to 36 hours in advance of any likely flooding and issue updates as required. If at any time during that period there was an imminent threat of floods occurring, the Flood Watch would be upgraded to a Flood Warning.

4. Flood Warnings

Overview

Flood Warnings are firm predictions of flooding based on actual rainfall and river height information as well as the results of streamflow-based models of catchment behaviour that take account of antecedent conditions (i.e. the 'wetness' of the catchment, storage levels within dams, etc) and likely future rainfall. Releases from dams are an essential input to such models.

Flood warnings are categorised as Minor, Moderate or Major (see BOM website for explanation of these terms and current flood class levels) and indicate the expected severity of the flood for agreed key locations along the river. More specifically, flood warnings usually include:

- Rainfall amounts for selected locations within and adjacent to the catchment
- River heights and trends (rising, steady, falling) at key locations within the catchment
- Outflows (in ML/d) from any major dams within the catchment
- Forecasts of the height and time of flood peaks at key locations
- Weather forecast and the likely impact of expected rainfall on flooding
- A warning re-issue date and time.

Note 1: The term "local flooding" may be used for localised flooding resulting from intense rainfall over a small area.

Note 2: The term “significant rises” may be used in the early stages of an event when it is clear that river levels will rise but it is too early to say whether they will reach flood level.

Additional information (e.g. weather radar and satellite images as well as updated rain and river level information) can also be obtained from the Bureau’s website (www.bom.gov.au/hydro/flood/vic) or for the cost of a local call on ☎ 1300 659 217.

4.1 McCallum Creek and Tullaroop Creek

There are currently no specific flood warning systems or arrangements in place for McCallum Creek, Tullaroop Creek or the Carisbrook Township. The tool provided in Section 7.6 of Appendix C1 does however provide indicative guidance on the likelihood and expected severity of flooding at Carisbrook based on consideration of rainfall.

4.2 Burnt Creek and Dunolly

There are currently no flood warning systems or arrangements in place for Burnt Creek or for Dunolly. The tool provided in Section 7.5 of Appendix C2 does however provide indicative guidance on the likelihood and expected severity of flooding at Dunolly based on consideration of rainfall.

5. 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).

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. 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.

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.

6. Local Flood Warning System Arrangements

Carisbrook

Use of the Carisbrook CFA siren as a warning communication method is currently promoted in the Carisbrook Local Flood Guide (LFG) produced by VICSES. The LFG states that “the Carisbrook CFA fire siren may be used to inform residents of a community flood meeting or to warn if the town is in the direct path of flood water as was done in 2016. Have a chat with your local CFA member to understand these types of local community notification”.

Although the siren was utilised in 2016, its activation for the 2022 flood event was delayed, in part due to a lack of shared understanding of trigger points across agencies. The *Carisbrook Flood Warning System Review* [July 2023] commissioned by NCCMA recommended that agencies "develop a local protocol for the use of the CFA siren as a flood warning communication method".

On behalf of the MFEPC, VICSES will lead a collaborative review of the siren's activation process and procedures. This work is expected to be completed during 2024 and will be followed by community engagement and an update of the LFG to ensure community members and visitors understand the outcomes of the review, the purpose of the siren and what action/s need to be taken upon its activation.

7. Flood class levels

The occurrence of a certain class of flooding at one point in a catchment will not necessarily lead to the same class of flooding at other points – for example along the main river and its tributary creeks or along a drainage network's overland flow paths. This is because the floodplain physiography and use (and thus flood impact) varies along the river or flow path and also because antecedent conditions combined with where and how rainfall occurs (both in time and space) will drive how a flood develops and progresses.

It is emphasised that the flood class levels quoted in the table below refer to that part of the watercourse where the flood effects can be related to the reading from the actual or proposed gauge.

It is important to remember that flood impact is dependent on more than the peak height or flow. The rate of rise, duration, extent and season of flooding are also important. For this reason, flood class levels can only be considered as a guide to flood severity.

Preliminary flood class levels have been proposed for the **Tullaroop Creek at Carisbrook** centred on a site on the right hand (east) bank of the creek immediately upstream of the Pyrenees Highway Bridge (see Section 7.4 – if gauge not installed the site is ideal for a PALS unit during a flood event) as follows:

- Minor flood level 190.700 m AHD
- Moderate flood level 192.200 m AHD
- Major flood level 193.000 m AHD

.

