

Eden, Twofold Bay, Towamba River Flood Study

Draft Flood Study



Contact Information

Rhelm Pty Ltd
 ABN : 55 616 964 517
 Level 1, 50 Yeo Street
 Neutral Bay NSW 2089
 Australia

Lead Author:

Emma Maratea
 Emma.maratea@rhelm.com.au

Document Control

Rev	Effective Date	Description of Revision	Prepared by:	Reviewed by:
Stage 1 Report				
0	16 January 2017	Template for Baird	Emma Maratea	NA
1	2 February 2017	Internal Draft for Review	Emma Maratea Luke Evans Sean Garber Holly Watson	Rhys Thomson
2	6 February 2018	Issue to Council	Luke Evans	Emma Maratea
Stage 2 Report				
0	16 August 2018	Internal Version	Emma Maratea	NA
1	10 September 2018	Issue to Council	Emma Maratea Luke Evans Sean Garber Holly Watson	Rhys Thomson
Stage 3 Report				
0	2 July 2019	Issue to Council	Emma Maratea Luke Evans Sean Garber	Rhys Thomson
Stage 4 Report				
0	25 October 2019	For Public Exhibition	Luke Evans	Emma Maratea

Prepared For: Bega Valley Shire Council
Project Name: Eden, Twofold Bay and Towamba River Flood Study
Rhelm Reference: J1053_R04_Stage_4_Rev0
Document Location: J1053 - Eden Flood Study\4. Reports\Stage 4 Report Draft for Exhibition\J1053_R04_Stage_4_Rev0.docx
Client Reference: Stage 4 Report

The report has been prepared and reviewed by suitably qualified persons. The scope of the report is based on the client brief and/or the Rhelm written fee proposal and assumes information provided by the client and sourced from other third parties is fit for purpose unless otherwise stated. The findings rely on a range of assumptions that are noted in the report.

Foreword

The primary objective of the New South Wales (NSW) Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the NSW Department of Planning, Industry and Environment (DPIE) and the NSW State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, flood emergency management and land-use planning matters.

The *Floodplain Development Manual* (NSW Government 2005) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process. **Figure F1**, taken from this manual, documents the process for plan preparation, implementation and review.

The *Floodplain Development Manual* (NSW Government 2005) is consistent with Australian Emergency Management Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AEM Handbook 7) (AIDR 2017).

