

APPENDIX 0

MITIGATION OPTION COSTING

SUMMARY OF COSTS

SCHEME NAME:

Kyabram Flood Study

SCHEME NO:

Mitigation Option P2

Scenario	Works Description	Estimated Construction Cost	Estimated Annual Maintenance Cost	
Final Mitigation P2	Preliminaries	\$100,000		
	Service Proving	\$30,000		
	Traffic Management	\$100,000		
	Basin Earthworks	\$453,431	\$2,267	
	Drainage	\$1,041,089	\$5,205	
	Service Alterations	\$150,000		
	Legal Cost	\$15,000		
	Environmental Management Plan	\$60,000		
		Sub-total 'A'	\$1,949,520	
		'A' x Engineering Fee @ 10%	\$194,952	
		Sub-total 'B'	\$2,144,472	
		'B' x Project Management Fee @ 5%	\$214,447	
		<i>(Land Acq only)</i> 'B' x Administration Fee @ 1%	\$0	-
		Sub-total 'C'	\$2,358,919	
	'A' x Contingencies @ 40%	\$779,808		
	FORECAST EXPENDITURE	\$3,138,727	\$7,473	

SUMMARY OF COSTS

SCHEME NAME:

Kyabram Flood Study

SCHEME NO:

Mitigation Option P4

Scenario	Works Description	Estimated Construction Cost	Estimated Annual Maintenance Cost
Final Mitigation P4	Preliminaries	\$50,000	
	Service Proving	\$20,000	
	Traffic Management	\$50,000	
	Drainage Upgrades	\$1,406,852	\$7,034
	Legal Cost	\$15,000	
	Environmental Management Plan	\$60,000	
		Sub-total 'A'	\$1,601,852
	'A' x Engineering Fee @ 10%	\$160,185	
	Sub-total 'B'	\$1,762,037	
	'B' x Project management Fee @ 5%	\$88,102	
	(Land Acq only) 'B' x Administration Fee @ 1%	\$0	-
	Sub-total 'C'	\$1,850,139	
	'A' x Contingencies @ 40%	\$640,741	
	FORECAST EXPENDITURE	\$2,490,880	\$7,034

SUMMARY OF COSTS

SCHEME NAME:

Kyabram Flood Study

SCHEME NO:

Mitigation Option P9

Scenario	Works Description	Estimated Construction Cost	Estimated Annual Maintenance Cost	
Final Mitigation P9	Preliminaries / Site establishment	\$50,000		
	Service Proving	\$20,000		
	Traffic Management	\$50,000		
	Title Survey and POA Overlay	\$40,000		
	Earthworks - Lowered Overland Flow Path	\$465,435	\$2,327	
	Land Acquisition	\$1,435,000		
	Vegetation Removal	\$98,000		
	Service Alteration	\$111,000		
	Legal Cost	\$30,000		
	Environmental Management Plan	\$60,000		
		Works Sub-total 'A'	\$924,435	
		'A' x Engineering Fee @ 10%	\$92,444	
	Project Sub-total 'B'	\$2,451,879		
	'B' x Project Management Fee @ 10%	\$101,688		
	(Land Acq only) 'B' x Administration Fee @ 1%	\$14,350	-	
	Sub-total 'C'	\$2,567,916		
	'A' x Contingencies @ 40%	\$369,774		
	FORECAST EXPENDITURE	\$2,937,691	\$2,327	

APPENDIX P

ARR2019 DATAHUB DOWNLOADS

Results - ARR Data Hub

[STARTTXT]

Input Data Information

[INPUTDATA]

Latitude,-36.316202

Longitude,145.051259

[END_INPUTDATA]

River Region

[RIVREG]

Division,Murray-Darling Basin

River Number,5

River Name,Goulburn River

Shape Intersection (%),100.0

[RIVREG_META]

Time Accessed,08 January 2020 04:25PM

Version,2016_v1

[END_RIVREG]

ARF Parameters

[LONGARF]

Zone,Southern Semi-arid

a,0.254

b,0.247

c,0.403

d,0.351

e,0.0013

f,0.302

g,0.058

h,0.0

i,0.0

Shape Intersection (%),100.0

[LONGARF_META]

Time Accessed,08 January 2020 04:25PM

Version,2016_v1

[END_LONGARF]

Storm Losses

[LOSSES]

Storm Initial Losses (mm),23.0

Storm Continuing Losses (mm/h),4.7

[LOSSES_META]

Time Accessed,08 January 2020 04:25PM

Version,2016_v1

[END_LOSSES]

Temporal Patterns

[TP]

code,MB

Label,Murray Basin

Shape Intersection (%),100.0

[TP_META]

Time Accessed,08 January 2020 04:25PM

Version,2016_v2

[END_TP]

Areal Temporal Patterns

[ATP]

code,MB

arealabel,Murray Basin

Shape Intersection (%),100.0

[ATP_META] Time Accessed,08 January 2020 04:25PM

Version,2016_v2

[END_ATP]

Median Preburst Depths and Ratios

[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),2.9 (0.166),2.6 (0.110),2.5 (0.086),2.4 (0.069),1.5 (0.035),0.8 (0.016)

90 (1.5),1.0 (0.052),1.0 (0.038),1.1 (0.032),1.1 (0.028),0.8 (0.017),0.5 (0.010)

120 (2.0),1.7 (0.082),1.8 (0.063),1.9 (0.055),2.0 (0.048),1.0 (0.021),0.3 (0.006)

180 (3.0),3.1 (0.132),3.1 (0.097),3.1 (0.081),3.1 (0.069),3.6 (0.067),4.0 (0.065)

360 (6.0),0.6 (0.021),1.5 (0.039),2.1 (0.046),2.7 (0.051),2.9 (0.045),3.0 (0.042)

720 (12.0),0.0 (0.000),0.4 (0.008),0.6 (0.011),0.8 (0.013),1.7 (0.023),2.4 (0.028)

1080 (18.0),0.0 (0.000),0.1 (0.002),0.2 (0.003),0.2 (0.003),0.9

(0.010),1.4 (0.014) 1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0

(0.000),0.3 (0.003),0.5 (0.004) 2160 (36.0),0.0 (0.000),0.0 (0.000),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000) 2880 (48.0),0.0 (0.000),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000) 4320 (72.0),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST_META]

Time Accessed,08 January 2020 04:25PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged. [END_PREBURST]

10% Preburst Depths

[PREBURST10]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0

(0.000),0.0 (0.000) 1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0

(0.000),0.0 (0.000),0.0 (0.000) 2160 (36.0),0.0 (0.000),0.0 (0.000),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000) 2880 (48.0),0.0 (0.000),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000) 4320 (72.0),0.0

(0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST10_META]

Time Accessed,08 January 2020 04:25PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged. [END_PREBURST10]

25% Preburst Depths

[PREBURST25]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.001),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST25_META]

Time Accessed,08 January 2020 04:25PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged. [END_PREBURST25]

75% Preburst Depths

[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),11.3 (0.652),15.2 (0.628),17.8 (0.609),20.3 (0.590),15.1 (0.362),11.2 (0.236)
90 (1.5),12.5 (0.644),13.2 (0.490),13.7 (0.421),14.1 (0.370),13.6 (0.295),13.2 (0.251)
120 (2.0),11.0 (0.523),13.6 (0.468),15.3 (0.439),16.9 (0.415),14.7 (0.299),13.0 (0.233)
180 (3.0),11.1 (0.469),13.6 (0.421),15.2 (0.396),16.8 (0.374),19.0 (0.353),20.7 (0.338)
360 (6.0),6.3 (0.219),9.2 (0.237),11.1 (0.242),12.9 (0.243),15.9 (0.252),18.2 (0.256)
720 (12.0),1.1 (0.032),5.9 (0.124),9.0 (0.161),12.0 (0.187),15.1 (0.198),17.5 (0.203)
1080 (18.0),0.7 (0.017),3.4 (0.063),5.2 (0.082),6.9 (0.094),11.4 (0.131),14.8 (0.151)
1440 (24.0),0.0 (0.000),1.6 (0.028),2.7 (0.039),3.8 (0.047),5.1 (0.053),6.1 (0.056)
2160 (36.0),0.0 (0.000),0.9 (0.013),1.5 (0.019),2.0 (0.022),2.0 (0.018),1.9 (0.015)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.4 (0.003),0.6 (0.005)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST75_META]

Time Accessed,08 January 2020 04:25PM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged. [END_PREBURST75]