8. Details of relevant gauges

Station No	River / Creek	Station	Flood Class Levels (m)			Gauge Zero (m AHD)	Comments
			Minor	Moderate	Major		
407214A	Creswick Creek	Clunes					Telemetry with rain gauge by CGSC. 42km upstream from Carisbrook
407222A	Tullaroop Creek	Clunes	---	---	---	253.076	Telemetry with rain gauge by CGSC. At road bridge 10km downstream from Clunes.
407244	Tullaroop Creek	Tullaroop Reservoir HG	---	---	---		G-MW monitored site. Approx 7km upstream of Carisbrook.
407248A	Tullaroop Creek	Tullaroop Res outlet	---	---	---		Of no relevance if reservoir is spilling. Telemetry with rain gauge by CGSC
407213C	McCallum Creek	Carisbrook	---	---	---	193.193	Approx 5km upstream of Carisbrook. Telemetry with rain gauge by CGSC
407211B	Bet Bet Creek	Bet Bet	4.00	---	---		Telemetry with rain gauge by CGSC. 1km upstream from Bet Bet
407220A	Bet Bet Creek	Norwood	---	---	---		Telemetry with rain gauge by CGSC. 22km upstream from Bet Bet.
407288a	Bet Bet Creek	Lillicur					Telemetry with rain gauge by CGSC. 59km upstream from Bet Bet
408206B	Avoca River	Archdale	---	---	---		Approx 3km upstream from Cherry Tree Creek junction. Telemetry with rain gauge by CGSC
408220	Avoca River	Avoca					
TBA	Upper McCallums Creek	Evansford – exact location to be confirmed with consultation from CHW	---	---	---		Telemetry Rain Gauge. Telemetry with rain gauge by CGSC

Appendix E – Agency action matrix

The following action matrix shows the agreed actions by agencies leading up to and during a flood event within Central Goldfields. The matrix is a guide to ensure that there is an understanding of agency roles and expectations during flood events.

Common Actions	VICSES	COUNCIL	POLICE	CFA	Community
Situation triggers					
Severe weather warning issued by BOM, with the risk of heavy rainfalls likely to cause flooding and/or a Flood Watch has been issued	• **Contact MEMO, MERC, CFA Group Officer and NCCMA to provide initial situational awareness** • **Incident control/Div Comm. Point facility considered for standby**	• Check all reservoirs (Goldfields, Timor, Dunolly, Bealiba) overflows • Council checks sandbag supplies and sand supplies. • Ensure Council has adequate signs. • Check staff availability. • Free up trailers for support.	• Receive notification text from water catchments/SES	• Receive notification by pager.	• Residents prepare for heavy rain and possible flooding. • Purchase sand and sandbags.
• Flood warning from BOM & SES for Avoca R, Loddon R, Tullaroop or Bet Bet Crks. • Flooding likely on key streams and creeks without warning levels.	• **Consider local knowledge sources** • **Maintain contact with Council, VicPol, CFA Grp.Officer & CMA** • **SES contact Council for access to Depot** • **L1 ICP initiated at LHQs** • **Monitor reservoir outflows for Tullaroop (G-MW), Cairn Curran (G-MW) available on BOM Website, Evansford, (CHW)**	• Check all reservoirs (Goldfields, Timor, Dunolly, Bealiba) overflows • Council checks sandbag supplies and sand supplies. • Ensures Dunolly SES has signs trailer. • Ensure Council has adequate signs. • Put staff on standby. • Free up trailers for support.	• Receive notification text from water catchments/SES. • Liaise with Council. • Check rosters. • Check availability of members. • Send units out to gather intelligence & confirm reports of flooding and provide feedback to SES & Council.	• Receive notification by pager. • Provide ground observation info to SES	• Residents prepare for heavy rain and possible flooding. • Purchase sand and sandbags.