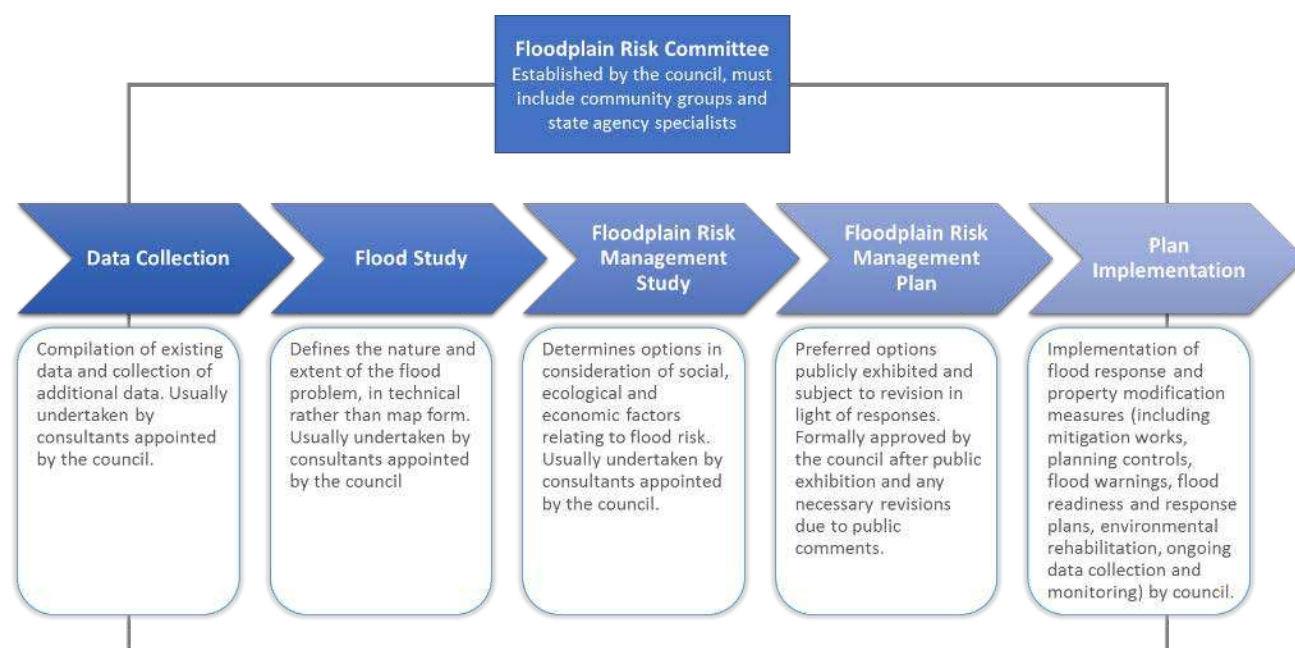


Figure F1 The Floodplain Risk Management Process (source: NSW Government, 2005)

Bega Valley Shire Council is responsible for local land use planning in its service area, including in the Twofold Bay and Towamba River catchment and its floodplain. Through its Floodplain Risk Management Focus Group, Council has committed to prepare a comprehensive floodplain risk management plan for the study area in accordance with the NSW Government's *Floodplain Development Manual* (2005). This document relates to the flood study phase of the process.

Executive Summary

The Eden, Twofold Bay and Towamba River Flood Study has been prepared for Bega Valley Shire Council (Council) to define the existing flood behaviour in the catchment and establish the basis for subsequent floodplain management activities.

Study Area and Scope

The study area covers the entire catchment of Twofold Bay with a focus on understanding the flood behaviour and risk in the foreshore locations of Eden, Quarantine Bay, Boydtown and Munganno Point / Jews Head and the catchment localities of Rocky Hall, Wyndham, New Buildings, Burragate and Towamba. The study area is shown in **Map G101**.

This project is a flood study, which is a comprehensive technical investigation of flood behaviour that provides the main technical foundation for the development of a robust floodplain risk management plan. It aims to provide a better understanding of the full range of flood behaviour and consequences. It involves consideration of the local flood history, available collected flood data, and the development of hydrologic and hydraulic models that are calibrated and verified, where possible, against historic flood events and extended, where appropriate, to determine the full range of flood behaviour.

Engagement

Comprehensive stakeholder engagement was undertaken throughout the development of the flood study. This involved:

- Engaging agency and industry stakeholder to obtain details of historical flooding, survey data and other relevant data sets. Stakeholders will also be invited to provide feedback on the draft flood study during public exhibition.
- Community engagement has been undertaken through the mail out of an information brochure and brief survey. A series of community drop in sessions were also held in Towamba and Eden. The purpose of the engagement was to raise awareness of the study and flood risk in the catchment, as well and obtain observations of historical flooding to assist in model calibration. Respondents were contacted for further information by phone and email, as required.
- This document will be placed on public exhibition for a period of four weeks. During this time Council will notify residents and property owners in the catchment area to be public exhibition, inviting them to learn more about the draft Flood Study. Another series of information sessions will also be held for community members to get information and ask questions. Council's website will include information about the study, the draft documents and an opportunity to provide submissions. Submission will also be able to be submitted at Council's Customer Service Centre and at the community information sessions.

Hydrological and Hydraulic Modelling

Due to the complex nature of flooding across the study areas, flood modelling been undertaken using a combination of hydrological, hydraulic and hydrodynamic models. This allows flooding to be assessed with regards to coastal processes, estuarine dynamics (in particular entrance scour), riverine flooding and overland flow. Hydrological modelling was undertaken for all study areas using XP-RAFTS, catchment driven flooding was modelled in TUFLOW and estuarine flooding driven primarily by coastal processes was modelled in Delft3D.

The flood models were calibrated and validated to historical flood events, where data was available. Historical flood data was compiled from rainfall and flow gauges as well as community observations. A summary of historical catchment and coastal events used for calibration and validation is shown below. No calibration data was available for Boydtown Creek, Nullica River, Shadrach Creek or Cocora Lagoon.