90% Preburst Depths

[PREBURST90]

min (h)\AEP(%),50,20,10,5,2,1 60 (1.0),20.8 (1.206),26.9 (1.116),31.0

(1.063),34.9 (1.015),29.2 (0.701),24.9 (0.523) 90 (1.5),22.8 (1.168),23.6
(0.876),24.2 (0.746),24.8 (0.649),24.4 (0.531),24.2 (0.461) 120 (2.0),25.7
(1.217),30.1 (1.036),33.0 (0.948),35.8 (0.877),34.9 (0.709),34.1 (0.610)
180 (3.0),23.6 (0.996),27.0 (0.837),29.2 (0.761),31.4 (0.700),37.0
(0.689),41.3 (0.676) 360 (6.0),19.9 (0.688),22.9 (0.591),24.8 (0.542),26.7
(0.504),31.9 (0.505),35.8 (0.502) 720 (12.0),13.4 (0.378),19.3
(0.408),23.2 (0.416),26.9 (0.419),30.0 (0.392),32.3 (0.375) 1080
(18.0),10.2 (0.257),15.2 (0.285),18.5 (0.293),21.7 (0.297),24.6
(0.283),26.8 (0.273) 1440 (24.0),1.1 (0.025),6.7 (0.115),10.4 (0.150),13.9
(0.173),16.7 (0.174),18.9 (0.174) 2160 (36.0),0.3 (0.007),6.8 (0.104),11.1
(0.141),15.3 (0.166),16.1 (0.145),16.7 (0.132) 2880 (48.0),0.1 (0.002),2.0
(0.028),3.3 (0.039),4.5 (0.045),7.9 (0.064),10.4 (0.074) 4320 (72.0),0.0
(0.000),1.2 (0.015),2.0 (0.021),2.7 (0.024),9.1 (0.065),13.8 (0.086)

[PREBURST90_META]

Time Accessed,08 January 2020 04:25PM Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged. [END_PREBURST90]

Interim Climate Change Factors

[CCF]

,RCP 4.5,RCP6,RCP 8.5

2030,0.816 (4.1%),0.726 (3.6%),0.934 (4.7%)

2040,1.046 (5.2%),1.015 (5.1%),1.305 (6.6%)

2050,1.260 (6.3%),1.277 (6.4%),1.737 (8.8%)

2060,1.450 (7.3%),1.520 (7.7%),2.214 (11.4%)

2070,1.609 (8.2%),1.753 (8.9%),2.722 (14.2%)

2080,1.728 (8.8%),1.985 (10.2%),3.246 (17.2%)

2090,1.798 (9.2%),2.226 (11.5%),3.772 (20.2%)

[CCF_META]

Time Accessed,08 January 2020 04:25PM

Version,2019_v1

Note,ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website. [END_CCF]

Baseflow Factors

[BASEFLOW]

Downstream,10972

Area (km2),929.510528

Catchment Number,10979

Volume Factor,0.068277

Peak Factor,0.031568

Shape Intersection (%),65.0

[BASEFLOW_META]

Time Accessed,08 January 2020 04:25PM

Version,2016_v1

[END_BASEFLOW]

[ENDTXT]

APPENDIX Q

DAMAGE CURVES

The adopted damage curves for the damages assessments are presented below.

Residential Damage Curves – Internal (OEH 2007 adjusted for CPI)

Depth Above Floor	Residential Damage (\$)
0	29582.13836
0.1	65259.03595
0.6	81085.30138
1.5	109570.727
1.8	119066.7509
10	145936.8735

Residential Damage Curves – External (OEH 2007 adjusted for CPI)

Depth Above Floor	Residential Damage – External (\$)
0	0
0.05	0
0.26	3555.900697
0.5	7759.739656
0.75	11961.63868
>1	16165.47764

Commercial Damage Curves (OEH 2004 adjusted for CPI)

Depth Above Floor	CM Damage Cost (\$) (Shops and other retailers <200m ² , medium value)	IM Damage Cost (\$) (Industrial 200-600m ² , medium value)	L1 (Large Commercial (\$) and Industrial >600m ² , high value)
0	0	0	0
0.01	3472	10126.9	28934
0.05	8680	25172.58	202538
0.1	15046	50345.16	202538
0.2	28934	101269	607614
0.25	37614	118629.4	665482
0.3	43401	133096.4	781218
0.4	54975	167817.2	839086
0.5	66548	202538	868020
0.6	78122	234365.4	1012690
0.7	88827	268507.52	1128426
0.75	101269	286446.6	1186294
0.8	104162	302070.96	1359898
0.9	107056	335634.4	1678172
1	118629	370355.2	2025380
1.1	125863	396106.46	4050760

APPENDIX R

FLOOD WARNING REPORT

Kyabram Total Flood Warning System Review



Report prepared by Risk Frontiers
For Water Modelling Solutions
June 2021



Version	Release history	Date	Author	Reviewer
V0.1	Draft for feedback	7/6/2021	G. McKay	A. Gissing

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1. Total Flood Warning System (TFWS)

The TFWS is based upon applying the Total Warning System, that is used for managing all hazards and is described in the Public Information and Warnings (AIDR 2018) Handbook, to floods. The Handbook presents nationally agreed principles for warning policy and practice and explores the essential elements of effective public information and warning delivery. The handbook also provides excellent advice on good practice for building disaster resilience.

The Total Warning System is illustrated in Figure 1.

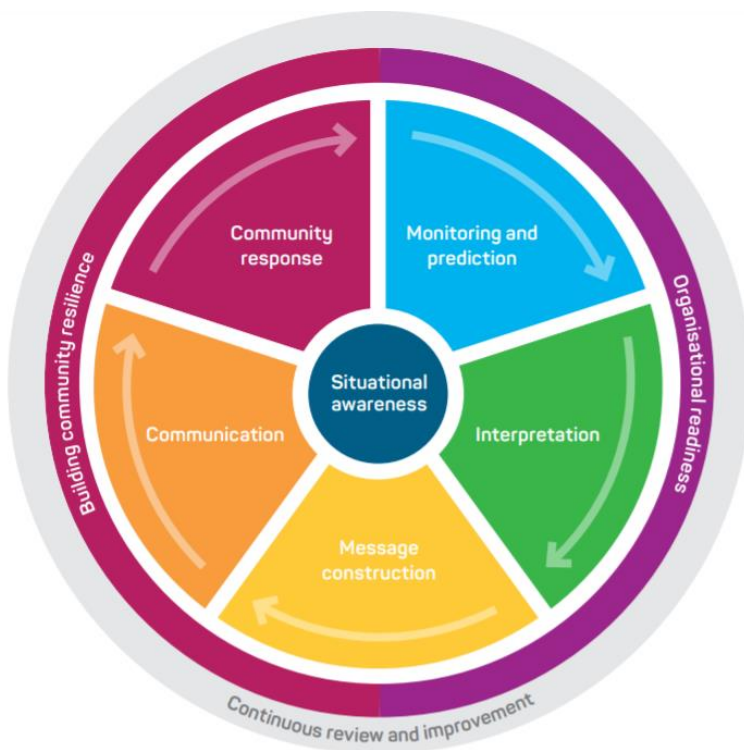


Figure 1: Total Warning System

Like a chain, the total flood warning system will only be as good as the weakest link. A successful flood warning system needs all elements of the Total Warning System to be integrated, rather than operating in isolation, so there is some repetition of key issues that are discussed in this review.

Part 3 of the Victorian Floodplain Management Strategy 2016 outlines the policy arrangements in place for the TFWS and roles of the various agencies involved. The Victorian Government has made the Department of Environment, Land, Water and Planning (DELWP) accountable for the

coordination of the TFWS at state level. DELWP does this in consultation with the Victorian State Emergency Service (VICSES), Bureau of Meteorology (Bureau), Melbourne Water, Catchment Management Authorities (CMAs), water corporations and other stakeholders as required.

All Victorian communities receive Bureau warnings of possible flood producing weather. They include Flood Watches, Severe Weather and Severe Thunderstorm Warnings, described in Section 3.4, that advise on weather conditions that have the potential to cause heavy rainfall and flooding.

All communities receive general safety messages, such as 'do not drive, walk or ride through floodwaters' from VICSES. Everyone also has access to advice on appropriate flood responses. For example, VICSES issues FloodSafe guides to help local communities prepare for and respond to floods.

Communities with a high potential for flood damage from riverine flooding receive more sophisticated flood warning services. These can include predictions about the rise and fall of floodwaters, details on the roads and properties likely to be inundated, and local advice about how to prepare for and respond to predicted floods.

Regional Floodplain Management Strategies and local flood studies may identify additional communities where more sophisticated services are warranted. The ongoing review of Regional Floodplain Management Strategies will enable the continual assessment of flood warning services to communities.