• Predicted heavy rainfall is occurring. • Lexton and Creswick area experiencing heavy flooding. • Burnt Creek, Mount Moliagul and Black Ranges receiving heavy rainfall. • Bet Bet Creek flooding at Bung Bong. • Avoca township flooding levels (including Avoca Football field)	• **SES to consider escalating local incident control level.** • **Situation reports to RDO.** • **Regular contact with local knowledge on streams maintained.** • **VICSES distributing Community information/warnings.** • **Local EMT formed to discuss likely consequences and actions required.** • **Ensure Dunolly has adequate sand and sandbags**	• Council proactive in putting out water over roads signage and/or closing roads where appropriate. • MOC set up not staffed. • Participate in Local EMT • Prepare for sandbag filling	• Participate in Local EMT. • Set up IPOC • Monitoring/enforcing road closures & road diversions • Confirm staff availability • Considering evacuation/resources • Assess staff isolation risk. • Vulnerable communities • Advise communities to activate safety plans/Media	• Notify Brigades in risk areas to be on standby. • Participate in Local EMT • Provide ground observation info to SES	• Implement personal flood plan.
• Areas of flooding & significant numbers of Requests For Assistance (RFA) received by VICSES • Multiple connector road closures. • Flooding of properties likely	• **Monitor access & egress routes for crews.** • **Incident Command Centre/Divisional Command Point established.** • **SES is responding to RFAs.** • **Seek support/relief crews.** • **Assess at risk areas for partial/full evacuation.** • **EMLO's from VicPol, CFA and Local Government into Divcom/ICC.**	• MRM reviews Dunolly staffing on standby (ERC staff). • Council advises VicRoads, VicPol and VICSES ICC of road closures. • Low level MOC initiated • Depot begins filling sandbags for Council use • Call in crews. • Consider availability of staff and facilities for relief centres. • ID buses for possible evacuations. • Provide EMLO to ICC/Div Comm. Point	• Monitor access & egress routes for crews. • MOC operating and staffed by police. • Police Operations Centre operating. • Identify personnel to support key locations. • Protracted staffing for the event. • Consider implementation of evacuation plans. • Provide EMLO to ICC/Div Comm. Point	• Monitor access & egress routes for crews • Provide info on road inundation and at risk properties to SES & Council • Provide EMLO to ICC/Div Comm Point • Provide crews to support SES as required	• Community to monitor websites, VicRoads. BOM, Emergency Services Broadcasts and ABC Radio • Be alert and monitor Emergency Broadcasters for Emergency Warnings and community information. • Monitor their immediate environment for flood risks

Appendix F – Sandbags

This applies to the procurement, storage, distribution, use and disposal of sandbags during flood emergencies, primarily riverine flood events. Sandbag distribution in response to flash flood events, due to their quick nature, may be directed by the local VICSES Unit.

1. Use

Sandbags can be used to block doorways, drains and other openings into properties as well as to weigh-down manhole covers, garden furniture and to block sinks, toilets and bath drains to prevent water backing up. They have proven to be successful in keeping water out for short periods of time.

Sandbagging is not always the most effective option and should be considered in the context of this Plan which includes alternatives for managing flood risk. Other alternatives include moving possessions to higher places, securing objects so they do not float away and placing valuables in water tight containers. During a flood event the Incident Controller or VICSES Incident Agency Commander (IAC) will assess the overall risk to communities and allocate sandbag resources based on risk.

2. Responsibilities

VICSES

- The management of state-wide procurement and storage of sandbags for flood emergencies
- Providing sandbags to local areas for distribution based on requirements identified in this Plan
- Identifying distribution arrangements
- Community education and awareness on sandbag management and safe use
- Identifying Critical Infrastructure and Community Critical Facilities
- Providing a support role in flood recovery.

Council

- Supporting VICSES in developing the MFEP
- Providing a support role during flood response
- Identifying Community Critical Facilities at a municipal level which are captured in our Vulnerable Groups and Facilities Register (Crisisworks)
- Procuring sandbags to protect council owned facilities including Community Critical Facilities managed by council
- Providing locations, where available and capable, to support sandbagging operations as agreed in this Plan
- Coordinating the clean-up and community recovery arrangements.

Community Critical Facility owners' responsibilities

- Working with VICSES to develop an effective flood mitigation plan for their property as part of the MFEP with a priority for permanent structures.