Historical Flood Events Used for Calibration and Validation

Event	Calibration / Validation Undertaken			Comments
	Towamba River Models	Eden Overland Flow Model	Coastal Models	
1978 Catchment and Coastal Event	Calibration	Validation of 20% and 1% AEP runs		The community were able to identify several flood levels and extents around Towamba. General observations were collected of flooding in Eden.
March 2011 Towamba River Catchment Event	Calibration			Although this was noted in several references as a major event. The majority of flood recollections provided for Kiah area. One calibration mark surveyed in Towamba for this event.
March 2012 Coastal Event			Calibration	It is one of the largest water level events associated with an entrance breakout. Event allows for the calibration of the entrance breakout of Lake Curalo
June 2016 East Coast Low			Calibration	Lake Curalo entrance was open (i.e. Lake was tidal) during June 2016 ECL. Exact entrance condition at that time is unknown. Event allows for the calibration of the interaction of rainfall runoff and storm surge in the lake. This was limited by the availability of rainfall data.

The hydrological, hydraulic and hydrodynamic models were analysed for the Probable Maximum Flood (PMF), 0.2% AEP, 0.5% AEP, 1% AEP, 2% AEP, 10% AEP and 20% AEP events. The models were analysed for durations ranging from 60 minutes to 36 hours, using the 10 temporal pattern ensemble approach detailed in ARR2016. Critical storm durations and median temporal patterns were determined from the hydrological modelling, with only the critical events applied to the hydraulic model.

Flooding within the Eden study area is driven by both lake flooding and catchment flooding. The extent of influence of lake flooding is limited, affecting primarily undeveloped areas along the lake foreshore. Some low-lying residential properties are impacted by lake flooding along the western edge of the lake. Catchment flooding controls the peak flood levels across much of the study area. Flow is well contained along most flow

paths, although increasing levels of break out flow occurring the larger AEP events and PMF. The critical duration across the study area ranged from 2 hours, for those areas with small upstream catchment areas, up to 9 hours, for those areas (such as Palestine Creek) with a larger contributing catchment.

In the coastal lagoons of Shadrachs Creek, Nullica River and Boydtown Creek flooding is generally confined to the creeks and lagoon areas in events up to the 5% AEP event. In larger events, flow begins to break out of the channels. While this largely occurs over vegetated areas or pastureland in Nullica and Boydtown, in Shadrachs, this breakout impacts the adjacent caravan park.

Flooding was assessed at five localities in the Towamba River catchment; Wyndham, Rocky Hall, New Buildings, Burragate and Towamba. Flooding in these locations is as a result of the Towamba River and Mataganah Creek overtopping their banks. Flooding within the Towamba River study areas is typically well defined, with little breakout flow from the main channel occurring, even in large flood events. The critical duration for flooding is long, 9 to 12 hours, due to the large contributing upstream catchment area. Several main access roads and bridges become inundated, isolating residents for the duration of the flood event.

Sensitivity

Sensitivity analysis of the hydraulic and hydrodynamic models to roughness, rainfall intensity and blockage of culverts and bridges was undertaken. The peak flood levels in the Towamba River catchment models were more sensitive to roughness changes than the other study areas, with increases of up to 1m. However, the increases did not result in significant increases to flood extents or number of properties impacted. The model was not particularly sensitive to blockage, with blockage of culverts in Eden only causing localised increases in flooding (i.e. immediately upstream of blocked culverts). Sensitivity to rainfall intensity was assessed through a comparison of the 0.5% AEP and 2% AEP to the 1% AEP event. The assessment showed that the model sensitivity to rainfall intensity increased for Towamba River study areas further downstream. In the upper catchment typical impacts were +/- 0.2 to 0.4 metres. This increased to +/- 0.7 to 1 metre at Towamba. Eden had more modest impacts in the order of +/- 0.1 metres. Shadrachs, Nullica and Boydtown had impacts of less than +/- 0.1.

Climate Change

For the Towamba River models, the impact of changes in rainfall intensity increases for study areas further downstream. In the upper catchment, increases in flood levels as a result of rainfall intensity increases were modest, typically in the range of 0.2 to 0.4 metres. Flood level impacts increased downstream, due to the additional upstream area contributing increased flow. Median increases in flood levels at New Buildings were 0.69 metres, increasing to 0.97 metres at Towamba.