The Victorian Floodplain Management Strategy 2016 also contains a section that discusses "Working towards flash flood warning services" for locations such as Kyabram. It suggests the Severe Weather Warnings issued by the Bureau offer a potential basis for flash flood warning services.

Given the short timeframes associated with flash flooding, more certainty is needed about each agency's roles, capacities, responsibilities and accountabilities, and the community's capacity to respond appropriately. VICSES says it is willing to issue bulletins for flash flooding if there is an approved predictive service available. It will take time for VICSES to build its capacity to address this accountability, so Regional Floodplain Management Strategies will need to outline appropriate timeframes for these services to be developed.

VICSES local Incident Controllers are authorised to publish a community notification of a verified risk to life or property from flooding in unmonitored locations, like Kyabram, that do not have a TFWS in place. The authoriser must ensure that the risk to life or property is significant enough to warrant issuing a community notification, and that the risk has been verified from a flood analyst or CMA. This arrangement is described Appendix B, page 42, of the State Emergency Response Plan – Flood Sub-plan 2.0.

2. Review Methodology

This review will examine the current status of each element of the TFWS for Kyabram and make recommendations for their development and/or ~~er~~-improvement.

Definitions, presented in italics for each element, are from the Public Information and Warnings (AIDR 2018) Handbook.

Evidence was captured from a desktop review of available flood emergency plans, FloodSafe guides, past flood warning reviews and other on-line resources as well as outputs from a flood study and management plan that is currently being prepared for Kyabram. This analysis was supported by interviews with staff at Campaspe Shire Council, VICSES, Goulburn Broken CMA and the Bureau of [Meteorology](#).

3. Description of the Kyabram Total Flood Warning System

3.1 Situational Awareness

This is the continuous attention to and connections with the past, current and emerging situation. Warnings should be informed and regularly reviewed with the most up-to-date intelligence and a clear understanding of operational strategies. This connection, at all times, is central to the coordinated, informed and timely delivery of warnings.

This is the core of the TFWS. A key component of situational awareness is flood intelligence, which relates past events to consequences, in order to effectively warn the community of the likely impact from predicted flood producing weather systems and, during the event, recorded rainfall and other on-the-ground observations. Flood intelligence is based on documented local flood experience from past events, community feedback on current flood impacts and the extrapolation of that information to more extreme situations based on flood studies that examine the impact of large, statistically based, rainfall events that are usually beyond anyone's ~~past~~ experience. Some of these flood studies have caused controversy when their results, particularly for extreme events, have challenged the experience of the community. However, there are many well documented historical extreme floods, for example the record 1870 flood at nearby Echuca, that obviously no living person has experienced. This flood intelligence underpins the community's flood preparedness to respond to future events.

Kyabram is subject to flash flooding from stormwater runoff and relies on a series of stormwater retention basins and Council operated pumps for its protection from smaller floods and the mitigation of larger events. About 80% of the towns' drainage is captured in Fauna Park Lake from which flood flows are eventually passed by gravity into syphon drains located under the Goulburn Murray Water Number 9 drainage channel to the west of McEwen Road.

Flooding in the surrounding rural area takes longer to develop, between 12 and 72 hours, with the timing of peaks affected by the flat terrain and the presence of natural and artificial depressions and storages.

Flood intelligence for Kyabram is presented in Appendix A – Flood Threats for Campaspe Shire in the Flood Emergency Plan for the Campaspe Municipal District (Feb 2019). This plan also outlines operational strategies and reference to past floods in Appendix C5 – Kyabram Action Plan.

~~Both~~ appendices ~~need to~~will be updated and expanded using the results of the Kyabram Flood Study and Management Plan - Draft Study Report (May 2021), referred to as the "Kyabram flood study" in this review. This ~~should~~will include reference to the mapping portal(s) that hold the updated flood inundation and hazard maps from the flood study. They will also ~~need to~~ contain flood action statements.

Commented [GM1]: Assuming WMS will attend to this

3.1.1 Property Level Flood Information

~~A decision needs to be made on which mapping portal is to be used and therefore which CMA site will host it. North Central CMA, that uses flood-eye, or Goulburn Broken CMA, that uses HydroNET.~~

The current VICSES website local flood guide for Campaspe <https://www.ses.vic.gov.au/get-ready/your-local-flood-information/campaspe-shire-council> <https://www.ses.vic.gov.au/plan-and-stay-safe/flood-guides/campaspe-shire-council> has a link to a 1% Annual Exceedance Probability (AEP) flood [planning level](#) map for Kyabram that is hosted on the North Central CMA's web site <http://www.nccma.vic.gov.au/flood-eye>. Although this service has been well developed for nearby Rochester, which experiences non-flash riverine flooding, it also supports property address searches for Kyabram, [that lies outside the North Central CMA](#), to check if they lie within the [current](#) AEP 1% flood [extent planning level](#) that needs to be updated with information from the current flood study. ~~For example, there is no information on flood depths for Kyabram presented in flood-eye. There is also some inconsistency with the flood extent shown in this map compared to the Kyabram flood study. For example, some properties along Wight Street that are identified as being inundated above floor level by AEP 1% and 2% events in the flood study lie outside the AEP 1% flood extent in the flood-eye map.~~

~~Kyabram lies in t~~The Goulburn Broken CMA [that](#) uses the HydroNET portal <https://www.gbcm.vic.gov.au/our-region/waterway-floodplain-management/floodplain-planning/qbfloodintelligenceportal> and ~~flood information for Kyabram will need to be uploaded to this portal.~~ When this portal has been developed the present link to the North Central CMA site should be redirected to HydroNET.

~~Kyabram lies in between the two CMA coverage areas.~~

~~Both~~ The HydroNET portals <https://my.floodreport.com.au/Gbcm/> provides excellent site-specific flood intelligence to underpin situational awareness, which is an integral element of an effective TFWS. [HydroNET supports Flood Information Reports for individual properties that provide water depths for the AEP 20%, 10%, 5%, 2%, 1% and 0.2% events. If applicable the report also relates these AEPs to a local flood gauge and, where available, details of over flood water depths as well as velocity and hazard vulnerability information.](#)

Although the information from both portals is easily understood by technically trained people it may need to be interpreted and directly communicated to affected individuals who may not have internet access or fully understand the technical information contained in these portals. For example, a lot of the public have a low understanding of probabilities and may be unable to interpret the [AEP information contained in the flood-eye and HydroNET](#) property reports.

~~Whilst publicly available flood information will be available through the HydroNET portal,~~ ~~t~~he DELWP [also](#) operates a flood warning and mapping system known as FloodZoom, see <https://www.water.vic.gov.au/managing-floodplains/flood-warning-and-mapping>, that [also](#) needs to be updated with the results from the flood study.

3.1.2 Rainfall Based Flood Intelligence

Appendix C5 – Kyabram Action Plan in the Flood Emergency Plan for the Campaspe Municipal District (Feb 2019) refers to an event in 1939 that had 225mm of rainfall but caused very little flooding. The AEP for 225mm, even over 72 hours, is rarer than 0.2% (1 in 500). The highest official daily rainfall recorded in 1939 was at nearby Tongala, which had 67.3 mm on 8 April 1939, that was also its highest on record daily total for any April and has an AEP of 10%. The 225 “mm” was probably measured in points, which equates to 57.2 mm, and has an AEP of 20% if it occurred over a 24-hour period. The 57.2mm probably occurred within a shorter time frame and was therefore a rarer event.

From a flood intelligence perspective, the threat of flash flooding and overland flows attributed to short duration high intensity rainfall, usually associated with isolated thunderstorms, that does not usually create widespread flooding, discussed in Section 3 of Appendix A of the Flood Emergency Plan for the Campaspe Municipal District (Feb 2019), should be highlighted in Appendix C5. The major flood events listed in Appendix C5 indicate the most serious flooding occurred during large scale flood producing weather events, such as in 1993 and 2012. These events coincided with major floods in the neighbouring Goulburn and Campaspe River catchments so the Flood Watches issued by the Bureau for these catchments are also a useful “heads up” for potential flash flooding in Kyabram.

Large scale flood producing weather events are typically the result of 1 to 3 days of heavy rainfall that often include localised heavy thunderstorm activity that produce the most intense rainfall and the maximum flash flooding impact recorded during the event. Such high intensity thunderstorms are typically preceded by less intense rainfall that has already saturated the catchment and caused significant runoff to occur.

Although flood peaks in Kyabram occurred within 1 to 2 hours of the most intense rainfall in 1993 and 2012 events, the underlying flood threat is strongly linked to heavy rain that fell over the previous 24 to 48 hours during the event.