Other 'Response' agencies responsibilities

- Supporting VICSES in their response role.

Residential and commercial property owners

- Understanding their own flood risk
- Preparing an emergency plan for their home or business
- Procurement and storage of sandbags to protect their own property
- Filling and movement of sandbags to protect their property
- Seek advice from Central Goldfields Shire regarding the removal of sandbags from their property, as part of the community recovery.

3. Community and business education

VICSES has an established community education program to support community and business in responding to flood emergencies. VICSES will use these community education tools and programs (such as Local Flood Guides) to promote practical information on:

- The purpose, use and disposal of sandbags
- Obtaining sandbags
- Safety considerations (e.g. OHS, manual handling, safe use and disposal)
- Alternative flood mitigation strategies
- Where to get information (e.g. VicEmergency Hotline 1800 226 226)
- The responsibilities of critical infrastructure owners, businesses and private individuals to understand their flood risk and develop a flood plan.

Key messages may include:

- Emergency response agencies will not always have the capacity to provide sandbags due to other competing priorities.
- Businesses and individuals need to understand the flood risk to their property and, where appropriate, develop a Flood Emergency Plan.
- Sandbagging is only one way of protecting properties against floodwater and not always the most effective option. Sandbagging should be considered in the context of a Flood Emergency Plan which considers alternatives for managing flood risk.

4. Procurement

VICSES

- VICSES will maintain a supply of sandbags to support the effective readiness and response to flood emergencies as identified in this Plan.
- The number of sandbags required will be determined from information provided through the planning process. There may be occasions where the supply of sandbags is limited and priorities for distribution will need to be determined through local emergency management arrangements.
- VICSES will maintain the current mutual aid arrangements for flood emergencies and will also work with local councils to access resource sharing arrangements established between councils during emergencies.

Council

- Council will procure sandbags to protect Council-owned facilities including Community Critical Facilities managed by Council.

Residential and commercial property owners

- Sandbags may be obtained (purchased) from hardware suppliers or rural suppliers. Sand may be obtained from sand and soil suppliers.

5. Storage

Sandbags will be stored by VICSES in appropriate locations across the municipality. VICSES will monitor the condition of its sandbags for deterioration. Sandbag storage locations and initial quantities:

- Maryborough VICSES Local Headquarters (LHQ) – 4000 bags (minimum)
- Dunolly VICSES Local Headquarters (LHQ) – 4000 bags (minimum)
- Carisbrook CFA Fire Brigade – 4000 bags (minimum).

Additional sandbag supplies are held at the VICSES office located in Bendigo. These can be accessed for replenishment or additional requirements. Additional sandbags will be supplied to these locations in the lead up to a flood event.

Central Goldfields maintains a small stock of sandbags at the Maryborough Works Depot for protection of essential Council assets. These are not for use of the general public. Council will monitor the condition of its sandbags for deterioration.

The sand at the Maryborough Works Depot is available for use of VICSES members upon activation/request, however it must be relocated if needed for a public sandbag point as it is not feasible to have large numbers of community members attend the Depot.

NB: Sand will be kept separate to the bags to ensure extended shelf life with arrangements in place to obtain additional sand locally, during business hours.

Council is a signatory to the Municipal Association of Victoria Protocol for Inter-Council Emergency Management Resource Sharing. Council also has an arrangement with neighbouring Councils and with Northern Victorian Cluster Councils for sharing resources, as required.

6. Distribution

Priorities

The Incident Controller may make sandbags and sand available for flood mitigation activities during declared flood emergencies. Consistent with the State Emergency Management Priorities and the SEMP Flood Sub-Plan, sandbags will be issued in priority order of protecting:

1. Community Critical Infrastructure identified:
    a. in the MEMP or this Plan; or
    b. by the Incident Management Team
2. Residential properties identified in the potential flood area
3. Commercial properties identified in the potential flood area
4. Environmental and conservation areas identified in the potential flood area.

As a guide, 25 sandbags are reasonable to supply to residents to allow for coverage of doorways, blocking vents, drains and toilets. If sandbag supplies are limited, then priority will be given to protection of critical infrastructure. Additional sandbags may be provided on a case-by-case basis with regard to individual issues and local priorities identified by the IMT.