In the coastal study areas, the increase in rainfall intensity had a much smaller impact on peak flood levels. Eden had more modest impacts in the order of +/- 0.1 metres, while Shadrachs, Nullica and Boydtown had impacts of less than +/- 0.1.

Sea level rise only impacts flooding in the coastal study areas. The Towamba River study areas are sufficiently far upstream to not be affected by sea level rise.

Along the northern shore of Lake Curralo, impacts were minimal, with negligible change in flood extent occurring even with a 0.9 metre rise in sea level. Along the western shore, sea level rise of 0.4 metres resulted in no significant increase in flood extent, although 0.9 metre of sea level rise resulted in a lateral expansion of 30 metres at Lakeside Drive that resulted in additional properties becoming flood affected. Along the southern

shore, additional inundation, while more wide spread than the northern and western shores, was typically restricted to open space and vegetated corridors. The exception was the aged care centre on Barclay Street, which was fully inundated under a 0.9 metre sea level rise scenario.

The steep terrain at Lake Cocora prevented any significant increase in flood affectation under a 0.4 metre sea level rise scenario. With 0.9 metres of sea level rise, overtopping of Ida Rodd Drive occurred.

Sea level rise at Shadrachs Creek primarily affected the caravan park, with an additional 20 metres and 30 metres of flood affectation occurring under the 0.4 and 0.9 metre sea level rise scenarios respectively. No impacts were shown upstream of the Princes Highway.

The terrain at Nullica and Boydtown prevent any significant expansion of flood extents under climate change scenarios. Increases greater than 0.1 metres in both the 2050 and 2100 scenarios did not extend past Juno Drive in Boydtown. The extent of increases within the channel extended further in Nullica with increases of 1.1 metres observed at Nullica Short Cut Road in the 2100 scenario. Impacts on developed areas were negligible, although increased flood affectation was observed across the pasture land adjacent to the Nullica River.

Conclusion

This report provides an understanding of the flood risk within the study area and provides Council with the tools for planning. This study provides a baseline against which a Floodplain Risk Management Study and Plan can be prepared.

Peak Overtopping Depths / Duration

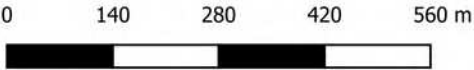
ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
W-1	Mount Darragh Road Bridge					0.7m / 6hrs+

G703-a
Wyndham
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



Scale : 1:10000@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
RH-1	Big Jack Mountain Road at Stockyard Creek	1.7m / 12hrs+	2.1m / 12hrs+	2.7m / 12hrs+	3m / 12hrs+	8.4m / 12hrs+
RH-2	Orchard Road	3.7m / 12hrs+	5.6 / 12hrs+	6.5 / 12hrs+	6.9m / 12hrs+	13.1m / 12hrs+

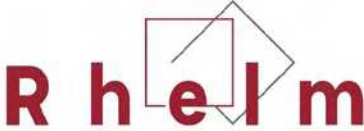


G703-b
Rocky Hall
Road Overtopping

- Model Area
- Infrastructure Locations
- 1% AEP Depth
 - 0.25
 - 0.5
 - 1
 - 1.5
 - 2
 - 2.5
 - 5
 - 10
 - >10



Scale : 1:7500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
NB-1	New Buildings Bridge					7.5m / 12hrs+
NB-2	Big Jack Mountain Road at New Buildings			0.4m / 3hrs	1m / 4hrs	8.4m / 12hrs+
NB-3	New Buildings Road at New Buildings			0.2m / 1hr	0.5m / 2hrs	8.5 / 12hrs+

G703-c
New Buildings
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



0 100 200 300 400 m

Scale : 1:7500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
B-1	Big Jack Mountain Road at Burragate	2.8m / 12hrs+	3.6m / 12hrs+	4.3m / 12hrs+	5.3m / 12hrs+	14.1m / 12hrs+
B-2	Davidson Street				0.3m / 2.5 hrs	7.67m / 12hrs+