Situational awareness should also take into account historical catchment wetness prior to significant floods. The size and impact of floods listed in Appendix C5 are strongly related to not only the AEP of the rainfall that occurred during the event but also the rain that fell over the previous month. For example, Figure 2 shows the monthly rainfall deciles for September 1993, that preceded the October 1993 major floods across Victoria, including Kyabram. It shows that rainfall was within the highest 10% range on record for September. Catchment wetness across Victoria would have been very high from this rain.

Commented [GM2]: Joells comment about flash floods generally being in response to local intense thunderstorms is correct but it's the ones that are embedded in these major long duration rain events that cause the most severe floods. There are no reported examples in various Kyabram reports where a one off severe TS caused a significant flood.

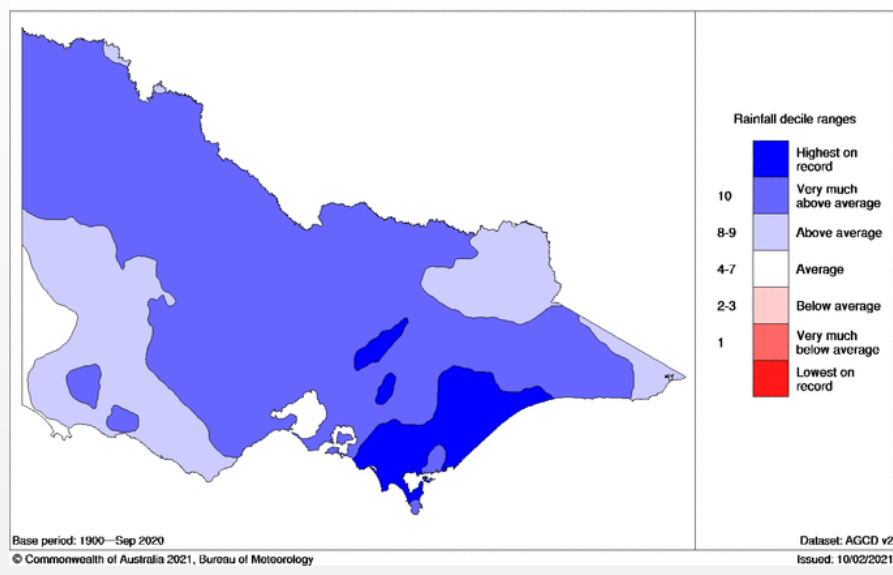


Figure 2: Monthly Rainfall Deciles for Victoria September 1993

Appendix C5 needs to be updated to include details of historical catchment wetness as well as including the 20 January 2008 and February/March 2012 floods.

A recently developed resource for assessing catchment wetness is the Australian Landscape Water Balance service provided by the Bureau in <http://www.bom.gov.au/water/>. This site will be upgraded in September 2021 to include rainfall forecasts. This should be a valuable guide to assess flood threats from a predicted high rainfall event, using flood intelligence such as Appendix C5 and the more general impacts described in Appendix A.

There are strategies in place to update and upgrade the collection of local flood intelligence. For example, VICSES has developed a pilot project using the Snap, Send and Solve app that allows local observers to provide pictures from the field depicting flood behaviour and impacts to the VICSES intelligence sections.

Section 7.5 of the State Emergency Response Plan – Flood Sub-plan 2.0 discusses the collection and dissemination of flood intelligence. One suggestion is using a network of Flood Wardens and local observers to provide information on possible predicted flood consequences to strengthen warning messages. Although there are no formal networks in place for Kyabram this avenue should be explored as there is always scope to improve knowledge about the impact of flooding in the town.

3.2 Building Community Resilience to Disasters

Engagement and education with communities well prior to any emergency about their risk, shared responsibilities and options for protective action.

Warnings are more effective when engagement and education has occurred with communities about their risk, shared responsibilities, and options for protective action, well prior to any emergency. This awareness of risk and confidence to act upon receiving a warning requires ongoing focus on:

- Risk communication, awareness raising and education
- Community engagement with communities at risk
- Development of local strategies and networks to mitigate local risk, including participatory planning processes
- Fostering empowerment and shared responsibility for risk

This element of the Total Flood Warning System has not been fully developed for most flood prone locations despite the plethora of publications on best practice. The Victorian Review of 2010-11 Flood Warnings and Response 2011 expressed concern that community feedback indicated they had not been actively engaged in all phases of emergency management, planning, preparation, response and recovery. The review found there was a prevailing sense that local communities had been disempowered within the emergency management framework. It also found that some communities suffered because of lack of basic knowledge and skills in emergency management, such as how to fill sandbags.

The Review also recommended “the state undertake a community education program to inform households of their respective flood risk. This may include information on rate notices of heights of houses above flood level and educating people about flash flooding”.

The only community members of the local Campaspe Flood Emergency Planning Committee listed in the Flood Emergency Plan for the Campaspe Municipal District 2019 are the VICSES Unit volunteer members, that includes a representative from Kyabram.

Building community resilience is a challenge for flash flood situations, such as Kyabram, where high impact events are few and far between and for where official warning messages from the Bureau, such as Flood Watches, Severe Weather Warnings and Severe Thunderstorm Warnings, described in Section 3.4, are usually not site specific and need to be locally tailored to be more relevant to the affected community.

People have a lot of personal priorities and flooding from infrequent events is often near the bottom of this list until they actually experience a major flood, face a shock increase in home insurance premiums to cover flood risk or when selling their property [only](#) to discover [it lies with the AEP 1% flood level. there is a flood clause on its title.](#)

The consultants who undertook the current Kyabram flood study organised a public meeting that was held on 22 October 2019. It attracted an audience of only 25 to 30 people out of a population of 7,300 even though Council also sent letters to some 100 individuals inviting their attendance.

The flood study report findings were widely advertised with a striking image of the AEP 1% flood map in September 2020, for example <https://www.sheppnews.com.au/kyabram-news/2020/09/07/1578193/kyabram-flood-study-out-for-comment> .

There is an active Kyabram Drainage Action Committee that did provide considerable input to the current flood study - <https://www.campaspe.vic.gov.au/Our-council/News-media/Latest-news/Kyabram-flood-study-a-step-closer> . The Committee’s primary focus is related to the capacity and reliability of the Council operated pump and drainage system, rather than the adequacy of the TFWS. The flood study addresses pump and drainage issues noting that the present capacity of pumps is generally less than 10% of AEP 1% flood inflows into the major sumps, such as the one on

Lake Road. The COVID restrictions and associated personal, financial and other issues [were a major may have been a](#) factor limiting the general public's response to the flood study.

VICSES aims to improve community flood resilience through its local FloodSafe program described in <https://www.ses.vic.gov.au/get-ready/floodsafe/local-floodsafe-information>. The program will explain local flood risks and advice on how to prepare and respond to flood events. [It includes](#) guidelines for filling and disposing of sandbags, which is a useful line of defence in Kyabram, where over-floor flood depths are generally relatively low and for which sandbags may be very effective [for limiting the passage of water through doorways and other limited openings in a building](#). [Sandbags would need to be deployed in response to warnings based on forecast rainfall. Given the flash flood nature of Kyabram the simple action of moving valuable items to higher locations would also contribute to minimising flood damage.](#) Also included are guidelines for rural properties. FloodSafe guides have been developed for other areas in the Campaspe Shire, Echuca and Rochester, but not for Kyabram. The results from the flood study present an opportunity to develop a similar site specific FloodSafe guide for Kyabram.

3.3 Organisational Readiness to Warn

Setting organisational capability, systems and arrangements in place to warn effectively.

Essential capabilities and arrangements to put in place include:

- Warning systems and protocols, with capable teams ready to respond
- Training, exercising and testing of systems, including with communities
- Forecasting, prediction and impact modelling to inform warning systems
- Knowledge of at-risk communities to target and tailor warnings during an emergency, including strategies to reach diverse or vulnerable groups.

The Bureau does not provide site specific flash flood warnings for locations such as Kyabram where flooding occurs in less than 6 hours of the start of the rain that causes it. The responsibility for establishing and operating flash flood warning systems lies with the States and Territories, working in collaboration with local councils where appropriate.

As part of its role in providing support to the development of flash flood warning systems, the Bureau has developed and coordinates FLARE (Flash Flood Advisory Resource) as a community of practice for assisting responsible agencies to design, implement and manage flash flood warning systems. FLARE is a registered-user website and telephone and email advisory service, and a platform for sharing the knowledge of experts from the Bureau and other agencies around the country.