Households in flood prone areas are encouraged to plan for potential risk of flooding and purchase 25 empty Hessian sandbags or more according to their need. Any properties identified as being outside the potential flood area will be referred to an alternative source of sandbags (e.g. local hardware store or sandbag supplier).

Distribution points

In preparation for a significant flood emergency, VICSES will work with local councils and other agencies to identify **appropriate** locations for sandbag collection points. Location considerations will include access, safety, human resources and machinery requirements.

Possible sandbag collection points:

- Jubilee Oval, Burns Street, Maryborough 3465
- Roscholler Park, Kennedy Street, Maryborough 3465
- JN Hedges Memorial Park, Rinaldi Drive, Maryborough 3465
- Carisbrook Recreation Reserve, 8 McNeil Street, Carisbrook 3464
- Bucknall Reserve, McCallum Street, Carisbrook 3464
- Dunolly Recreation Reserve, 20 Elgin Street, Dunolly 3472
- Dunolly Racecourse Reserve, Dunolly-Timor Road, Dunolly 3472.

Additional and/or alternate points can be nominated by the IC based on risk and need.

The VICSES Sandbag Quick Reference Guide provides details to community members about the indicative number of sandbags required for residential property protection and guidance on the safe use, filling and laying of sandbags.

During response, the Incident Controller will track distribution of sandbags through the IMT and will provide this information to the recovery team as part of the transition from response to recovery.

7. Provision of sand

VICSES has plans in place to acquire sand through its own supply arrangements and where necessary through the emergency management arrangements. VICSES Units maintain a list of suppliers for their local area. During a localised non-declared flood event, sand will be procured by the local responding VICSES Unit. During a declared flood event, sand will be procured via the ICC.

Council will have arrangements in place to acquire sand for its own purposes. Where possible, sand should be sourced from local suppliers (e.g. garden supply centres).

8. Disposal and relocation of used sandbags

Sandbags may be contaminated after use and local councils should ensure that clean up and disposal is considered as part of recovery. Removal and disposal of sandbags used for flood mitigation shall be dealt with under the clean up and community recovery arrangements outlined in the SEMP. The disposal of sandbags is a shared responsibility between different agencies.

Incident Controllers will provide information on sandbag locations to councils, to assist with clean-up. VICSES will continue to work with relevant agencies to develop protocols for the safe and environmentally responsible disposal of sandbags.

Appendix G – References

The following studies are useful in understanding the nature of flooding in Central Goldfields.

- Hydrology and Risk Consulting (HARC) (July 2020): Rapid Flood Risk Assessment – North Central Region (Moliagul, Bet Bet, Talbot, Bealiba, Timor-Bowenvale)
- Water Modelling Solutions (May 2022): Maryborough Flood Study Draft Study Report
- Water Technology (August 2019): Carisbrook Flood Mitigation Modelling
- Water Technology (April 2013): Carisbrook Flood and Drainage Management Plan
- Water Technology (July 2014): Dunolly Flood Investigation

Other sources of information with direct relevance to the municipality include:

- Central Goldfields Municipal Emergency Management Plan (MEMP)
- North Central Catchment Management Authority for various references
- Planning Maps Online allows you to find a property and lets you turn on planning zones and overlays within a Council Planning Scheme.
- Planning Schemes Online provides access to all of Victoria's planning scheme provisions (planning controls) and maps.
- Water Measurement Information System (WMIS) for surface water (level, flow and quality) and groundwater (level and quality) monitoring data; contains real time data (less than 1 hour old) data for all telemetered surface water gauges and groundwater bores
- Bureau of Meteorology (BOM) for river gauge readings and flood warnings
- BOM Special Climate Statement 26: Record wet January brings unprecedented flooding to northwest Victoria
- Flood Victoria provides links to information from several different government departments and agencies and can direct you to other websites.
- Victoria State Emergency Service
- DEECA provides ongoing emergency recovery services to help Victorians respond to, rebuild and recover from floods, storms and bushfires.
- FloodZoom brings together flood forecasts, flood mapping, real-time river height gauges and property data to provide response agencies with improved knowledge of likely flood impacts.
- Central Goldfields Shire, NCCMA and VICSES' Geographical Information System (GIS) each contain layers showing drainage assets, flooding extents, flood related call-out locations, roads, title boundaries and other useful information.
- Water Technology (May 2012): Strategic Flood Intelligence Report – Loddon and Avoca Basins.