G703-d
Burragate
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



Scale : 1:7500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
T-2	Towamba Bridge	3.7m / 12hrs+	4.7m / 12hrs+	6.5m / 12hrs+	7.2m / 12hrs+	15.1m / 12hrs+
T-4	Perricoe Road	1.6m / 12hrs+	2.7m / 12hrs+	4.6m / 12hrs+	5.3m / 12hrs+	13.2m / 12hrs+
T-1	Perricoe Road		0.9m / 3hrs	2.8m / 12hrs+	3.1m / 12hrs+	11.4m / 12hrs+
T-3	Towamba Road			0.9m / 4hrs	1.6m / 6hrs	9.8m / 12hrs+
T-5	Towamba Road	2.9m / 6hrs+	3.9m / 6hrs+	5.8m / 12hrs+	6.6m / 12hrs+	14.8m / 12hrs+

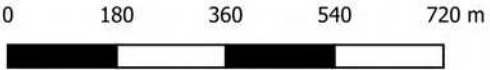


G703-e
Towamba
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



Scale : 1:12500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



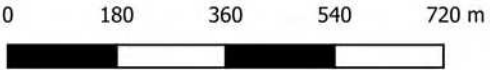
Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
EN-7	Bardlay Street	0.2m 2hrs	0.2m / 2hrs	0.3m / 2.5hrs	0.3m / 3hrs	1.7m / 4hrs
EN-6	Imlay Street at Freshwater Creek				0.1m / 1hr	0.4m / 1.5hrs
EN-5	Imlay Street at Golf Course	0.1m / 1hr	0.1m / 1hr	0.2m / 1hr	0.2m / 2hrs	1.2m / 3.5hrs
EN-2	Imlay Street					0.6m / 1.5hrs
EN-1	Imlay Street at Palestine Creek					1.7m / 2.5hrs
EN-3	Government Road at Palestine Creek					2.7m / 3hrs
EN-4	Government Road at Bellbird Creek					0.4m / 1hr

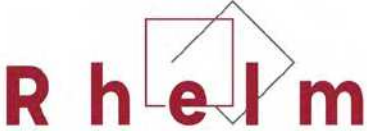


G703-f
Eden - North
Road Overtopping

- Model Area
- Infrastructure Locations
- 1% AEP Depth
 - 0.25
 - 0.5
 - 1
 - 1.5
 - 2
 - 2.5
 - 5
 - 10
 - >10



Scale : 1:12500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

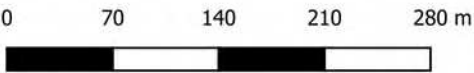
ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
ES-1	Cosham Cl	0.1m / 1hr	0.1m / 1hr	0.1m / 1h	0.1m / 1hr	0.7m / 2hrs
ES-2	Cosham Cl	0.1 / 2hrs	0.1 / 2hrs	0.1 / 2hrs	0.1 / 2hrs	0.4m / 3hrs
ES-3	Ida Rodd Dr	0.1m / 1hr	0.1m / 1hr	0.1m / 1hr	0.1m / 1hr	0.4m / 2hrs
ES-4	Cattle Bay Road	0.1m / 2hrs	0.1m / 2hrs	0.1m / 2hrs	0.1m / 2hrs	2.7m / 5hrs

G703-g
Eden - South
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



Scale : 1:5000@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55

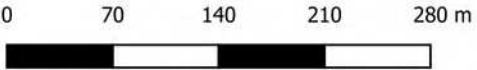
Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
S-1	Princes Highway					



G703-h
Shadrachs
Road Overtopping

- Model Area
- Infrastructure Locations
- 1% AEP Depth
- 0.25
 - 0.5
 - 1
 - 1.5
 - 2
 - 2.5
 - 5
 - 10
 - >10



Scale : 1:5000@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55



Peak Overtopping Depths / Duration

ID	Location	20% AEP	10% AEP	2% AEP	1% AEP	PMF
N-1	Nullica Short Cut Rd					
N-2	Princes Highway					



G703-i
Nullica / Boydton
Road Overtopping

- Model Area
- Infrastructure Locations

1% AEP Depth

- 0.25
- 0.5
- 1
- 1.5
- 2
- 2.5
- 5
- 10
- >10



Scale : 1:12500@A3
Date : 18 June 2019
Revision : A
Created by : LRE
Coordinate System : MGA94 Zone 55