Flash flood warning systems will likely have some limitations, including:

- warnings will likely be a simple alert of impending flooding rather than a detailed prediction
- warning system success relies on the effective dissemination of alerts
- warning times provided will be limited

- given limited warning time the key objectives of the system will be focused on life safety rather than property protection
- community awareness is critical to ensuring effective response to warnings
- the system must be maintained.

The Flood Emergency Plan for the Campaspe Municipal District 2019 states “there is currently no flood warden network, however, local intelligence during flood events is paramount and will be sourced from local agencies and community members”.

There are no local flood warning system arrangements in place for Kyabram and the surrounding rural area.

The VICSES has protocols in place to issue Flood Bulletins after receipt of a Flood Watch, Severe Weather or Thunderstorm Warning. Although Flood Watches are issued for the neighbouring Goulburn and Campaspe River catchments, they do not specifically include Kyabram. However, [for major widespread flood events](#) there is a good correlation between the risk of flooding in all three catchments, [particularly when a major event is predicted](#).

A local capability needs to be developed for these risks to be translated via a local flood warning system to make Bureau warnings, particularly the Severe Weather Warning, more relevant to the Kyabram community. The design of such a system needs community engagement, discussed in Sections 3.2 and 3.9, to incorporate their understanding of risk, and risk appetite, in order for them to understand and use local warnings.

3.4 Monitoring and Prediction

Detecting conditions that can lead to threat to life and property and predicting the likelihood, timing, level and nature of impact.

Diverse inputs such as weather and current incident activity need to be continuously monitored. Hazard modelling and relevant information inputs allow for the dynamic prediction and analysis of risk. The likelihood, timing, level and nature of impact on communities will continually adjust and should inform the creation and ongoing review of all warnings.

The Bureau of Meteorology provides the following warnings that are relevant to potential flooding at Kyabram:

- Severe Thunderstorm Warnings**

These are issued when severe thunderstorms are likely to develop, or extend into a specified area over the next few hours. The warnings are issued for specific areas in the state, where more targeted and detailed information may be provided, but are also available state wide. Based on past experience, Section 3 of Appendix A of the Flood Emergency Plan for the Campaspe Municipal District (Feb 2019) concludes that the threat of flash flooding and overland flows attributed to short duration high intensity rainfall, associated with thunderstorms, does not usually create widespread flooding. [The major floods at Kyabram occurred during major and longer duration flood producing weather events that typically contain embedded thunderstorms that cause flash flooding on an already saturated catchment.](#)

Thunderstorms, that are notoriously difficult to predict in terms of location, duration and severity, can cause significant localised flooding of roads and property. Their movement and intensity can be monitored from the Yarrawonga weather radar by VICSES and the community for local response planning and actions.
- Severe Weather Warnings**

These aim to provide advance notice of very heavy rainfall leading to flooding. They are issued when severe weather is expected to affect land-based communities within the next 24 hours which is not directly the result of severe thunderstorms. The Victorian Floodplain Management Strategy 2016 suggests using Severe Weather Warnings as a basis for flash flood warning services.
- Flood Watches**

These ~~are may be~~ issued for ~~specific broad~~ regions (e.g. ~~East Gippsland or~~ North East Victoria) and advise that a flood is possible in those regions. [Kyabram lies in Flood Watch Area #17 - Goulburn River downstream of Seymour.](#) They are issued 24 to 36 hours in advance of any likely flooding and updated as required.

Flood Watches are based on upon rainfall forecasts and catchment wetness and are issued for the neighbouring Goulburn and Campaspe River catchments. They are [also](#) a-useful indicator for ~~potential-an increased risk of~~ flooding at Kyabram, particularly when major [widespread](#) flooding is expected.

- Flood Warnings

[The Bureau does not issue flood warnings for flash flood locations, such as Kyabram.](#)

- Flood warnings, including predictions of flood severity (minor, moderate and major) and at specified locations, river levels, are issued when there is an imminent threat of a flood occurring. Major flooding at Kyabram has coincided with major flooding in the neighbouring Goulburn and Campaspe Rivers, for which Flood Warnings are issued.

[The Bureau does not issue flood warnings for flash flood locations, such as Kyabram.](#)

- As with most flash flood locations across Australia there are no site-specific monitoring and prediction protocols in place for Kyabram.

The hydrological and hydraulic computer models used for flood studies are generally not suitable for real-time flood prediction purposes. The main reason for this is there is insufficient rainfall and local water level data available in real time to support model calibration in a flood warning operational environment for predictions to be made within a very short, typically, 1 to 2 hour flood response time frame that is available for Kyabram.

The heightened risk of flooding at Kyabram during wet seasons has been discussed in previous sections. Effective monitoring, and situational awareness, means the degree of wetness needs to be quantified in terms of how rare it is to allow better use of rainfall predictions to develop a local assessment of whether the likely flood risk is for a small or large event. This assessment can then be related to the 1993 and 2012 floods, and possibly the larger floods, based on statistically-based rarer rainfalls, described in the current Kyabram flood study, as the foundation for a generalised local flood prediction and warning system.

A useful catchment wetness monitoring tool, introduced in Section 3.1 - Situational Awareness, is the Australian Landscape Water Balance service provided by the Bureau. A sample output is shown in Figure 3 which shows the root zone moisture level for 28 February 2012, the day before highest daily rain total that resulted in the 29 February 2012 flood peak in Kyabram. The root zone moisture was “very much above average”, i.e. in the highest 10% range, hence very wet. Note that this analysis uses total rain recorded over the past 24 hours to 9am on a particular day. This means, for example, that the heavy rain fell in the evening of 29 February 2012 is reflected in the 1 March 2012 assessment that shows that root zone wetness was then in the highest 1% range.

This is similar to the scenario presented in Section 3.1.2, based on observed rainfall for the month prior to the 1993 flood, that also indicates very wet catchment conditions ahead of the flood producing rain event.

This Bureau’s water landscape site will be upgraded in September 2021 to include rainfall forecasts that should be a valuable resource to help assess the flood threat from an impending high rainfall event.

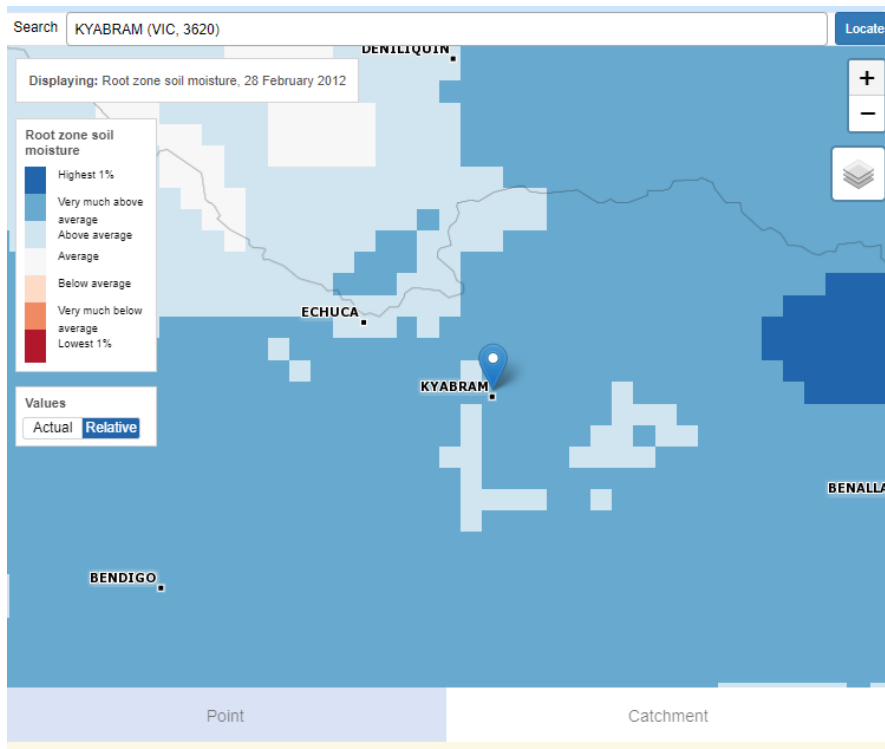


Figure 3: Root Zone Soil Moisture - source <http://www.bom.gov.au/water/landscape/>

There are several forecast rainfall products available on the Bureau website including <http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp>, based on combining the rainfall predictions from several leading Australian and international weather prediction computer models, and MetEye http://www.bom.gov.au/australia/meteye/?loc=VIC_FA001. These products also provide probabilities for different rain totals that can be useful when determining whether or not to warn, based on forecast rain, as well as formulating generalised flood predictions. In addition to providing rainfall total predictions, MetEye also provides details of timing.