Relevant but more general references include:

- Agriculture and Resource Management Council of Australia and New Zealand. Standing Committee on Agriculture and Resource Management (SCARM) (2000): Report No 73: Floodplain management in Australia: best practice principles and guidelines.
- Bureau of Meteorology (2018): National Arrangements for Flood Forecasting and Warning
- EGIS Consulting (2000): Flood Data Transfer Project
- VICSES Caravan Park Emergency Management Plan tool to assist caravan park owners to meet their statutory obligations under the Residential Tenancies (Caravan Parks and Movable Dwellings Registration and Standards) Regulations 2010 (Regulations 22-25).
- Victorian Floodplain Management Strategy
- Water Act 1989
- Emergency Management Act 1986
- Emergency Management Act 2013
- Emergency Management Legislation Amendment Act 2018
- Australian Disaster Resilience Handbook Collection
  - Public Information and Warnings Handbook
  - Managing the Floodplain Handbook

- Flood Emergency Planning for Disaster Resilience Handbook
- Emergency Planning Handbook
- Manual 21: Flood Warning (2009)

1. Guidance on the use of the quick look Flood / No Flood tool

In the lead up to a flood

Unless there are unusual circumstances, actions as per the Flood Intelligence Cards in this Plan should be initiated as soon as the tool suggests flooding is likely. Response can be escalated if the tool indicates an increase in the expected severity of flooding.

During a flood - using the quick look tool

Plot cumulative rainfall depth against elapsed time on a copy of the tool. Do not start using the tool until rainfall exceeds approximately 2mm an hour (i.e. ignore early drizzle or very light rain).

At each time step, after plotting the cumulative rainfall, assess the likelihood and expected severity of flooding from the curves. Some degree of judgement is required to determine if the quick look tool is providing an answer that is in line with expected outcomes. When plotted rainfall data crosses a curve on Figure 5 this indicates that flooding of around that severity is possible.

If the catchment is dry, it would generally be appropriate to step down one level. For example, if the rainfall plot is on the 2% AEP curve and the catchment is dry, refer to the 5% AEP map and associated consequences listed in the flood intelligence card available in the Plan. The exception to this would be if there was very heavy rain on a dry catchment. In that circumstance, adopt a cautious approach and do not step down a level. If the catchment is dry and/or rain extends over more than 12 hours, the quick look tool will tend to over-estimate the likelihood of flooding.

The tool is based on reservoirs upstream being at FSL or very close to it (i.e. spilling during the event). If the storage is below FSL and unlikely to spill during the event, it would be appropriate to step down a level.

After a flood – updating the tool

After a flood event, plot the event rainfall depth (with date) on the quick look tool. At the same time, include an overview of the event, along with commentary on antecedent conditions and other relevant information, in the relevant Appendix of the Plan.

Example use of the quick look tool

The section below is a fictitious example of how to use the quick look tool. Table 94 shows the rainfall depths recorded at the rain gauge and the action to take on the basis of the recorded rainfall. Figure 81 shows the fictitious example plotted up on the quick look tool.

Note that in cases where the tool has not been used from the start of rain (i.e. from early in the event), data should be either picked up from the start of the event or the first data plotted should include an estimate of how much rain has fallen and the time over which it has fallen. If this is not done, the tool will likely under-estimate likely flood severity.

Table 94: Rainfall depths for example use of tool		
Time (hours)	**Rainfall Depth (mm)**	**Action**
0	1	Ignore
1	2	Ignore
3	2	Ignore
4	1	Ignore
5	15	Plot as 15mm at 1 hour
6	2	Plot as 17mm at 2 hours
7	10	Plot as 27mm at 3 hours
8	5	Plot as 32mm at 4 hours Indicates it may be a 5-year (20% AEP) event
9	12	Plot as 44mm at 5 hours Indicates it may be a 10-year (10% AEP) event Start planning for a 10% AEP event
10	2	Plot as 46mm at 6 hours More confident that a 10% AEP event is likely
11	5	Plot as 51mm at 7 hours
12	1	Plot as 52mm at 8 hours
13	3	Plot as 55mm at 9 hours
14	10	Plot as 65mm at 10 hours Indicates it may be a 20-year (5% AEP) event.
15	5	Plot as 70mm at 11 hours More confident that a 5% AEP event is likely
16	2	Plot as 72mm at 12 hours

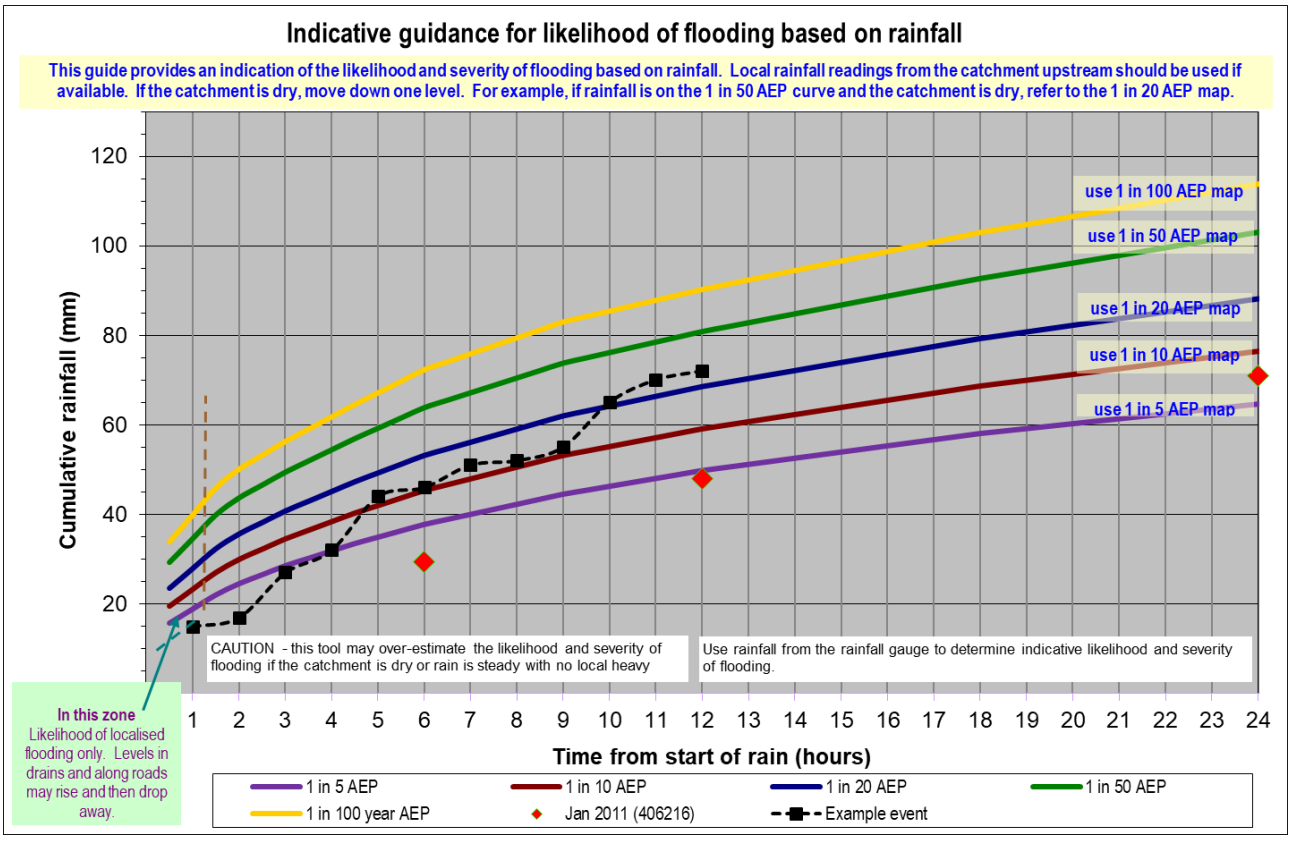


Figure 81: Quick look tool example