Location specific rainfall is still very difficult to accurately predict. It is therefore essential to monitor the rainfall as the event unfolds to test any assumptions made in warnings based upon the interpretation of these rainfall predictions and to update them accordingly.

Kyabram has a Bureau automatic weather station from which rainfall can be monitored in near real time. Shepparton AWS is the closest other automatic rain gauge. Data can be accessed on http://www.bom.gov.au/vic/flood/goulburn_broken.shtml.

Local farmers and urban residents may also own manually-read rain gauges that can potentially be used in real time to provide information on the variability of intense rain across the Kyabram area. This is a particularly useful resource when thunderstorms, that often occur during major flood

producing rain events, can produce very high local falls that are missed by nearby automatic rain gauges. The rain gauge quality and exposure, e.g. proximity to buildings and trees, should be assessed before including them in a local network.

Across Australia networks of automatic rain and river gauges with threshold alarms have been established in some flash flood catchments to directly alert the VICSES and flood prone residents of potential danger. These catchments usually have a high flood risk in terms of flood depths and velocity from creeks and rivers, which is not the situation that exists in Kyabram. Direct alerts from rain and river gauges are only useful if the event is unexpected, for example, very intense localised rain caused by a severe thunderstorm, and the threat to life can be reduced in a fairly short time frame, typically 1 hour or less. [Automated rainfall and river networks are expensive to instal and maintain and would be unlikely to improve a flood warning service for Kyabram that would mainly rely upon forecast rainfall to provide effective warning lead times.](#)

Commented [GM3]: This section addresses the point raised by joell in the recommendations section

There is also a weather watch radar at Yarrowonga to help local monitoring of the intensity and progression of storms.

After allowing for time to develop a prediction and disseminate a warning, a generalised flood prediction for Kyabram that is based only upon recorded rainfall linked to catchment wetness would typically provide about 1 hour, or less, warning lead time for the community. It is understood that the 1993 and 2012 flood peaks occurred around 8pm, so 7pm is not an ideal time to initiate a community response.

Generalised flood warnings based on forecast rainfall would be less accurate than those based on recorded totals but, despite the increased uncertainty, they can provide more warning lead time for the community to prepare for possible flooding. These generalised warnings, that contain predictions relating this event to 1993 and 2012, can be adjusted in magnitude and timing as the event unfolds by comparing recorded rainfall to predicted. If there is a threat of major flooding, lead time may be more important than absolute accuracy to achieve an effective community response.

Although monitoring and prediction using the above resources is a moderately complex task, possibly beyond the capacity of many in the community, there is scope to publish some simple guidelines, such as threshold rainfall rates, either predicted or observed, for the community to monitor and empower them to make their own risk assessment and to verify any locally issued flood warnings.

A predictive guideline for Kyabram, published in a local FloodSafe guide, might be "watch out for 70 mm in 24 hours if it's been a wet month". 70 mm in 24 hours is an AEP 10% rainfall.

Commented [GM4]: I assume guy wants this highlighted

Using the guidelines described here and in previous sections, a generalised prediction contained in a flood warning for Kyabram could be:

"Over 70 mm (or a higher figure, if applicable) of rain is predicted to fall over the next 24 (or other period) hours. Based on local knowledge and studies of past floods Kyabram could/is very likely to (depending on predicted total rain and catchment wetness) experience flooding similar to (or higher than) the 1993 and 2012 events during (specify the approximate time frame, for example, Friday morning)".

Once the heavy rain has started to fall this initial prediction can be updated to either confirm this assessment or adjust it based on recorded rain and observed flood impact. The predictions should

be general and relate the current event to the 1993 and 2012 floods in terms of being “similar to” or “higher than”.

The rest of the warning message would follow VICSES guidelines that relates this prediction to consequences, including published flood maps, action statements, and emergency contacts. Note that the prediction doesn’t contain a statement about the reliability of rainfall forecasts, catchment wetness etc, as this assessment of risk should rely on the professional judgement of the authority that issues the warning. If the warning contains too many “if and buts”, for example, a range of probabilistic outcomes and/or a statement on the reliability of rain forecasts, the message is likely to cast doubt and confusion in the community that needs to respond within a relatively short time frame. The suggested forecast also doesn’t try to differentiate between major floods such as 1993 and 2012 and smaller events. The flood study indicates there are only relatively minor differences in flood risk for most significant floods that are likely to occur in anyone’s lifetime so, given the uncertainty with rain forecasts, the decision to warn should focus on impacts up to an AEP 1% flood identified in the flood study that are similar to 1993 and 2012. The flood study indicates the flood impacts and risk from an AEP 0.2% flood are not significantly higher.

3.5 Interpretation

Understanding the impact as predicted and deciding whether and how to warn.

The need for, level of, and location of warnings to be issued should be determined considering consequence and drawing on further inputs such as local history of similar events, community characteristics, and seasonal or concurrent events. Use of a warning framework supports consistent interpretation.

This element is strongly linked to the previous 4.

There is an official flood warning framework in place, described in the Flood Emergency Plan for the Campaspe Municipal District 2019, noting that there is currently no flood warning system in place for Kyabram.

Section 3.1 recommends this needs to be updated and strengthened using the results from the current Kyabram flood study and management plan including reference to any published flood maps and property reports.

As the time between heavy rain and peak flooding at Kyabram is only 1 to 2 hours, initial flood warnings should be based on predicted rain, linked to catchment wetness, in order to give the community enough time for an effective response. This is different to the protocol in place for the larger river catchments that would be issued with a Flood Watch based on this information.

Flood warnings for Kyabram should be issued when the Bureau issues a Severe Weather Warning for the district (and/or a Flood Watch or Warning for major flooding has been issued for the neighbouring Goulburn or Campaspe River catchments) and a higher than AEP 10% rainfall event is expected, or has occurred, and the catchment is wet. A simple rainfall threshold, referred to in the previous section, may be 70mm in 24 hours. If rainfall-based predictive warnings are not issued, then recorded rain and/or observed flooding on the ground will be the trigger for issuing a flood

warning. Flood warnings that are triggered by observations, rather than predictions, will be limited to describing what is happening on the ground as well as other information listed in Section 3.6.

The Kyabram flood study indicates the direct impact of flooding up to an AEP 1% flood is limited to over-floor flooding of 38 residential and 17 commercial properties. This is a manageable target audience for direct warnings of flood risk if a local flood warning system was established to facilitate a reduction in property damage. The interpretation also needs to focus on the location of high-risk locations, such as aged care facilities and schools, the homes of elderly and disabled people, the caravan parks, as well as properties that are affected by less than AEP 10% floods. The rest of the community whose homes and businesses are unlikely to be flooded would need to be warned of the more generic flood risks to life and property via public warnings.

Due to its flat terrain and low flood depth and velocity much of Kyabram has a low-risk flood hazard in term of flood depth and velocity. However, there are locations where flood depths are high, such as drainage sumps, that present a substantial risk for drowning, and roads covered by flood water, which are always dangerous to drive through.

3.6 Message Construction

Devising the content of a message to inform and warn people of their risk, including recommended action.

Warnings should be well-constructed, targeted and include pertinent information about the hazard, its expected impact, consequences for communities, a clear call-to-action and tailored advice to those affected.

Section 3.3.8 of the Flood Emergency Plan for the Campaspe Municipal District 2019 provides the following industry standard guidelines for warning message construction which should contain the following:

- **The current flood situation**
This should begin with a reference to any Severe Weather Warning issued by the Bureau of Meteorology for the area.
The current situation should also refer to predicted rain for Kyabram ahead of and during an event as well as details of recorded rain and observed local flood impacts.
- **Flood Predictions**
As suggested in Section 3.4, any initial flood predictions for Kyabram would be generalised assessments of likely flooding along the lines of "Over 70 mm (or a higher figure, if applicable) of rain is predicted to fall over the next 24 (or other period) hours. Based on local knowledge and studies of past floods Kyabram could/is very likely to (depending on predicted total rain and catchment wetness) experience flooding similar to (or higher than) the 1993 and 2012 events during (specify the approximate time frame, for example, Friday morning)".
Refer to Section 3.4 for suggested updated prediction messages.

- **What the consequences of predicted levels may be**
This will be based on flood intelligence, discussed in Section 3.1 , including information contained in Appendices A and C5 in the Flood Emergency Plan for the Campaspe Municipal District 2019 and reference to flood map portals.
- **Public safety advice**
Use standard public safety messages found in the latest version of the VICSES Hazard Key Messages to be found in the Public Information section of the IMT toolbox – see section 4.2.9 of the State Emergency Response Plan – Flood Sub-plan 2.
- **Who to contact for further information – flood wardens**
As per VICSES guidelines found in Section 4.2.5 of the State Emergency Response Plan – Flood Sub-plan 2.0. There is no flood warden network in Kyabram.
- **Who to contact for emergency assistance**
As per VICSES guidelines found in Section 4.2.7 of the State Emergency Response Plan – Flood Sub-plan 2.

Warning messages need to be concise, persuasive and use plain language. Excellent guidance can be found in the “Essentials of message construction” section of the Public Information and Warnings (AIDR 2018) Handbook.

A key challenge in composing a warning message is to adequately describe the consequences of predicted flood levels as these are so variable across the flood affected area.

For Kyabram, which has very short flood response time, warning messages for various flood scenarios need be pre composed, with community input, to facilitate rapid delivery and understanding.

Appendix B of State Emergency Response Plan – Flood Sub-plan 2.0 states that “Only the dedicated ‘unmonitored warning templates’ that are available via the Emergency Management Common Operating Platform (EM-COP) Public Publishing should be used. If impacts are expected (in) less than 6 hours, follow EM-COP Flash Flood Business Rules available on IMT Toolbox.”

As mentioned in the previous section there is scope to provide tailored site-specific flood warning advice to people whose properties are affected by over-floor flooding as well as the vulnerable in the community.

3.7 Communication

Disseminating timely, targeted and tailored warnings through multiple channels to all who may be affected.

Messages should be made available through a wide range of channels appropriate for each hazard and targeted to impacted communities.

Sharing of messages by other parties can be facilitated and encouraged. This can also encompass two-way discussion with warning recipients, e.g. via telephone, face-to-face meetings, radio and digital media channels.

Communication should continue throughout an event and include announcement or advice when a threat has reduced or passed.

Section 4.2.5 of the State Emergency Response Plan – Flood Sub-plan 2.0 provides guidelines for issuing warnings for locations such as Kyabram, that do not currently receive a flood warning service, otherwise known as an unmonitored location. VICSES has also developed a process to support personnel who issue warnings. This applies only in instances where there is a verified risk to life or property that is significant to warrant a flood warning. Further information is available in the Riverine Flood EM-COP Public Publishing Business Rules.

VICSES will also issue public information and warnings for severe weather, thunderstorms and flash flooding as the triggers within the EM-COP Public Publishing Business Rules are met for each hazard.

Communication channels used by VICSES are discussed in Section 4.2.6 of the State Emergency Response Plan – Flood Sub-plan 2.0. VICSES use the state endorsed multi-hazard warning platform, EM-COP Public Publishing, to disseminate public information and warnings to the community via VicEmergency and its associated channels.

VicEmergency warning recipients include emergency broadcasters (i.e. commercial and ABC radio) who are required to re-disseminate warning information and sound the Standard Emergency Warning Signal (SEWS) if required, in accordance with the Emergency Broadcasting Practice Note and the agreed Memorandum of Understandings.

A range of approaches are used by VICSES to disseminate public information and warnings that are selected based on the needs of the community and the nature of the event. Examples include:

- Door knocking for evacuation of a small area, if time permits.
- Emergency Alert (EA) for urgent dissemination of warnings to telephones (including mobile phones) within a specific geographic location (see section 5.2.4).

VICSES ensure public information and warnings align to current best practice, as outlined in the National Public Information and Warnings Handbook, (see knowledge.aidr.org.au/resources/public-information-and-warnings-handbook) and the Victorian Warnings Protocol, available on the Public Information section of the IMT Toolbox on EM-COP.

The various communication channels are listed in the Flood Emergency Plan for the Campaspe Municipal District 2019 and include:

- Emergency Alert
- Phone messages (including SMS)
- Radio and Television
- Two-way radio
- Mobile and fixed public address systems
- Sirens
- Verbal Messages (Doorknocking)
- Agency Websites
- VICSES Flood Storm Information Line

- Variable Message Signs (road signs)
- Community meetings
- Newspapers
- Email
- Telephone trees
- Community Flood Wardens (not formally established in Kyabram)
- Fax Stream
- Newsletters
- Letter drops
- Social media and/or social networking sites (i.e. Twitter and/or Facebook).

Further guidance can be found in the Public Information and Warnings (AIDR 2018) Handbook.

The use of direct communication of warnings to those impacted by over-floor flooding and ~~high risk~~high-risk locations, discussed in Section 3.5, is recommended. Kyabram has a local VICSES unit with some 12 volunteers. About half have been long term members with flood experience. There are another 3 neighbouring VICSES local units that may also be able to assist the Kyabram Unit. In the event of an impending major flood there is potential to door knock the 38 residential and 17 commercial properties in Kyabram that experience over-floor flooding up to an AEP 1% event. [Alternatively, a tailored telephone service could be developed.](#) The Kyabram VICSES Unit has its own Facebook page that can be used to communicate flood warnings to the community.

3.8 Community Response

Seeking assurance communities have received, understood and are acting upon warnings.

Insight should be sought on whether warnings have reached their intended audience and how communities are responding with protective action.

Community response should then inform the issue of any subsequent warnings and response strategies.

The Review of the 2010-11 Flood Warnings and Response page 76 describes the current situation faced by communities such as Kyabram, which have no TFWS in place. “Warnings must be provided early enough to enable those at risk to take appropriate action in response to the warning. In some cases, despite the best intention, plans and the desire to protect life and property, a warning will not be given. The rapid onset of unforeseen emergencies, such as a flash flood, can occur with little or no opportunity for a warning.”

As discussed in previous sections the most effective community response to protect lives and property in Kyabram is most likely to be achieved from warnings based on rainfall forecasts that can provide much more than 1 hour net lead time, or less, if they are based on recorded rainfall or observed flooding.

The Flood Response (AIDR 2009) Manual page 19 describes how difficult it is to interpret the potential specific flood consequences in flash flood environments where no gauge height predictions

are provided and rainfall information may be the only data available. In these cases it is important to conduct reconnaissance of low-lying areas (where it is safe to do so) to ensure that the development of flooding is properly identified. In many cases it will be necessary to adopt a worst-case appreciation of possible flood consequences, based upon whatever flood mapping is available.

The Manual also advises decision makers to appreciate the limitations on the accuracy of the flood intelligence they are using. All flood intelligence records are approximations. This is because no two floods at a location, even if they peak at the same height, have identical impacts. The gradients of the floods may differ, they may be at or close to their peaks for different durations, there may have been land-use changes between the flood events, flood mitigation structures may have changed in the interim and the channel and floodplain environments in which flooding occurs are unlikely to be the same.

For Kyabram the major floods of 1993 and 2012 have been recommended as a key reference points in several elements of the TFWS, including response. The flood study indicates that rarer floods, such as an AEP 0.2% event, should be only slightly higher than, and have a similar flood risk to, these historical floods. The limitations of flood intelligence, that includes flood depths predicted for larger events in the flood study, also needs to be considered when planning a local flood response. Hence a worse case appreciation of flood consequences may be appropriate given all the uncertainty about future rainfall and the resultant flood behaviour.

Section 3.8 of the Flood Emergency Plan for the Campaspe Municipal District 2019 describes the local response to flash flooding. The focus is on protecting lives rather than property. It acknowledges that challenges due to the rapid development of flooding, to establish evacuation (relief) centres ahead of actually triggering the evacuation as is normal practice but this is insufficient justification for not adopting evacuation.

Evacuation response arrangements should target the most vulnerable section of the community, such as those whose properties have the highest flood risk as well as elderly, sick and disabled residents, aged care facilities and schools. The Report of the 2012 North East Victoria Flood Review found only one in three councils in the flood affected area had an up-to-date register of vulnerable people.

The Kyabram Action Plan in Appendix C5 of the Flood Emergency Plan for the Campaspe Municipal District 2019 needs to be updated and upgraded to document recommended actions, including who is responsible, to help the community prepare itself for and effective response to flooding.

3.9 Continuous Review and Improvement

Examining all aspects of the total warning system through evaluation, research and engagement.

All activities across the total warning system should be evaluated to continuously improve the delivery and effectiveness of warnings. Ongoing improvement requires:

- real-time and post-incident review
- pre-event exercises to test message construction and community interpretation and action
- research and evaluation of policy, systems, processes and outcomes

- community involvement in review and evaluation activities.

As noted in Section 3.2 most of the active community concern and participation in Kyabram is related to floodwater drainage and pumping capacity issues rather than the lack of a TFWS. This focus needs to change as a new flood warning system for Kyabram will need to be designed with community input to ensure people understand the risks and benefits of using predicted rainfalls to trigger flood warnings, as recommended in this review.

Pre-written flood warning messages need to be tested with community focus groups selected from flood affected properties in town, the surrounding rural area and the general public, to ensure they are clearly understood by as many people as possible.

Pre-event exercises should target members of the community who occupy the 38 residential and 17 commercial properties identified as having over-floor flooding by an AEP 1% event as well as schools, aged care facilities, the hospital and caravan parks. Their flood preparedness will be vital to limit the overall risk to life and property.

Post flood reviews should begin by holding a meeting with the community as soon as possible after a significant flood. Such meetings provide an opportunity to gauge how well the flood warning system worked as well as explaining how and why any shortcomings, such as inaccurate predictions, late warnings, inaccurate advice, gaps in flood awareness and response occurred.

This will provide a valuable input to the agency post-flood review that typically examine the technical, system and policy issues for each element of the TFWS and recommend and implement improvements.

4. Recommendations

This report contains a number of detailed observations for improvement for each element of the TFWS. Several observations have been repeated for various elements, reflecting the interrelationship between them to achieve a reasonably successful TFWS.

In summary, the key recommendations are:

1. Flood intelligence for Kyabram needs to be updated and upgraded using the results from the Kyabram Flood Study and Management Plan – Draft Study Report May 2021 that is being prepared for Council. This includes making the flood maps and heights from the flood study publicly available on a suitable mapping portal(s), discussed in Section 3.1.1 of this report, and updating and upgrading the flood intelligence presented in Appendix A – Flood Threats for Campaspe Shire and Appendix C – Kyabram Action Plan in the Flood Emergency Plan for the Campaspe Municipal District (Feb 2019). Appendix C also needs to have flood action statements, similar to those presented for Echuca and Rochester.
2. Local flood warning procedures should be developed. [Pre-constructed flood warnings](#) ~~should be developed and should be~~ issued when the catchment is wet, and the Bureau has issued a Severe Weather Warning for heavy rainfall for the district (and/or a Flood Watch or Warning for major flooding in the neighbouring Goulburn or Campaspe River catchments) and the predicted total rainfall for a 24-hour period

is expected to exceed 70 mm. Flood predictions and warning messages would be general, compared to, for example, the specific river level predictions that are available for Rochester, and simply relate the current situation to the 1993 and 2012 events in terms of being “similar to” or “slightly higher than”. Other recommendations for flood warning message construction are in Section 3.6.

3. Local agencies undertake a community education program using the results from the Kyabram flood study to inform households of their respective flood risk.
4. Direct communication of flood warnings to the 38 residential and 17 commercial properties in Kyabram that experience over-floor flooding up to an AEP 1%, as well as to high high-risk locations, such as aged care facilities and schools, the homes of elderly and disabled people and caravan parks, is strongly recommended to minimise the risk to life and property. The Municipal Emergency Management Committee needs to ensure that it has an up-to-date register of vulnerable residents to support this. Section 3.7 of this report provides further details.

References

Flood Emergency Plan for the Campaspe Municipal District

<https://www.ses.vic.gov.au/documents/112015/134667/Campaspe+Shire+-+Municipal+Flood+Emergency+Plan+%28MFEP%29+-+Feb+2019%2C+v7.PDF/6202e189-58d8-3fd5-6719-d66a82f6a24d>

Flood Response (AIDR 2009) Manual

<https://knowledge.aidr.org.au/media/1965/manual-22-flood-response.pdf>

Public Information and Warnings (AIDR 2018) Handbook

<https://knowledge.aidr.org.au/resources/public-information-and-warnings-handbook/>

Kyabram Flood Study and Management Plan – Draft Study Report. Solutions Water Modelling. May 2021.

Report of the 2012 North East Victoria Flood Review

https://www.researchgate.net/publication/279861366_Report_of_the_2012_North_East_Flood_Review

Review of the 2010-11 Flood Warnings and Response

http://www.floodsreview.vic.gov.au/images/stories/documents/review_20101011_flood_warnings_and_response.pdf

State Emergency Response Plan – Flood Sub-plan 2.0

<https://www.ses.vic.gov.au/documents/112015/2504320/State+Emergency+Response+Plan+-+Flood+Sub-Plan+-+Edition+1.pdf/e4d997fa-080b-39fd-366b-42b5cb23443f>

Victorian Floodplain Management Strategy 2016

<https://www.water.vic.gov.au/managing-floodplains/new-victorian-floodplain-management-strategy>

APPENDIX S

COUNCIL MINUTES CONFIRMING ADOPTION

The Road Management Plan (RMP) details the inspection regime, defect intervention levels and defect repair response times for all nominated road related assets under Council's management.

The RMP was reviewed as scheduled for 2021, after the election of a new Council. The plan has been amended to align with updated insurance advice, current policy, operational objectives, and available resources.

The draft RMP was exhibited to the public and received 11 submissions, including the 4 petitions received prior to the notice period, and they were considered in the preparation of the RMP.

This report seeks Council's decision to formally adopt the Draft RMP.

Moved by Cr Jarman

Seconded by Cr Marwood

That Council

- 1. Adopt the Road Management Plan (and associated appendices) as presented, in accordance with the requirements of Part 4, Division 5 of the Road Management Act 2004.**
- 2. Publish a Notice of Amendment of the Road Management Plan in Government Gazette and Local Newspapers stating the following as required by section 55 of the Road Management Act 2004:**
 - a) That the Road Management Plan, including the Council's Register of Public Roads, has been amended.**
 - b) That the Road Management Plan may be inspected or obtained from Campaspe Shire Service Centres or downloaded from Council's website.**

Cr Pentreath called for a Division.

The decision was set aside and the Mayor put the matter to a vote.

Those in favour of the motion: Cr Marwood, Cr Mackrell, Cr Weller, Cr Zobec, Cr Gates, Cr Jarman, Cr Amos and Cr Weston

Those against the motion: Cr Pentreath

CARRIED

Cr Weston declared a conflict of interest at item 9.6 and left the virtual meeting at 6:56pm

9.6 Kyabram Flood Study

Author	Department	Manager	General Manager
Manager Assets	Assets	Manager Assets	General Manager Infrastructure

This report seeks Council adoption of the draft Kyabram Flood Study following its formal exhibition and consultation with the broader Kyabram community.

The report identifies the extent and depths of flooding and associated risks to be expected in a series of 'design' events comprising floods ranging from 20% (5 year) to 0.0% (100 year) probability of exceedance in any one year (Annual Exceedance Probability, AEP) and Probable Maximum Flood.

Council approved formal exhibition of the report seeking community comment on the 16 June 2021. No written submissions and four verbal submissions relating to specific properties were received generally confirming the

accuracy of modelling. The key issue consistently raised was reliability of the large diesel pump at the Lake Road Sump; several examples of its failure to operate were cited. Results of this consultation indicates a high level of community support for the study and its recommendations.

Moved by Cr Zobec

Seconded by Cr Jarman

That Council:

- 1. Adopt the Kyabram Flood Study Report as a policy document to guide flood management within Kyabram,**
- 2. Refer the draft planning layers to the next scheduled review of the Campaspe Planning Scheme,**
- 3. Refer implementation of the recommendations contained therein to the budget process, and**
- 4. Seek funding from the Department of Environment Land Water and Planning to prepare an amendment to the Campaspe Planning Scheme to implement the recommended draft planning layers.**

CARRIED

Cr Weston re-entered the virtual meeting at 7:02pm

9.7 Echuca Holiday Park

Author	Department	Manager	General Manager
Manager Community Business	Community Business		General Manager Community

The Echuca Holiday Park Master Plan, including a capital works implementation plan for the first five years, developed in conjunction with key stakeholders was adopted by Council in April 2019.

The Master Plan outlined both capital and operational improvements to the park to create a destination/resort style park catering for multiple target markets, including:

- A park that contains modern guest amenities and a range of resort style facilities aimed at delivering quality guest experiences.
- Enhanced recreational facilities to allow the park to attract target markets in the low and midseason periods of the year.
- Providing a focus on offering improved guest experiences i.e., improved Wi-Fi, coffee cart, tourist attraction options.

The implementation plan is now in its third year; therefore, it is considered timely to inform Council of progress to date.

This report also seeks to provide further information to Council for its consideration regarding potential amendments to the implementation plan and options for funding and an extended delivery timeframe.. All proposals have been fully discussed with current Park Management at both a state and national level.

Moved by Cr Jarman

Seconded by Cr Amos

That Council approve the proposed amendments to the Echuca Holiday Park Master Plan Implementation plan and consider alternative funding sources and an extended timeframe for the delivery of the adopted implementation plan: