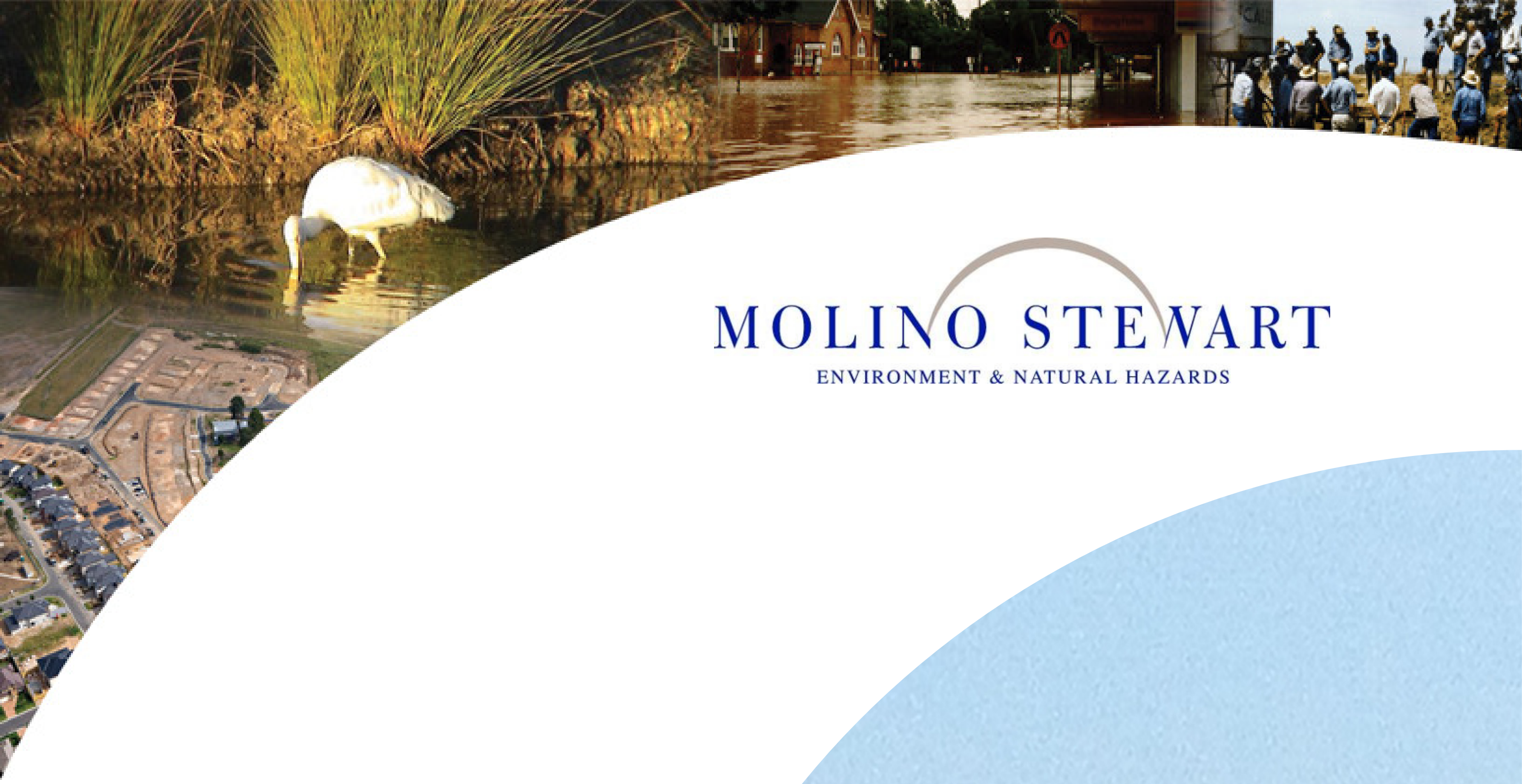

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Glenelg Hopkins Catchment Management Authority

Port Fairy Flood Warning Assessment Project

Report

Port Fairy Flood Warning Assessment Project

REPORT

for

Glenelg Hopkins Catchment Management Authority

by

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JULY 2013

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CONTENTS

EXECUTIVE SUMMARY 1

1 INTRODUCTION 3

1.1 The Total Flood Warning System (TFWS) 3

1.1.1 Flood warning systems 3

1.1.2 Manual 21 Flood Warning 3

1.1.3 A TFWS framework for this project 4

1.1.4 Riverine flooding 4

1.2 Flood warning in Victoria 6

1.2.1 Legislation, plans and policies 6

1.2.2 Flood warning arrangements 7

1.2.3 The Victorian Floods Review 7

1.2.4 Victorian Emergency Management Reform – White Paper 7

1.3 Port Fairy and the Moyne catchment 8

1.3.1 The catchment 8

1.3.2 The community 9

1.3.3 Flood risk 11

1.4 This project 13

1.4.1 Background 13

1.4.2 Project objectives 13

1.4.3 Project scope 13

2 METHODOLOGY 15

2.1 Steering Committee 15

2.2 Part 1 - Flood warning service needs assessment 15

2.2.1 Calculating the benefits of a flood warning system for Port Fairy 15

2.2.2 Assessing what is needed for a TFWS at Port Fairy 17

2.3 Part 2 – TFWS Optons Analysis 17

2.3.1 Benefit -cost analysis of components 17

2.3.2 Analysis of options in relation to other factors 17

2.3.3 Identifying preferred options 18

2.3.4 Benefit of a new TFWS for Port Fairy 18

2.4 Part 3 – TFWS Development Plan 18

2.5 Limitations 18

3 PART 1 – FLOOD WARNING SERVICE NEEDS ASSESSMENT 19

3.1 Need for a flood warning system at Port Fairy 19

3.2 Assessment of requirements for a TFWS at POrt Fairy 21

3.2.1 Understanding flood hazards and risks 21

3.2.2 Emergency management planning 21

3.2.3 Community flood education 22

3.2.4 Data collection 22

3.2.5 Flood prediction and interpretation 25

3.2.6 Message construction 28
3.2.7 Message communication 28
3.2.8 Response 29
3.2.9 Review of the TFWS 30
3.2.10 Community and stakeholder consultation 30
3.2.11 Integration of TFWS components 30
3.3 Recommended options 31

4 PART 2 – TFWS OPTIONS ANALYSIS 33
4.1 Option evaluation 33
4.1.1 Benefit-cost analysis of options 33
4.1.2 Further analysis of options 34
4.2 The value of a Port Fairy TFWS 34

5 PART 3 - DEVELOPMENT PLAN 35
5.1 Background 35
5.2 Priorities 36
5.3 Costings 36
5.4 Ownership and cost sharing arrangements 36
5.5 Action plan 37

REFERENCES 38

LIST OF TABLES

Table 1: Port Fairy - flood damage assessment costs for existing conditions 11
Table 2: % responses for indicators of community strength, Moyne LGA, 2008 29
Table 3: Benefit-cost ratios for the four TFWS options 33

LIST OF FIGURES

Figure 1: Flood warning systems are a critical link between emergency service providers and communities 3
Figure 2: The Total Flood Warning System (source: Molino et al, 2011) 5
Figure 3: Map of Port Fairy and the Lower Moyne Catchment (source: Glenelg Hopkins CMA) 10
Figure 4: Moyne River estuary at Port Fairy (photo: N.Dufty) 10
Figure 5: Extent of flooding for 100 year ARI under existing conditions (blue) and with 0.2m flood level increase (Source: Water Technology, 2012) 12
Figure 6: Flood timeline (based on Manual 21 Flood Warning) 16
Figure 7: Day curve (source: Day, 1970) 16
Figure 8: Relative flood response and travel times in the Moyne catchment for the 1% AEP flood (source: Port Fairy Regional Flood Study, Water Technology, 2008b) 20
Figure 9: Peak flood level at Toolong correlated with flood level upstream of Gipps Street Bridge, Port Fairy 27

Figure 10: Moyne River peak flow correlation – Willatook to Toolong (source: Water Technology, 2008) 27

EXECUTIVE SUMMARY

The Port Fairy Regional Flood Study concluded that sufficient warning time is available for a flood warning system to potentially be implemented. It recommended that:

The Moyne Shire and GHCMA explore options for the development of a flood warning system for Port Fairy in conjunction with the BoM and SES.

In response, a flood warning service needs assessment was conducted for Port Fairy and the Moyne catchment. The assessment was conducted by Molino Stewart Pty Ltd in liaison with a Technical Steering Committee consisting of:

- Glenelg Hopkins Catchment Management Authority
- Moyne Shire Council
- Department of Environment and Primary Industries (DEPI) Floodplain Management Unit
- VICSES
- Bureau of Meteorology (BoM)
- Local community stakeholders.

The assessment examined the following components of the Total Flood Warning System (TFWS) guided by the Australian Government's Manual 21 – Flood Warning:

1. Understanding of flood risks and hazards
2. Emergency management planning
3. Community flood education
4. Data collection
5. Flood prediction and interpretation
6. Message construction
7. Message communication
8. Response
9. Review of the TFWS
10. Community and stakeholder consultation
11. Integration of the TFWS components.

The assessment estimated that a TFWS at Port Fairy would provide reduction in damages of $400,274 over a 20 year life cycle. Moreover, it would improve public safety by markedly increasing warning time and improving community response to floods.

The assessment identified the following main options to build an effective TFWS at Port Fairy:

1. Installation of an automated real-time river level gauge at a location such as Willatook, upstream from the existing Toolong river gauge
2. Installation of an automated real-time prediction location gauge near the Gipps Street Bridge, Port Fairy
3. Installation of two automated real-time rain gauges in, and close, to the upper Moyne catchment
4. The conduct of a social research study and resultant emergency planning, community education and community development actions to improve potential warning response.

Several other ways of improving the Port Fairy flood warning service were identified in the assessment:

- Conduct hydrologic studies for floods greater than the 200 year ARI
- Include a social profile and analysis of potential community response to flood warnings in the Moyne Shire MFEP
- Install an additional automated real-time rain gauge adjacent to the existing Toolong gauge
- Align the flood intelligence data that is in the Port Fairy RFS with that in the MFEP
- Include an evacuation plan including a map of evacuation routes in the MFEP
- Test run the Port Fairy RORB model using the August 2010 flood event to help validate the RORB parameters adopted by Water Technology in the Port Fairy RFS
- Use the CFA siren located in Port Fairy as a flood alert and 'heads-up' for the

community to seek further flood warning information

- Assess the lead warning times and impacts as floodwaters rise including properties becoming isolated
- Assess the possible rainfall/flood scenarios that would trigger cancellation of the Port Fairy Folk Festival
- Review the Port Fairy TFWS based on the Technical Steering Committee for this project
- Develop a Port Fairy TFWS monitoring and evaluation plan to ensure the long-term sustainability and effectiveness of the TFWS
- Consider a flood warden and/or flood observer program for Port Fairy.

A plan was prepared to guide the development of the Port Fairy TFWS. The recommended actions in the plan are:

1. Commence a Port Fairy Flood Warning Committee to manage the governance of the actions.
2. Request that the BoM provide a flood prediction service for Port Fairy using the TFWS once established.
3. Seek financial support for the four TFWS options.
4. Ask emergency agencies to agree on TFWS arrangements for Port Fairy and put them in place.
5. Consider the other suggested improvements to the existing flood warning system at Port Fairy.
6. Implement the TFWS options and advise the BoM, VICSES and Port Fairy community.
7. Refine other components of the new Port Fairy TFWS accordingly, including communications and community education.

1 INTRODUCTION

1.1 THE TOTAL FLOOD WARNING SYSTEM (TFWS)

1.1.1 Flood warning systems

"Flood warning systems are developed with the fundamental aim of increasing safety and reducing the harmful effects of floods (referred to as 'damages' or 'losses'). The extent of losses avoided as a result of a warning is therefore the key measure of warning system effectiveness." (Molinari and Handmer, 2011, p. 23)

Mileti and Sorenson (1990, p.1) identify warning systems within the tools used to minimise the risks and effects of hazards and disasters. They note that "warning systems bear an interesting relationship to other hazard management tools. They are the last lines of defence after, for example, engineered solutions are applied to reduce the probability of an event below an acceptable level".

This value of warning systems 'as a last line of defence' can be visualised as in Figure 1. Related to floods, warning systems are a critical conduit between emergency management (and its emergency service providers) and affected communities immediately prior to and during a flood event. This relationship operates within the 'residual risk' afforded by structural and non-structural floodplain risk management options.

Mileti and Sorenson add that "warning systems for low-probability events often do not make cost-benefit sense. Warning systems are economically rational only when a risk becomes an actual event and when having inadequate or no warning systems is politically and socially unacceptable".

In practice, flood warning systems provide individuals and communities with time to carry out actions to protect themselves, and if possible, aspects of their properties.

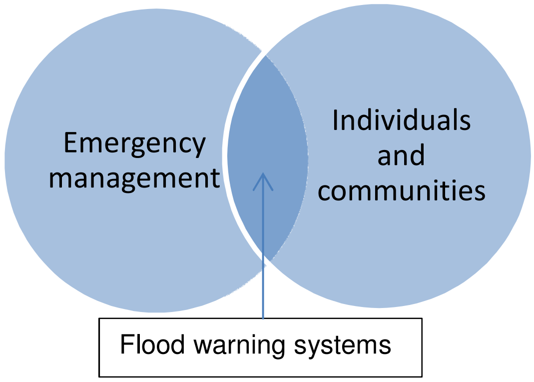

Figure 1: Flood warning systems are a critical link between emergency service providers and communities

According to Carsell, Pingel and Ford (2004, p. 132), a flood warning system "gives property owners and floodplain occupants and those responsible for their safety more time to respond to a flood threat before the threshold is exceeded. With this increased time, lives and property are protected." Not only is time of the essence, but also good warning advice to those impacted. Even if warnings are timely and accurate, individuals and communities also need to be responsive to the warnings.

1.1.2 Manual 21 Flood Warning

In Australia, the concept of the 'total flood warning system' (TFWS) has been used to describe the full range of elements that must be developed if flood warning services are to be provided effectively.

The lead guiding document for the development of the TFWS in Australia is Manual 21 – Flood Warning (Attorney-General's Department, 2009).

According to Manual 21 (page 6), at its simplest, the TFWS consists of six components:

1. Prediction - Detecting changes in the environment that lead to flooding, and predicting river levels during the flood.
2. Interpretation - Identifying in advance the impacts of the predicted flood levels on communities at risk.

3. Message Construction - Devising the content of the message which will warn people of impending flooding.
4. Communication - Disseminating warning information in a timely fashion to people and organisations likely to be affected by the flood.
5. Response - Generating appropriate and timely actions from the threatened community and from the agencies involved.
6. Review - Examining the various aspects of the system with a view to improving its performance.

Manual 21 (page 7) stresses that for the TFWS to "work effectively, these components must all be present and they must be integrated rather than operating in isolation from each other."

When designing a TFWS, Manual 21 (pages 7-8) advises that the following points need to be addressed:

- The system must meet the needs of its clients including identifying:

  - levels of flooding at which warnings are required

  - the impacts at the different levels of flooding

  - warning time the community requires and what can be provided,

  - appropriate subject matter content for warning messages

  - the ways in which warning messages are to be disseminated

  - the frequency of warning updates
- The system must be part of the emergency management arrangements established by the relevant State or Territory as defined in disaster or emergency management plans.
- The review of the system must be carried out by all emergency agencies and by the community itself.
- The roles of the emergency agencies must be clearly defined for each component of the system.
- The system must be incorporated into the wider floodplain management.
- The system should be regularly tested and maintained.

1.1.3 A TFWS framework for this project

As noted in Section 1.1.2, Manual 21 advocates six basic components of a TFWS. However, others such as Molino et al (2011) believe that there are other preliminary components required for an effective TFWS, including understanding the residual risk that the TFWS operates under, the impact of prior community flood education and the guidance provided by action plans (e.g. emergency plans for emergency service providers, local government, business, residents). This more holistic TFWS is shown in Figure 2 and is adopted for analysis in this project.

In relation to Figure 2, Molino et al (2011) note that "it is important to realise that the diagram is imperfect and does not reflect the significant amount of iteration which is required for each of the components to be done well and properly aligned with the others". They add that "each of these warning system parts can work well or can work poorly or at worst, not work at all. The overall effectiveness of the warning can only be as strong as the weakest link in the chain and, unlike a real chain, errors or weaknesses can accumulate as they are passed along the chain e.g. poor data plus poor interpretation can be worse than either poor data or poor interpretation."

1.1.4 Riverine flooding

The study area for this project involves a riverine flooding scenario, with some oceanic influence (see Section 1.3.3).

Riverine (or mainstream) flooding refers to heavy or sustained rainfall resulting in a river or creek exceeding channel capacity causing inundation of the adjacent floodplain.

As opposed to flash flooding, riverine flooding can provide a reasonable amount of 'warning lead time'. This is the time for communities to take action and is a sub-set of the maximum potential warning time (refer to Figure 6).

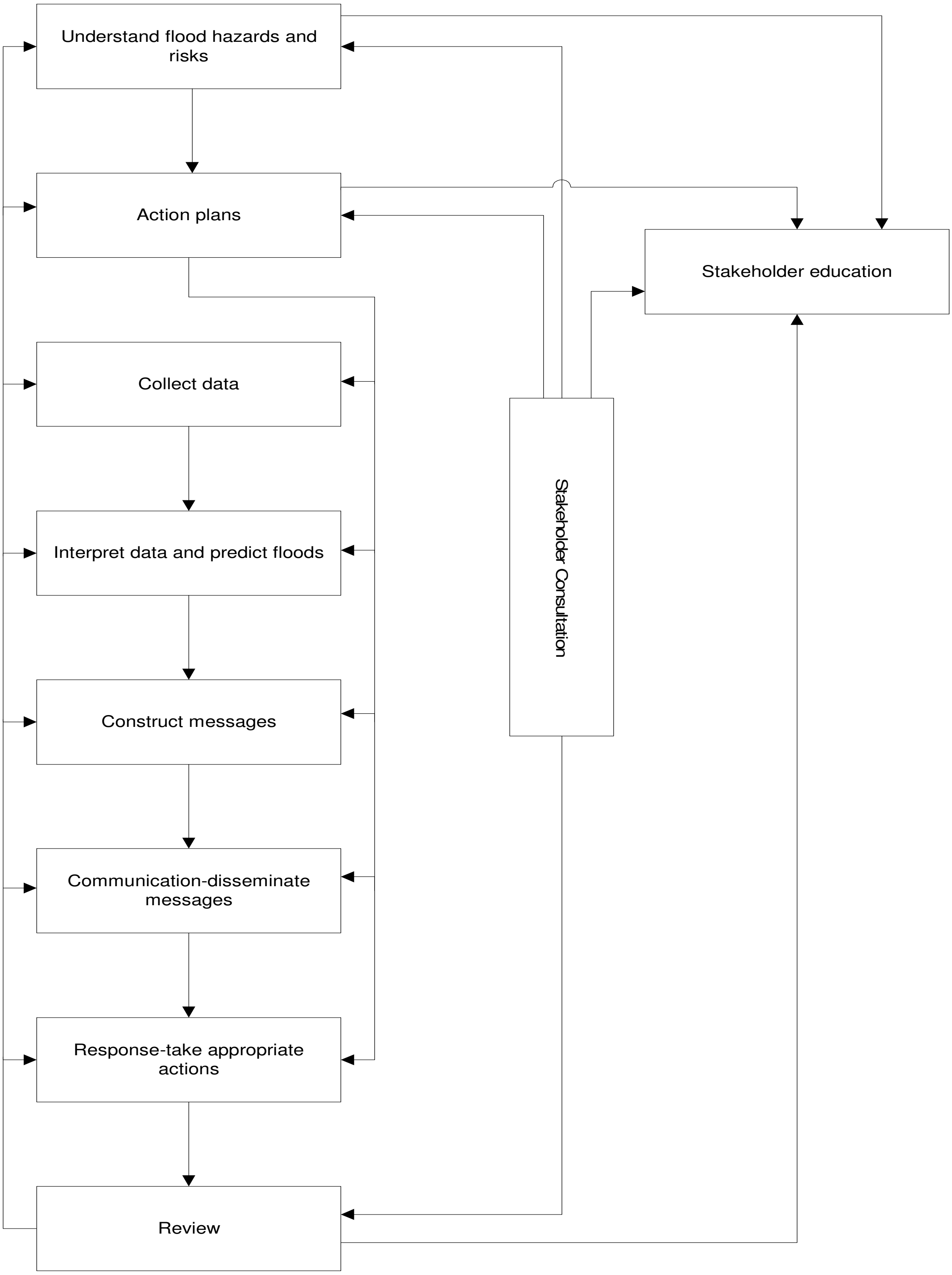

Figure 2: The Total Flood Warning System (source: Molino et al, 2011)

1.2 FLOOD WARNING IN VICTORIA

1.2.1 Legislation, plans and policies

The 1998 Victorian Flood Management Strategy (VFMS) provides the strategic policy framework for flood management in Victoria. The strategy contains a program of actions to collate the available data on floodplains and implement measures to reduce the flood risk to communities. It also importantly outlines the roles and responsibilities for governments, organisations and communities involved in flood management, including flood studies, mapping, mitigation works and flood warning.

The emergency arrangements in Victoria are regulated through the *Emergency Management Act 1986* (the EM Act), which is intended to ensure an organised structure exists to facilitate planning, preparedness, operational control and coordination as well as community participation in the prevention, response and recovery from an emergency incident.

Specific control and coordination arrangements during an emergency, including flood, are outlined in the Emergency Management Manual Victoria (EMMV). This manual contains procedures for dealing with emergencies of all sizes and includes arrangements that cater for those events requiring multi-agency action, including those requiring participation from both state and commonwealth agencies.

The EMMV identifies the Victoria State Emergency Service (VICSES) as the agency nominated to control response activities to a flood in Victoria. In 2007, the VICSES published the State Flood Response Plan (SFRP) that provides strategic guidance for effective emergency response to flood events in Victoria. The Plan also describes the roles and responsibilities of agencies and organisations in flood management and key activities in responding to flood including minimising the threat and impact to people, property and the environment. The State Flood Emergency Plan was released in 2012.

Consistent with any emergency event in the state, Victoria Police (VicPol) retains the responsibility for emergency services coordination during a flood, which includes ensuring that effective control has been established by the control agency and the effective coordination of resources and services. The EMMV also details the responsibilities of several other agencies involved in flood management such as the Bureau of Meteorology (BoM), municipalities, catchment management authorities (CMAs), the Country Fire Authority (CFA), Department of Health (DH), Department of Human Services (DHS) and Department of Environment and Primary Industries (DEPI).

The Victorian Warning Protocol was established in 2009 to provide emergency response agencies with coordinated and consistent direction on advice and/or warnings to inform the Victorian community of a potential or actual emergency event.

"The Protocol is based on the all-hazards approach. Taking such an approach will reassure the community that regardless of the emergency type, any alerts or warnings disseminated will be authoritative, consistently constructed, timely and appropriate." (Victorian Government, page 7)

The Protocol is in line with national warning guidelines and consists of seven elements which are similar to those in Manual 21 (see Section 1.1.2) and the extended TFWS framework (see Section 1.1.3) used in this report. The seven elements are:

1. Community preparedness
2. Situational awareness and analysis
3. Decision-making and authorisation
4. Message construction and dissemination
5. Management of warning consequences
6. Real-time monitoring
7. Real-time closure.

There are several Standard Operating Procedures (SOPs) derived from the Protocol which guide warning activities particularly in relation to the state, regional and local Incident Control Centres.

1.2.2 Flood warning arrangements

The arrangements for flood warning networks are outlined in the VFMS and Arrangements for Flood Warning Services in Victoria 2001.

The responsibility for issuing flood related warnings clearly remains with the BoM and VICSES. Under the current institutional arrangements, the BoM is the organisation charged with the primary responsibility for weather forecasting and flood prediction. The BoM constructs flood warning messages for selected streams throughout Victoria with the exception of those streams within the area delegated to Melbourne Water. The nature of these predictions or warnings depends on the quality of the information available to the BoM or Melbourne Water, including data from rainfall and stream gauges owned by others (water corporations, local government, DEPI) throughout Victoria. VICSES issues subsequent information as Flood Bulletins which relate flood predictions to possible impacts on communities.

In Victoria, two state-wide flood committees operate to ensure integration of all levels of government to deliver on flood management objectives, including establishment, evaluation, and maintenance of flood warning systems.

1. The State Flood Policy Committee (SFPC) which provides advice on flood policy to government
2. The Victorian Flood Warning Consultative Committee (VFWCC) which identifies requirements and coordinates the development and operation of flood warning services in Victoria.

1.2.3 The Victorian Floods Review

Although there had been improvements to the TFWS in Victoria over at least the past decade, the widespread and devastating floods between September 2010 and February 2011 highlighted some major deficiencies.

The Review of the 2010-11 Flood Warnings and Response led by Neil Comrie AO made 93 recommendations to improve flood warning services throughout the state. Recommendations were made under the following aspects of the TFWS:

- The adequacy of flood predictions and modelling
- The timeliness and effectiveness of warnings and public information
- Emergency services command and control arrangements
- The adequacy of evacuations of people most at risk, including those in health and aged care facilities
- The adequacy of clean-up and recovery arrangements
- The adequacy of service delivery by federal, state and local governments
- The adequacy of funding provided by state and federal governments for emergency grants
- Community resilience.

1.2.4 Victorian Emergency Management Reform – White Paper

The Victorian Government is undertaking major reform to the State’s crisis and emergency management arrangements to create a more disaster resilient and safer Victoria.

The Government’s White Paper on Victorian Emergency Management Reform was released in December 2012. It provides a 'road map' for emergency management reform over the next ten years. The proposals in the White Paper are informed by the Final Report of the 2009 Victorian Bushfires Royal Commission, the Final Report of the Review of the 2010-11 Flood Warnings and Response, submissions on the Green Paper ‘Towards a More Disaster Resilience and Safer Victoria’ and the Fire Services Reform Action Plan.

In the White Paper there are several actions for improving warning systems in Victoria. In relation to making information available during emergencies there are the following actions (page 8 of the White Paper):

- Develop a single emergency management web portal to provide information and advice to help people prepare for, respond to, and recover from emergencies.
- Continue to develop the current multi-agency, multi-hazards and multi-channel approach to providing community warnings and information, focusing more on understanding and responding to the various ways communities choose to access information.
- Expand the reach of official emergency broadcasts to include more commercial television and culturally and linguistically diverse media in partnership with emergency broadcasters, and in line with the Floods Review recommendations.
- Where possible, memoranda of understanding with broadcasters will include provision for broadcast of community meetings and dissemination of warnings across a range of communication channels (such as internet-based media).
- Develop a single all-hazards telephone hotline for the community to access information during emergencies.

In relation to agency collaboration (page 25 of the White Paper), the Emergency Management Commissioner (EMC) will be responsible for ensuring appropriate warnings are issued to the public, and keeping relevant ministers and secretaries informed on the management of the emergency and its consequences.

So the EMC can ensure appropriate control arrangements are in place, agencies will be required to report to the EMC as soon as they become aware that a major emergency may occur, is occurring or has occurred.

In relation to capability (page 38 of the White Paper), there is a vision for Victoria's emergency communication systems and information characterised by:

- high transmission capability and flexible platforms able to support diverse applications
- control centres with systems needed to collect information from diverse sources, including emergency workers and members of the public. These will also be capable of processing, analysing and disseminating acquired knowledge
- field workers with access to information and equipment that is simple and intuitive. Equipment will support the transfer of large volumes of data and communicate (by voice or data transfer) directly with field personnel from other agencies
- community members with access to sophisticated, timely and accurate information (via diverse media) before, during and after emergencies.

There is a subsequent action in the White Paper to "continue developing a long term strategic plan for emergency information and communications, including the integration of the Information Interoperability Blueprint to deliver a common operating platform."

1.3 PORT FAIRY AND THE MOYNE CATCHMENT

1.3.1 The catchment

Port Fairy is located near the mouth of the Moyne River Estuary in south-west Victoria (Figure 3).

The Moyne River catchment has a total area of approximately 758 km² with significant tributaries including Murray Brook (133 km²), Nardoo Creek (75 km²) and Back Creek (77 km²).

Port Fairy itself is situated on low-lying ground with the Moyne River running along the east side of the town (Figure 4). A high sand dune (crest elevation approximately 5 to 15 m AHD) separates the river/estuary from the ocean.

To the north (upstream) of Port Fairy the river/estuary widens into a shallow open water body known as Belfast Lough. The Moyne River flows into the estuary approximately 3 km upstream of the town. Other waterways that enter the estuary include Murray Brook and Reedy Creek.

According to Water Technology (2008a, p. 6), the catchment is characterised by relatively gentle grades with a maximum elevation of approximately 250 metres above sea level and an average slope of 0.003 or 3 metres in 1000 metres. Slope through the catchment does not vary greatly with the upper reaches showing only moderately higher slopes than the lower reaches.

The catchment is also distinguished by significant floodplain storages in the form of wetlands and swamps. Whilst many low-lying areas have been drained, the efficiency of these drains in large flood events (e.g. greater than 5% AEP) is expected to be low and hence significant active storage would be developed throughout the catchment (Water Technology, 2008a, p. 7).

1.3.2 The community

According to the 2011 census data (Australian Bureau of Statistics, 2012), Port Fairy has a population of 2,835. From the census data, some relevant features of the Port Fairy community are:

- A relatively older population with an average age of 50 years (compared with the average age of 37 for all Victorians). Twenty-seven percent of the population is 65 years or older.
- Ten percent of the population on census night were visitors i.e. their normal place of residence was elsewhere (note – Census night is in winter, these figures would most likely be higher in the middle of summer or early autumn when the 1946 flood occurred).
- Less than two percent of the population speak a language other than English at home (compared with the Victorian average of 26%).
- The average household size is 2.2 persons (Victoria average is 2.6 persons per household).
- There are 1,818 private dwellings in Port Fairy of which 1,132 (62%) were occupied at the time of the 2011 census and 686 (38%) were unoccupied. The Victorian average was 89% occupied.
- Most people (90%) live in separate one storey homes, with eight percent living in flats/town houses, and the remaining two percent in other dwellings such as caravans and cabins.
- Seventy-two percent of the properties in Port Fairy are owned, with the remainder (28%) being rented.
- About six percent of the population require some form of disability assistance.

These statistics are consistent with Port Fairy being a tourist location. There is a relatively older population (retirees) and reasonably large number of unoccupied premises (absentee owners). Some of the features listed reflect social vulnerabilities to flooding and will be referenced later in the report (see Section 3.2.8).

Port Fairy is characterised by seasonal tourism that swells the population throughout the year. The population can jump to around 12,000 over the summer.

Port Fairy Folk Festival is held in early March and the population can increase to over 40,000 during the folk festival weekend. The devastating 1946 floods in Port Fairy occurred on the same weekend the Port Fairy Folk Festival is now held.

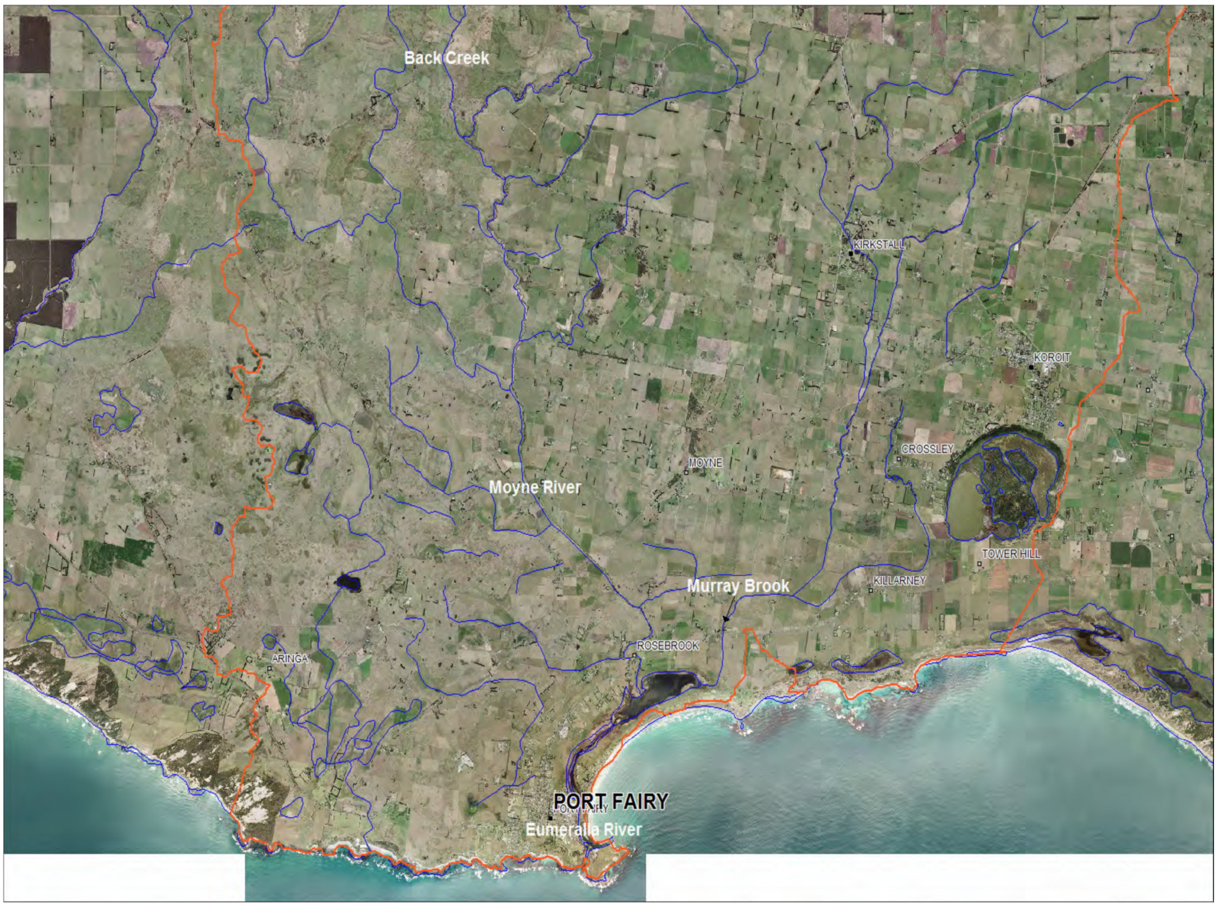

Figure 3: Map of Port Fairy and the Lower Moyne Catchment (source: Glenelg Hopkins CMA)

Figure 4: Moyne River estuary at Port Fairy (photo: N.Dufty)

1.3.3 Flood risk

The Port Fairy Regional Flood Study (RFS) was completed in 2008 (summary: Water Technology, 2008a).

In August 2010, the Port Fairy RFS was updated to incorporate policies set out in the Victorian Coastal Strategy (VCS) 2008 for the inclusion of sea level rise in long-term planning. The Port Fairy RFS Addendum – Sea Level Rise Modelling (Water Technology, 2010) investigated sea level rises of 0.8 m and 1.2m. A 0.2m Sea Level Rise Modelling investigation has also been recently completed.

The Port Fairy RFS provides information on flood levels and flood risks within the township for both catchment and ocean-based flooding. A hydrologic analysis of the Moyne River catchment was undertaken to determine design flood hydrographs for the 5, 10, 20, 50, 100 and 200 year Average Recurrence Interval (ARI) flood events at key locations around Port Fairy.

Significant floods have occurred at Port Fairy in the past fifty years (e.g. in 1978, 2001, 2010); however, the 1946 flood was much larger and damaging. Water Technology (2008a) estimates that the 1946 flood at Port Fairy was to be around a 1,000 year ARI event. Most of the larger floods recorded occurred between August and November.

As part of the Port Fairy RFS, flood behaviour was assessed for flooding originating from the Moyne River and the ocean. The hydraulic model was calibrated to three historic flood events. The outputs of the hydraulic modelling are considered appropriate for the definition of flood risk in Port Fairy.

A flood risk assessment was then undertaken in the Port Fairy RFS which involved the estimation of tangible flood damages for a range of design events. The average annual damage (AAD) was then calculated to be approximately $219,200 per year with current topography and flows. These results showed that up to and including the 10 year flood event relatively minor flood damages are predicted with only four properties flooded above floor from a total of 43 flood affected properties. Upwards of the 20 year flood, damages increase more rapidly as shown in Table 1.

Table 1: Port Fairy - flood damage assessment costs for existing conditions

ARI	Properties Flooded Above Floor	Properties Flooded Below Floor	Total Properties Flooded
10 year	4	39	39
20 year	14	100	114
50 year	29	121	150
100 year	50	141	191
200 year	88	135	223

Source: Water Technology (2008a)

For the 100 year ARI flood, the number of properties with above floor flooding is less than three percent of all properties in Port Fairy (refer to Section 1.3.2). However, the damage estimated at this level is close to $2 million. Furthermore, the Gardens Caravan Park (located near the Gipps Street Bridge) accommodating a large number of tourists is particularly vulnerable to relatively minor flooding.

The impacts of sea level rise were also subsequently modelled (Water Technology, 2012) as follows:

- 0.0m SLR scenario and 10% AEP storm tide – plus 0.2m global flood level increase (Scenario 1)
- 0.2m SLR scenario and 10% AEP storm tide (Scenario 2)
- 0.8m SLR scenario and 10% AEP storm tide (Scenario 3)

Each scenario was assessed using the 5 year, 10 year, 20 year, 50 year, 100 year and 200 year ARI events to allow for the completion of the damages assessment.

As shown in Figure 5, there was a slight increase in the areas flooded with the 0.2m global flood level increase at the 100 year level (Scenario 1). All flood scenarios showed that there would be increased numbers of properties flooded.

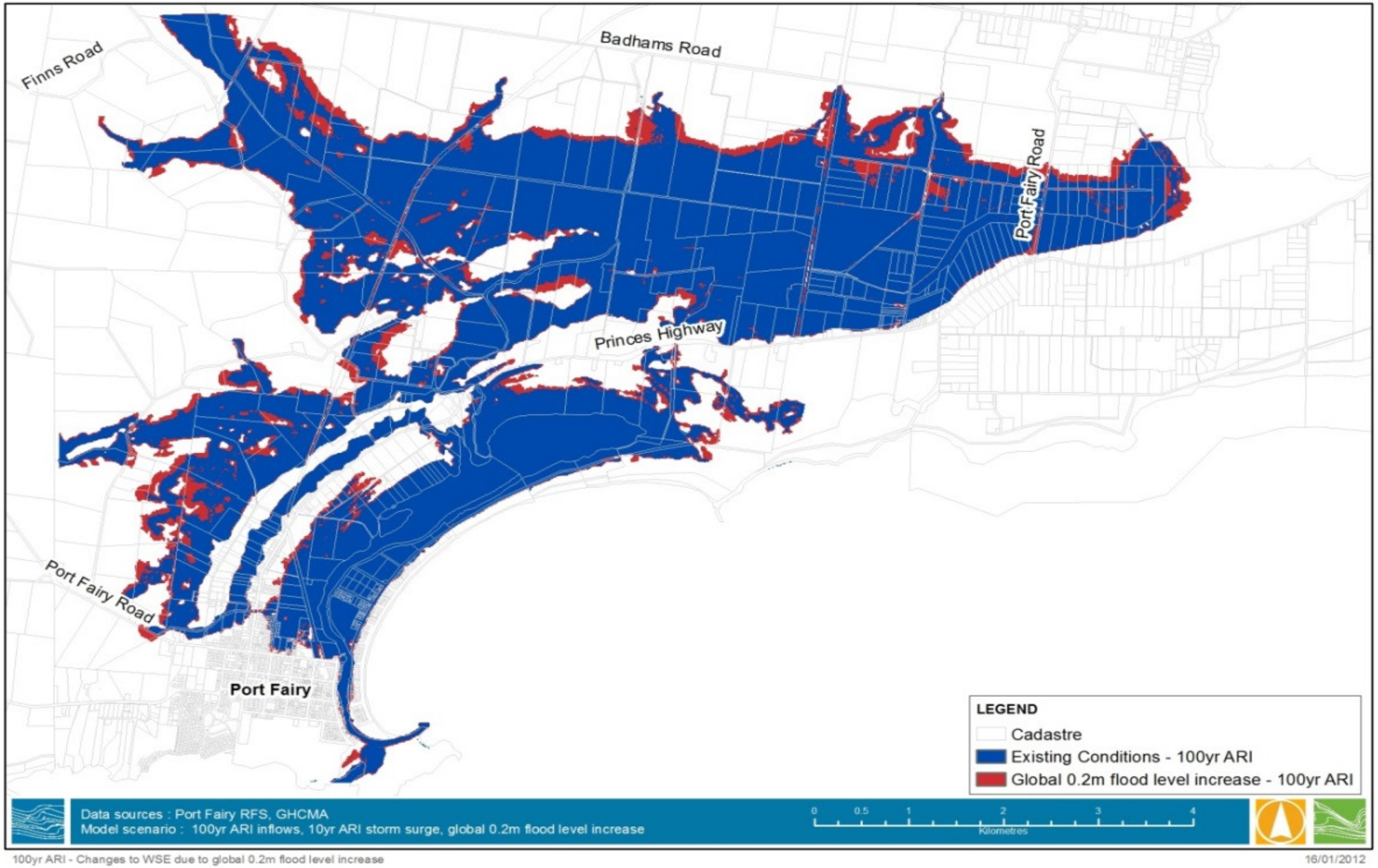

Figure 5: Extent of flooding for 100 year ARI under existing conditions (blue) and with 0.2m flood level increase (Source: Water Technology, 2012)

1.4 THIS PROJECT

1.4.1 Background

A preliminary assessment of flood warning issues was addressed in the Port Fairy RFS (Water Technology, 2008a). The RFS concluded that sufficient warning time is available for a flood warning system to potentially be implemented. It recommended (page 57) that:

The Moyne Shire and GHCMA explore options for the development of a flood warning system for Port Fairy in conjunction with the BoM and SES.

Following up on this recommendation, the Glenelg Hopkins CMA and other stakeholders decided that further work was required to investigate possible improvements for flood warning available to response agencies to manage flood emergencies and assist in the reduction of flood impacts on the township.

The CMA engaged the services of Molino Stewart Pty Ltd to assess current and available warning services and guide the development of a TFWS for Port Fairy. This is Molino Stewart's report for the project.

1.4.2 Project objectives

The objectives of the project were to:

1. assess the flood warning service need
2. determine the nature of the TFWS elements to meet this service need.

To achieve this, the project was divided into three parts:

1. Flood warning service needs assessment
2. TFWS options analysis
3. TFWS Development Plan.

1.4.3 Project scope

a) Part 1 – Flood warning service needs assessment

The consultant in conjunction with the Technical Steering Committee was to assess the flood warning service need for Port Fairy. This assessment was to determine the potential benefits of a TFWS to reduce flood impacts.

The methodology for this part of the project is outlined in Section 2.2 and the findings provided in Section 3.

b) Part 2 –TFWS Options Analysis

The consultant was to evaluate effectiveness of each element of the TFWS to achieve a reduction in flood impacts.

The flood impacts examined should include direct and indirect impacts, and social/intangible aspects. The consultant should assess the range of potential benefits for various TFWS configurations.

The consultant was to consider:

- Data collection: rainfall and river height gauges
- Flood forecasting approaches
- Flood interpretation requirements
- Community education and awareness material
- Flood response

Through discussions with the Technical Steering Committee, the consultant was to propose a preferred TFWS configuration.

The methodology for this part of the project is outlined in Section 2.3 and the findings provided in Section 4.

c) Part 3 – TFWS Development Plan

From the flood warning service needs assessment and TFWS options analysis, the consultant was to prepare a development plan for the preferred total flood warning system configuration. The plan was to outline the nature of each element of the TFWS.

The consultant was to prepare a report detailing a development plan for the preferred total flood warning system configuration for consideration by the Technical Steering Committee.

The methodology for this part of the project is outlined in Section 2.4 and the development plan provided in Section 5.

2 METHODOLOGY

2.1 STEERING COMMITTEE

As mentioned in Section 1.4.3, a Technical Steering Committee was established to provide assistance and technical guidance to the consultant throughout the course of the project. The Committee consisted of representatives from:

- Glenelg Hopkins CMA
- Moyne Shire Council
- DEPI Floodplain Management Unit
- VICSES
- BoM
- Local community stakeholders.

2.2 PART 1 - FLOOD WARNING SERVICE NEEDS ASSESSMENT

As noted in Section 1.4.3, Molino Stewart, in consultation with the Technical Steering Committee, was required to assess the flood warning service need for Port Fairy. This assessment will determine the potential benefits of a TFWS to reduce flood impacts.

To assess the flood warning need, it is important to firstly understand the types of benefits that a flood warning system can offer. USACE (1994) identifies four categories of benefits:

1. Direct tangible benefit. Tangible benefits are those to which monetary value can be assigned, and direct benefits are those that accrue to people and property who are 'protected' by the system. Examples of direct tangible benefits include moving belongings, temporarily raising items, temporary flood proofing (e.g. sandbags), traffic control, early notification of emergency services (e.g. establishing evacuation centres)
2. Direct intangible benefit. Intangible benefits are those accrued within the floodplain that cannot be readily expressed in monetary terms. Examples of direct intangible benefits include protection of human health and safety (e.g. timely and orderly evacuation of a floodplain which reduces risks to evacuees), reduced stress, reduction in family disruption.
3. Indirect tangible benefit. These are economic benefits to those who are outside the area protected by the flood warning system. Examples include companies that may have their fate tied to commercial activity within the floodplain, consumers who shop, recreate in or otherwise use the floodplain benefit from a flood warning system.
4. Indirect intangible benefit. These are non-economic benefits that accrue to those outside the floodplain as a consequence of reduced stress. For example, the effective and widespread communication of warning messages can benefit the mental health of families and friends located outside the floodplain.

2.2.1 Calculating the benefits of a flood warning system for Port Fairy

There have been numerous methods developed that estimate the benefits of a flood warning system and its components.

A key relationship is that of 'warning time' (see Flood Time Line - Figure 6) and the 'damages' incurred from a flood. A rudimentary, yet universally accepted, way of estimating tangible benefits of a flood warning system is the Day curve (Day, 1970). The Day curve (see Figure 7), based on a series of tests in floods, proposes that the tangible benefit of a flood warning system can be estimated as a function of warning time due to the system.

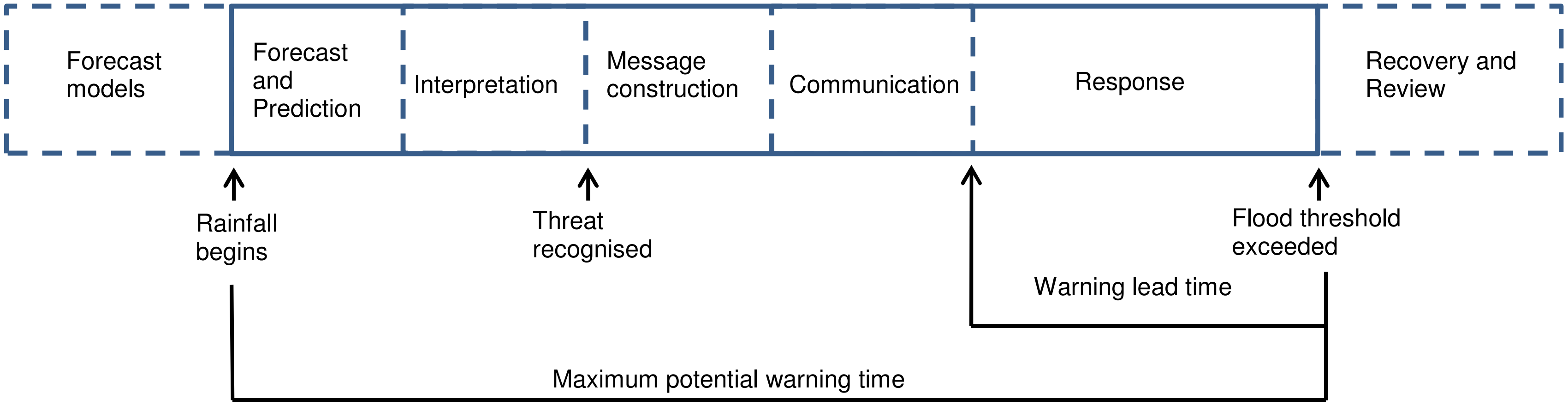

Figure 6: Flood timeline (based on Manual 21 Flood Warning)

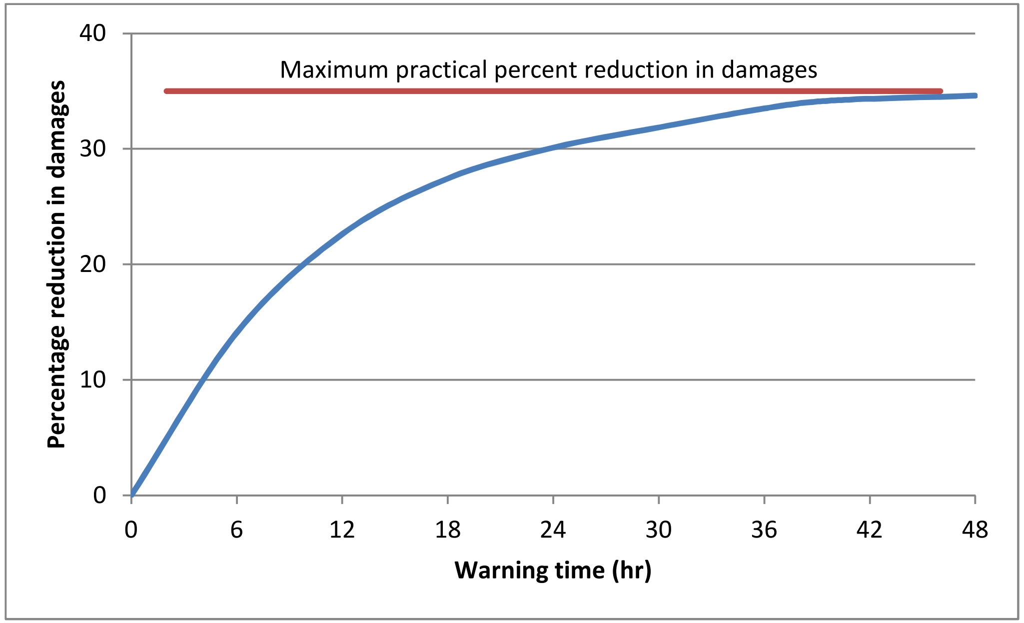

Figure 7: Day curve (source: Day, 1970)

The Day curve is used in this report (Sections 3.1 and 4.1) to provide an indication of the benefit of having not only a flood warning system but also a TFWS. It also provides a basic understanding of the benefits of each option suggested for a TFWS at Port Fairy (Section 4.1). The damage estimations made by Water Technology (2008a) are used as a baseline in these calculations.

Warning time for the Day curve is mitigation time or 'warning lead time' i.e. the time that people can respond to warning messages (see Figure 6).

However, the damage reduction predicted by the Day curve is optimistic as it presumes that when notified, property owners will act rationally and efficiently. To factor in human response, the following equation (Parker, 1991) is used in conjunction with the Day curve:

FDA = PFA x R x PRA x PHR x PHE

where:

FDA = Actual flood damage avoided

PFA = Potential flood damage reductions (as per Day curve)

R = Reliability of the flood warning process (i.e. the proportion of the population at risk which is warned with sufficient lead time to take action)

PRA = Proportion of residents available to respond to a warning

PHR = Proportion of households able to respond to a warning

PHE = Proportion of households that respond effectively

There are sliding scales provided for each of R, PRA, PHR and OHE (Carsell, Pingel and Ford, 2004, p. 137) from which coefficients can be chosen for Port Fairy.

This approach to calculating damage reduction is used by the UK Government (SNIFFER, 2006).

It should be noted that there are other methods for calculating the benefit of flood warning systems including using the residential content depth-damage relationship (USACE, 1991) and attempting to factor in intangible benefits (SNIFFER, 2006). The choice of the abovementioned method was based on prior data available (e.g. Water Technology report) and the requirement to empirically demonstrate the benefit of each component of the TFWS.

2.2.2 Assessing what is needed for a TFWS at Port Fairy

There is an existing 'flood warning system' for Port Fairy; however, it may not have all the attributes of a TFWS (see Section 1.1.3). A qualitative gaps analysis was conducted by comparing the components of the existing flood warning system with requirements for a TFWS as per Manual 21.

Suggested options for the development of a Port Fairy TFWS were identified for further analysis (Section 2.3).

2.3 PART 2 – TFWS OPTONS ANALYSIS

2.3.1 Benefit -cost analysis of components

A benefit-cost analysis was conducted to compare the options suggested for each TFWS component (see Section 2.2.2). This was carried out using the empirical methodology explained in Section 2.2.1 in relation to an estimation of initial and maintenance costs for the option. The incremental benefit of each component can then be compared with the incremental cost of each component. Central to this process was the notion of using options for increasing warning lead time (see Figure 6) and improving community response (Section 2.2.1).

2.3.2 Analysis of options in relation to other factors

A qualitative analysis of other factors was conducted for the suggested options in addition to the benefit-cost analysis.

Other factors that were investigated were:

- Accuracy of the warning

- Climate change ramifications
- Intangible benefits
- Reliability
- Maintenance
- Sustainability.

2.3.3 Identifying preferred options

Based on the findings described in Sections 2.3.1 and 2.3.2, a set of preferred options for a TFWS at Port Fairy was identified and described.

2.3.4 Benefit of a new TFWS for Port Fairy

A benefit-cost analysis (using the methodology described in Section 2.2.1) was conducted for the suite of TFWS preferred options outlined in Section 2.3.3.

2.4 PART 3 – TFWS DEVELOPMENT PLAN

Using the preferred options identified, a development plan (business plan) was prepared that could be submitted to the relevant authorities. The development plan consisted of:

- Brief background to provide context
- Priorities for the design of an effective TFWS for Port Fairy
- Costing of each option and suite of options
- Arrangements for cost sharing and ownership
- An action plan for implementation.

2.5 LIMITATIONS

There are several limitations for this project that should be acknowledged:

- The Port Fairy RFS has been used as a basis for many of the calculations in this report. It was not the intention of this project to review the RFS and all of its findings were accepted. However, Water Technology (2008a, p. IV) does note that "due to limitations of the available rainfall and flow data, some uncertainty surrounds the design flood estimates developed by this study". As real-time flood data is obtained, further analysis should be made to monitor the warning times and hydraulic data presented in this report.
- Damage estimations are based on existing conditions. Although there has been modelling of different levels of sea level rise, existing conditions would give the best estimation of the implications for the early life of the TFWS. The impacts of sea level rise should be monitored and the appropriateness and efficacy of the Port Fairy TFWS reviewed accordingly.
- In this report there tends to be a focus on warning lead time to gauge the benefits of a flood warning system (Section 3) and calculate the benefit-cost ratios of TFWS options (Section 4). This approach is justified based on current research (Section 2.2.1). However, in practice, there is a dilemma for forecasters and emergency managers between the timeliness and accuracy of warning messages. As Manual 21 (page 16) notes "usually a flood can be predicted with high accuracy only in the later stages of its development when more information such as observed rainfall becomes available. Therefore, in order for sufficient warning time to be provided it is often necessary to accept a less accurate prediction. Thus there is a trade-off between prediction accuracy and warning time."

3 PART 1 – FLOOD WARNING SERVICE NEEDS ASSESSMENT

3.1 NEED FOR A FLOOD WARNING SYSTEM AT PORT FAIRY

There are currently parts of a flood warning ‘system’ for Port Fairy including: flood watches and warnings issued by the BoM for the region; a river level gauge at Toolong; flood mapping and historic data; an incident control centre (ICC) that would be activated to construct and communicate warning messages; and, emergency service staff that would be available to help evacuate and, if required, rescue people. A detailed review of this ‘system’ in relation to a TFWS (as per Manual 21) is conducted in Section 3.2.

As explained in Section 2.2.1, economic benefits of having a warning system can be calculated in addition to protection of human health and safety (which is difficult to quantify). Thus, using the formula promoted in Section 2.2.1, an estimation of the benefit of the current flood warning system at Point Fairy can be obtained. This can then be compared (Section 4.1.3) with the benefits for the options identified to build a Port Fairy TFWS.

Water Technology (2008b, page 23) states that “the results of the hydraulic modelling indicate there is approximately 8 hours travel time between a flood peak on the Moyne River at Toolong and the flood peak at Gipps Street Bridge (Port Fairy) during a 1% AEP (100 year) flood.” This is shown in Figure 8.

This would most likely resemble the time in which the ‘threat is recognised’ (Figure 6) and there may be up to two hours for further interpretation, message construction and communication, prior to the ‘warning lead time’ for response. Thus a warning lead time of six hours is assumed and used in the Day curve calculations. Using the equation in Section 2.2.1 assumptions are also made about current community response, keeping in mind that the last flood was in 2010 (albeit only a 3 year ARI event according to the Port Fairy RFS) and that there has been prior community flood education provided by VICSES (see Section 3.2.3).

The response assumptions (Section 2.2.1) for the existing flood warning system at Port Fairy are:

R = 0.6 (this is obtained from social research results found in other communities in Victoria with similar flood history and community profiles – refer to Section 1.3.2)

PRA = 0.8 (value in sliding scale for this length of warning time)

PHR = 0.7 (value in sliding scale for this type of community)

PHE = 0.7 (value in sliding scale for this type of community)

FDA = PFA x R x PRA x PHR x PHE

where:

FDA = Actual flood damage avoided

PFA = Potential flood damage reductions (as per Day curve)

R = Reliability of the flood warning process (i.e. the proportion of the population at risk which is warned with sufficient lead time to take action)

PRA = Proportion of residents available to respond to a warning

PHR = Proportion of households able to respond to a warning

PHE = Proportion of households that respond effectively

Using these values, the benefits of the existing flood warning system at Port Fairy (under existing conditions) were estimated. The average annual damages (AAD) for Port Fairy were calculated to be $219,200 (Water Technology, 2008a). Based on the ADD, the damages reduced per year were estimated to be $30,688 using the Day curve. Over a 20 year life span of the warning system this amounts to a reduction of $325,109 (applying 7% compound rate).

However, after applying the response factors above the estimated damage reduction of the existing warning system over 20 years is estimated to be $76,466.

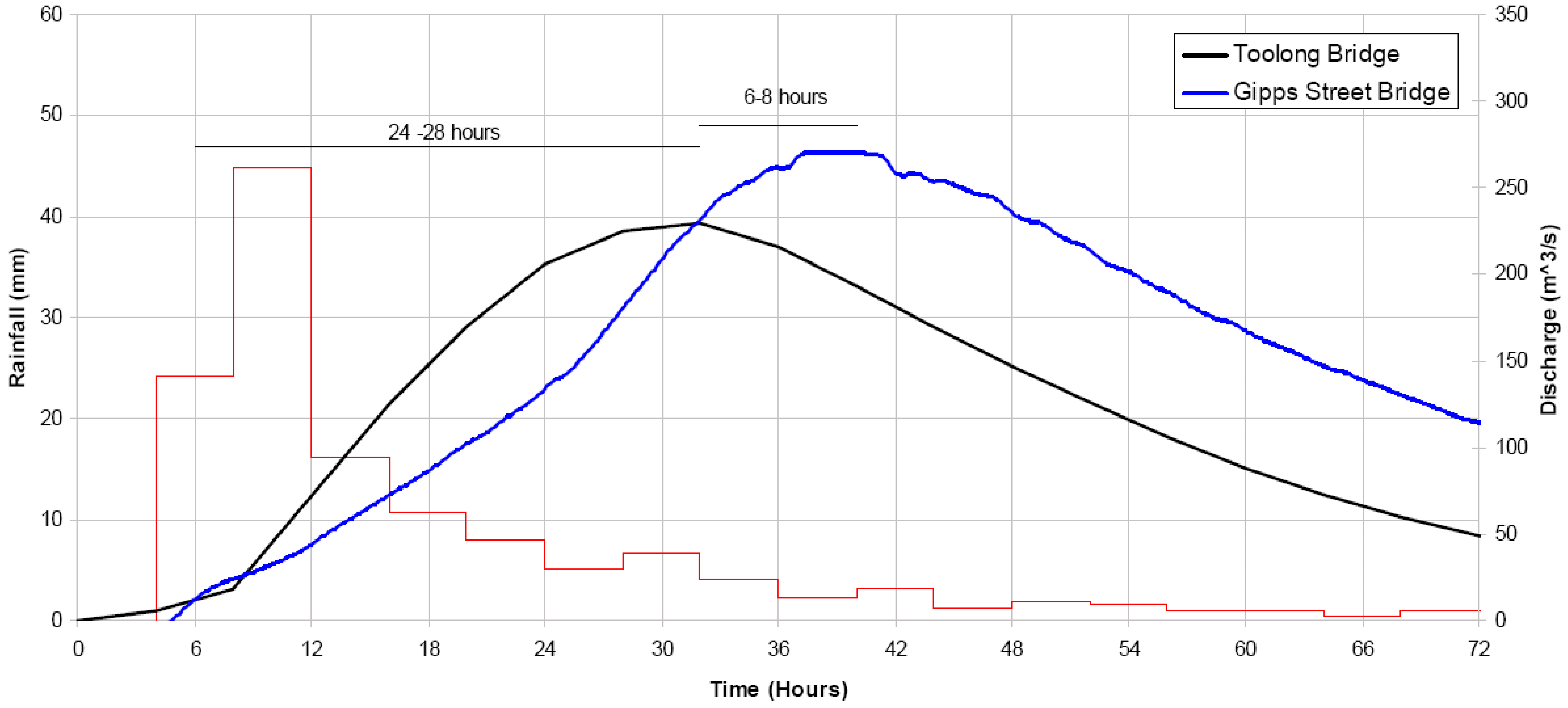

Figure 8: Relative flood response and travel times in the Moyne catchment for the 1% AEP flood (source: Port Fairy Regional Flood Study, Water Technology, 2008b)

It should be noted that some properties (including upstream of Port Fairy) may not have eight hours warning time as they become isolated early as floodwaters rise.

3.2 ASSESSMENT OF REQUIREMENTS FOR A TFWS AT PORT FAIRY

The following examination of the existing 'flood warning system' for Port Fairy is based on the components of the TFWS framework provided in Figure 2 and related to the guidance in Manual 21 Flood Warning. As discussed in Section 1.1.3, it is not only important to have the components of the TFWS in place, but also have them integrated.

3.2.1 Understanding flood hazards and risks

There is a good understanding of the flood hazards and risk for Port Fairy through the flood studies completed including Water Technology (2008a), Water Technology (2010) and Water Technology (2012). There has also been several floods including and after the 1946 flood that can be used to calibrate these studies and to help with community risk awareness.

There is a need to understand flood risks for floods greater than the 200 year ARI (particularly as the 1946 flood was estimated to be a 1,000 year ARI flood).

Moyne Shire Council provides property purchasers with Section 32 certificates that flag a flooding issue, although do they not directly quantify the flood risk.

3.2.2 Emergency management planning

The Moyne Shire Municipal Flood Emergency Plan (MFEP) is a sub-plan of the Shire's Municipal Emergency Management Plan. The MFEP is currently being drafted and covers all flood risks in the Shire including in the Moyne River catchment and Port Fairy.

The draft MFEP provides a description of the flood hazards and risks at Port Fairy based on the flood studies (Section 3.2.1). It explains the warning times based on the Water Technology (2008a) report (Section 3.1). It also provides a community emergency plan specifically for Port Fairy. This includes details of properties flooded and the depth of flooding (including over-floor). The greatest depth is 1.26 m in Whalers Drive for the 100 year ARI flood.

The draft MFEP notes that there are seven caravan parks in Port Fairy. Three will be affected by flooding as follows:

- Port Fairy Gardens Caravan Park at 111 Griffiths Street from about the 5% AEP event
- Pelican Waters Holiday Park at 34 Regent Street from about the 1% AEP event
- Gum Tree Caravan Park at 8 Amble Lane (off Toolong Road) from about the 20% AEP event.

According to the draft MFEP, properties along the coastal strip (on the primary sand dune) become isolated when Griffiths Street is inundated. The eastern end (near the Golf Course) becomes impassable during an approximate 5 year ARI event. Access to (or from) the township to the west is cut somewhere between the 20 and 50 year ARI events. Griffiths Street can be closed in both directions (towards Port Fairy and towards Warrnambool).

Of particular importance are the areas of Port Fairy and hinterland that become isolated as floodwaters rise and in only a relatively minor flood. This should be taken into account by emergency managers and will shorten the warning lead time (see Section 3.2.4) for those properties.

The draft MFEP provides a flood consequence-response table outlining impacts and related emergency management actions triggered by different flood levels. It also will provide details of command, control and coordination arrangements in line with EMMV and other guiding documents, although this section was not completed at the time of writing (see Section 1.2.1).

No mention is made in the draft MFEP of the Port Fairy Folk Festival and its impact on the caravan park and other population. Even though the Festival site is outside the floodplain, the impact of a generally flood unaware population on emergency management should be considered in emergency planning.

There is no evacuation plan for Port Fairy in the draft MFEP including a map of evacuation routes.

There also appear to be discrepancies in the flood intelligence data between that in the Port Fairy RFS and the draft MFEP.

There is a CFA crew at Port Fairy to assist emergency management, with the SES providing volunteers from its units at Port Fairy and Warrnambool.

As noted above in this section, in Port Fairy the Gardens Caravan Park is particularly vulnerable to flooding. As required by Victorian Government legislation, the Gardens Caravan Park has an emergency management plan (EMP). The EMP provides details of the flood risk and impacts on the caravan park in relation to different levels as per the Port Fairy RFS. For example for river flooding at 100 year ARI, “All camping sites are inundated. Depth exceeds 1.2m near Dusty Miller Drive and exceeds 1.4m along river frontage. All access is cut by high hazard flood water.”

The EMP acknowledges the 8 hour available warning time (4 hour ‘effective’ warning time based on prescribed EMP descriptions) and 22 hours flood warning if it is based on detection rainfall causing runoff (16 hour ‘effective’ warning time based on prescribed EMP descriptions).

The EMP details actions that need to be taken by the Caravan Park in relation to different trigger levels. Actions include advising occupants of the threat, evacuating occupants, turning off power and sandbagging toilets if possible. The total time needed for these actions is at least six hours which is more than the current warning lead time.

The two other flood affected caravan parks should also have similar EMPs.

3.2.3 Community flood education

Community flood education should include guidance for residents and businesses in terms of flood risk, what precautions to take prior to a flood and what to do if a flood is imminent and then occurs.

The VICSES FloodSafe program is designed to inform people about their flood risk, and how to prepare, respond and recover from flooding. It encourages flood-affected residents and businesses to develop emergency plans that include responses to warning triggers.

A new (2013) FloodSafe Guide has been produced by VICSES for the Moyne Catchment including Port Fairy. The Guide provides details of the flood risk at Port Fairy based on the Port Fairy RFS and includes a ‘flood history’ related to flood heights at the Toolong Gauge.

The Guide then provides details of the different types of flood warnings issued by the BoM. It also outlines ways to prepare, respond and recover from a flood and how VICSES can help.

The VICSES community education programs for Port Fairy have also included business breakfasts and doorknocks.

3.2.4 Data collection

Manual 21 (page 15) provides guidance regarding data collection from rain and river level gauges. According to Manual 21, effective routine monitoring of the potential for flooding requires “sufficient rainfall and river flow data to provide a representative picture of what is happening over the river basin” and “close liaison between meteorological and hydrological forecasting groups.”

Manual 21 adds that such “routine catchment monitoring is carried out to maintain a continual awareness of the rainfall amounts and that to ensure needed to produce flood runoff. Data from networks of rainfall and river-level stations are used to monitor catchment wetness (i.e. soil moisture) and river conditions, normally on a daily basis. The combination of current catchment state and future rainfall allows an early assessment to be made of the possibility of future flooding and the river levels likely to be reached."

The hydrologic section of the Port Fairy RFS (Water Technology, 2008c) includes a discussion (pp. 7-22) regarding the existing hydrologic data available in the Moyne River catchment. According to Water Technology (2008c), this data includes:

- "A good spatial and temporal coverage of daily rainfall records for the catchment"
- "A relatively long record of instantaneous and daily streamflow at Toolong."

a) Additional rain gauges

Water Technology (2008c) states that gaps in the hydrologic data record that could potentially be filled through future data collection include the "absence of a pluviograph record within the catchment". The lack of pluviograph data implies an undesirable level of uncertainty in the temporal distribution of rainfall for hydrologic model calibration.

Furthermore, there is a need for additional automatic real-time reporting rain gauges in the catchment to reduce the uncertainty of non-representative temporal rainfall distribution, as well as to improve the spatial rainfall distribution assessment.

Water Technology (2008c) also states that "the lack of gauge data for tributaries downstream of Toolong requires that rainfall-runoff characteristics be interpolated from the catchment area upstream that is gauged. Although the Murray Brook catchment is a significant area, it is not expected to greatly influence the flood peak at Port Fairy due to:

- The difference in timing between runoff from this catchment and the broader Moyne catchment upstream of Toolong, i.e., peak flow from Murray Brook will arrive before the Moyne peak.
- The Murray Brook flow is attenuated through the Korongah Flats storage area prior to arriving at Port Fairy."

This appears to be a reasonable assessment of the behaviour of the catchment downstream of the Toolong gauge on the Moyne River, and while a new level gauge on Murray Brook would be of some benefit in gaining a better understanding of the hydrologic behaviour of the lower catchment, its relative benefit for flood warning is likely to be minimal. It also should be noted that there is a weather station located in Port Fairy that could be used to provide general rainfall readings for the lower catchment.

b) Additional river level gauges

Manual 21 stresses the importance of having a system of river level gauges across a relatively large catchment such as the Moyne.

On page 7, Manual 21 states that in developing a TFWS one of the requirements that need to be addressed is "levels of flooding for which warnings are required (including the level at which flooding begins and critical levels such as levee heights)."

In addition, on page 8 it states that the community's flood warning needs will typically relate to:

- "the levels of flooding (usually at a specified gauge) for which warning will be needed"
- "the consequences of flooding at different flood heights in areas around the gauge (i.e. in the gauge reference area)".

The need to use available streamflow records from the previous Moyne River at Willatook level gauge was identified by Water Technology in its rainfall-runoff catchment modelling for Port Fairy to provide improved representation of the catchment upstream of the Toolong gauge.

The Willatook site which operated for just over 10 years from 1974 to 1985 is strategically located about halfway up the catchment gauging 272 km² or 48% of the catchment area to Toolong.

It is believed to have been closed down due to the lack of a stable low flow control. However, from the available stage-discharge rating data the high flow control at Willatook, which is more important than the low flow control in flood applications, appears to be more stable than the high flow rating at Toolong.

Historical flood data and RORB design modelling indicates that the Moyne River at Willatook rises and peaks approximately 6 to 8 hours prior to the peak arriving at Toolong.

This basic catchment characteristic means that an estimate of the eventual peak flow at Toolong can be made with more confidence 6 to 8 hours beforehand, which translates to 6 to 8 hours of additional flood warning time available at Port Fairy with a real-time level gauge located in the vicinity of Willatook.

A gauge for prediction location at Port Fairy would complement the existing Toolong Gauge and an upstream gauge at, or near, Willatook.

To reduce the uncertainty of the flooding effects in a reference area from a particular prediction location gauge it is self-evident that the closer that prediction location gauge is located to the reference area the less uncertainty will result.

The physical seven kilometre distance from the Toolong gauge to the essential reference area in Port Fairy is too far removed from that reference area and prone to too many uncertainties, including the unknown amount of attenuation of the flood peak through the natural storages (e.g. Belfast Lough) between Toolong and Port Fairy.

Water Technology (2008c) highlighted the strategic importance of Gipps Street Bridge at Port Fairy saying that “from a flood hydraulics perspective, the Gipps Street Bridge and associated abutments provide an important control on the passage of floodwaters through Port Fairy”.

The area immediately upstream of the Gipps Street Bridge is also where the first properties begin to flood at Port Fairy, including the Gardens Caravan Park.

A new automatic real-time level gauge on the Moyne River at Gipps Street, Port Fairy, while not providing any additional warning time, will serve as:

- a much more reliable prediction location gauge than Toolong for the BoM to provide flood predictions relevant to the essential reference area at Port Fairy
- a local community focus for flood levels during a flood event that could include a flood information sign and/or historical flood level marker
- in time, a means of confirming, or otherwise, the accuracy of the theoretical flood modelling that underpins flood mapping in the Port Fairy RFS.

c) Additional rain gauges and river gauge

One of the important factors that can introduce inaccuracy into rainfall-runoff modelling in either hydrologic model calibration mode or real-time flood forecasting mode is errors in the amount of rainfall estimated to have fallen across the catchment, the spatial distribution, and the timing of the rainfall during the storm (temporal distribution).

The Port Fairy RFS acknowledges the uncertainty in its RORB rainfall-runoff modelling calibration runs using the assumption that the temporal distribution of the storm rainfall across the Moyne River catchment was the same as recorded at the Mortlake pluviograph, some 50 km to the east of the catchment.

Apart from the Koroit daily read rain gauge in the south-east extremity of the catchment and the Port Fairy AWS and/or daily read rain gauge at the southern extremity of the catchment, only one daily read rain gauge was available to represent the bulk of the 750 km² Moyne catchment, and that was at Hawkesdale.

The potential errors in the hydrologic modelling resulting from the considerable amount of spatial rainfall interpolation, in most cases from daily read rain gauges 10 km or more outside the catchment, are considerable and need to be addressed if rainfall-runoff modelling is to be used for flood forecasting at Port Fairy.

The advantages of rainfall-runoff modelling over peak flow hydrograph correlation methods is that a reasonable initial estimate of the likely magnitude and timing of the flood peak can be made much earlier than by simply waiting for the river level to rise to an eventual peak at the upstream river level gauge.

From the RORB storm data file information available, and examination of the RORB design output files, it appears that once 85 per cent of the total storm rainfall has occurred in the catchment then 4 hours of additional flood warning time would be available.

A real-time level gauge in the vicinity of Willatook and a strategically located automatic real-time rain gauge, or series of automatic real-time rain gauges, would provide an additional 10 to 12 hours of flood warning time for Port Fairy above and beyond the amount of flood warning lead time afforded by the existing real-time level gauge on the Moyne River at Toolong (currently 6-8 hours, refer to Figure 8).

In terms of where the new automatic real-time rain gauges should be located, it is suggested that given the strategic central location of Willatook in the catchment the real-time level gauging station should also include a real-time rain gauge.

Ideally, the existing daily read rain gauge at Penshurst, only about 5 to 6 km outside the northern catchment boundary, could be upgraded to real-time telemetry to improve the spatial distribution assessment of the rainfall in the upper 120 to 150 sq km of the catchment to the north of Willatook.

3.2.5 Flood prediction and interpretation

a) Prediction

The BoM does not currently provide a flood prediction service for Port Fairy or the Moyne River at Toolong.

As noted previously, the Toolong Gauge on the Moyne River is telemetered. "The flood inundation maps in the Port Fairy RFS have been linked to an approximate gauge height at the Toolong Gauge and could potentially assist the coordination of emergency response activities in the event of a large flood at Port Fairy. While it is recognised that the magnitude of flows from the ungauged sub-catchments around Port Fairy will influence the extent of flooding at Port Fairy, the magnitude of the flows in the Moyne River at Toolong are considered to provide a reasonable estimate of the relative magnitude of flooding that could be expected at Port Fairy." Water Technology (2008b, page 23)

As shown in Figure 8, the available hydrology and hydraulic data and modelling suggests the potential maximum warning time between storm rainfall in the Moyne River catchment and flood peaks arriving at Port Fairy may exceed 24 hours.

However, it should be recognised that there is a heavy reliance on the accuracy of the stage-discharge rating for the Moyne River at Toolong for flood forecasting and interpretation.

Manual 21 (page 17) states that "a prediction is normally made for a particular location and time and ideally is expressed as a specific river level at a nominated gauge. This requires confidence that available data and prediction techniques allow the hydrologic behaviour of the catchment and hydraulic behaviour of the river to be reliably modelled."

The Port Fairy RFS notes that "the Toolong rating curve can be seen to experience a shift in shape sometime after the mid 1980's. This corresponds to a period over which annual flood peaks have significantly reduced (in line with average rainfall totals). The physical justification for this shift of rating curve is not clear."

This "shift in shape" has potentially significant ramifications for flood prediction at Port Fairy. For example, at just under the 5 year ARI flood level at a level of 4.0 metres the rating applicable in May 1979 indicated a corresponding flow of 100 cumecs or 8,640 ML/day. However, by March 2001 a flood level of 4.0 metres only corresponded to half that flow, 50 cumecs or 4,320 ML/day.

This underscores a degree of uncertainty that presents itself at the Toolong gauge site in confidently assuming a resultant peak flow to select the most appropriate Flood Emergency Response Map based on the recorded flood level at Toolong.

The best way to manage this is to ensure regular high flow gaugings are carried out when possible to verify the current status of the rating and adjust as necessary.

Furthermore, an upstream (Willatook) river level gauge would enhance the certainty provided by the available hydrology and hydraulic data and modelling.

Figure 9 shows an excellent correlation between the peak flood level in the Moyne River at Toolong and the resultant peak flood level in the Moyne River upstream of the Gipps

Street Bridge in the vicinity of the Gardens Caravan Park. This correlation graph could play an important part in the emergency flood response for Port Fairy.

As mentioned in Section 3.2.4, the re-establishment of an automatic real-time level gauge on the Moyne River at Willatook would provide a means of predicting the resultant peak level and flow downstream at Toolong.

As shown in Figure 10, the correlation between the peak design flow at Willatook and the corresponding peak design flow at Toolong produces an excellent correlation.

While these two correlations provide a simplistic and potentially useful flood forecasting tool, they should be used with caution with preference given to real-time rainfall-runoff catchment modelling as the preferred flood forecasting approach.

It would be highly desirable to carry out a test run of the RORB model using the August 2010 flood event which had a peak flow almost double the 2001 flood and almost equivalent to the 1978 flood. This would serve to check the adequacy of existing rainfall and river level data in the catchment as well as validating or otherwise the RORB parameters adopted by Water Technology in the Port Fairy RFS.

On a broader regional and state-wide level, improvements to flood prediction and interpretation are being made in response to the recommendations of the Victorian Floods Review (Section 1.2.3).

b) Interpretation

According to Manual 21 (page 21), “operational coordination and communication are essential between the prediction agency and the lead response agency involved in the reception and interpretation of predictions. On-site reports provide valuable feedback to the prediction agency on the impacts of flooding and on the accuracy of the predictions. Information on forecast accuracy can be used to adjust hydrological prediction models so future forecasts can be made more accurate.”

For a flood at Port Fairy, the BoM as the prediction agency would liaise with lead response agency (VICSES) at the state, regional and local level. Both agencies would interpret flood data through the appropriate level of Incident Control Centre (ICC).

According to Manual 21 (page 36), “when a flood prediction is received, a primary task of the response agency (usually the local council, local SES or catchment management authority) should be to link the predicted conditions to potential impacts within the local area. This will then determine and direct response and recovery operations and the messages communicated to the community. As flood effects ultimately impact on the community itself, it is worthwhile for response agencies to develop knowledge of the local conditions and potential reactions, both within the physical and social environments.”

The Moyne Shire MFEP, coupled with data from the Port Fairy RFS and local knowledge, provides flood intelligence records that link flood peaks at Toolong Gauge to impacts on Port Fairy. This can be used by the ICC to interpret flood predictions prior to the issuing of Flood Bulletins.

No change is identified to local interpretation arrangements other than the BoM providing specific local flood prediction services for the Moyne catchment.

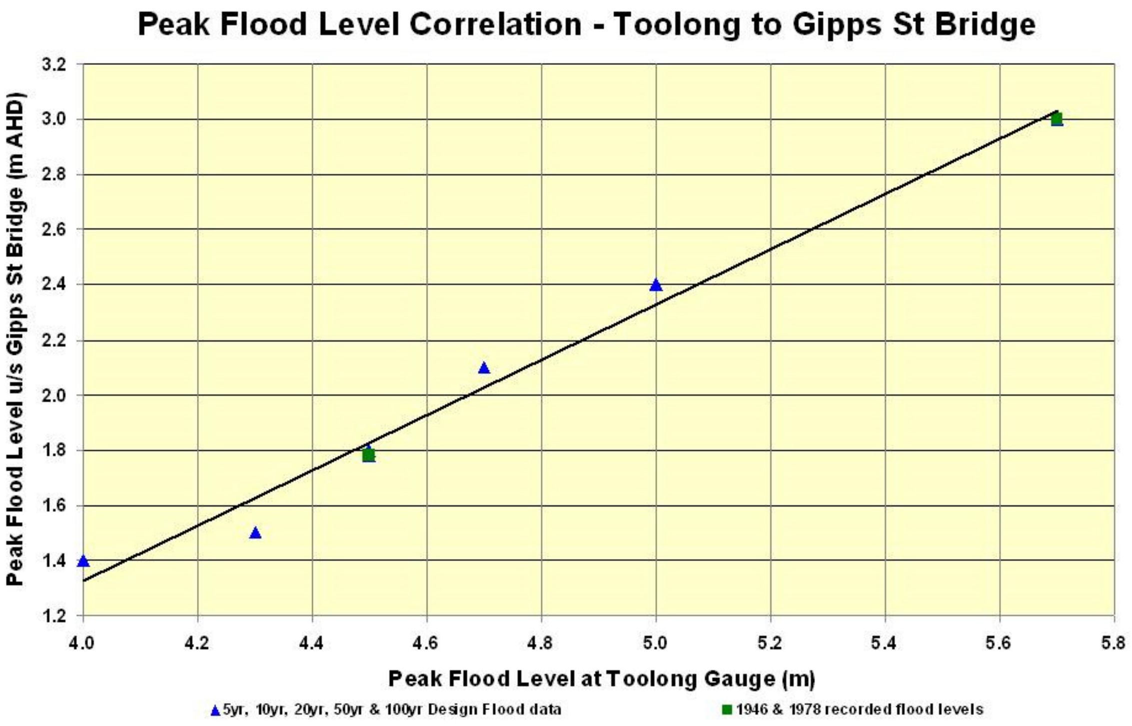

Figure 9: Peak flood level at Toolong correlated with flood level upstream of Gipps Street Bridge, Port Fairy

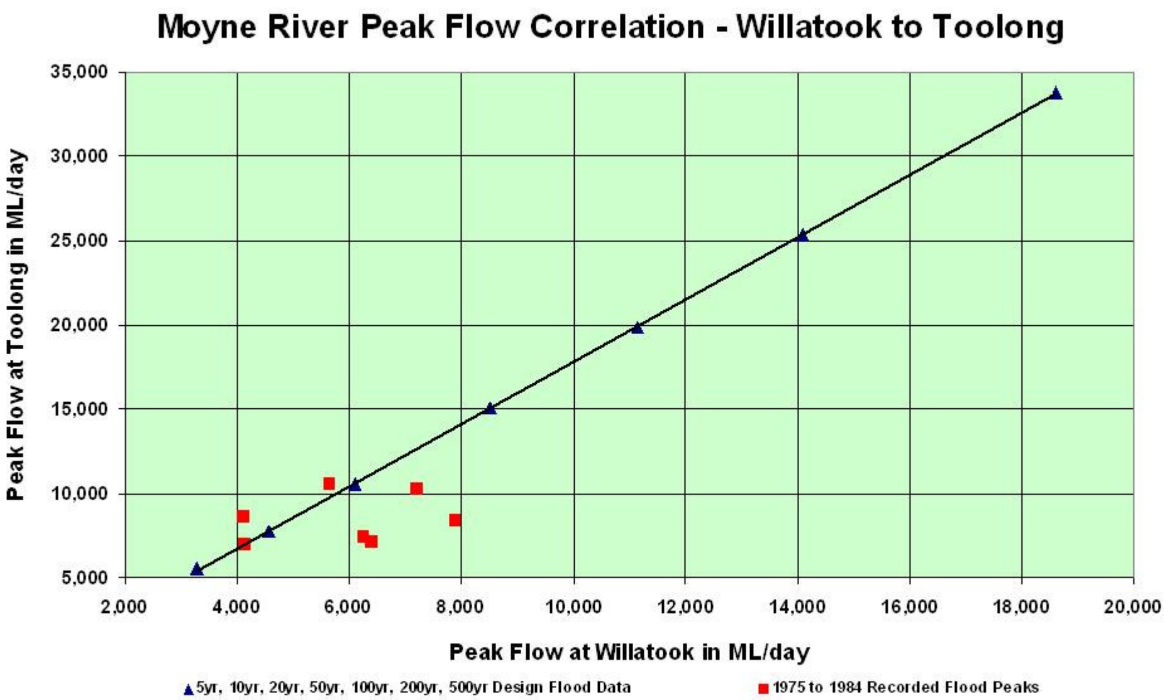

Figure 10: Moyne River peak flow correlation – Willatook to Toolong (source: Water Technology, 2008)

3.2.6 Message construction

According to Manual 21, "the warning message is the critical link between flood prediction and interpretation on the one hand, and the taking of protective action on the other. It must be 'user friendly', it should explain what is happening and what will happen, where, how the flood will affect the recipient of the message and what he or she can do about it. The message must come from a credible source (such as the Bureau of Meteorology or a State or Territory Emergency Service), be informative and persuasive and be clearly understood by those receiving it. The message may be either in written form or communicated verbally."

Warning messages will be released by the BoM as Severe Weather Warnings, Flood Watches and Flood Warnings. As noted in Section 3.2.5, VICSES through the ICC will release messages as Flood Bulletins that provide details of the likely impacts on communities and what people should do. Evacuation messages could also be sent specifically to those residents in danger.

The current requirement in Victoria is for messages to be 'timely, relevant and tailored' (Fire Services Commissioner, 2011). Note that this helps to resolve the accuracy-timeliness dilemma (see Section 2.5) in favour of timeliness (which has advantages in the protection of belongings and evacuation).

Message construction is strongly addressed through the State Flood Response Plan, the Victorian Warning Protocol and several SOPs for the ICC. No specific improvement is suggested for a TFWS at Port Fairy other than the BoM providing a flood prediction service that would provide relevant flood warnings related to the Moyne catchment.

3.2.7 Message communication

According to Manual 21 (page 50), "the best predictions, the best interpretive material and the best warning messages are of little value if they have no impact on damages or safety. Failure is guaranteed if warning messages based on flood predictions and interpretations of them are not conveyed effectively to those expected to respond. In essence, a warning which is not communicated effectively is no warning at all: if it is not heard or heeded."

Manual 21 (page 51) identifies two different types of message communication based on target audience:

1. General warnings are disseminated ('broadcast') to whole communities or regions.
2. Specific warnings are intended for individuals or parts of communities, and reflect the need for 'narrowcasting' to specific audiences who may have specific characteristics or be at different kinds of risk.

General warnings are communicated by VICSES through the appropriate level ICC using One Source One Message (OSOM) which links to the media, emergency service websites, the VICSES Flood and Storm Information Line and social media.

Specific warnings are communicated by the ICC using Emergency Alert (providing location warning messages to mobile phones and landlines). VICSES (or delegated authority such as CFA or DEPI) also use local and personal communication methods such as doorknocking, community meetings, and community bulletins.

Message communication is strongly addressed through the State Flood Response Plan, the Victorian Warning Protocol and several SOPs for the ICC. The technologies available are rapidly evolving and several improvements are included in the White Paper on Emergency Management (refer to Section 1.2.4).

Some possible localised additions to the suite of communications methods available to Port Fairy are:

- Use of the CFA siren located in Port Fairy has an emergency warning and 'heads-up' for the community to seek further flood warning information.
- Use of a prediction location gauge at Gipps Street (refer to Section 3.2.4) to help the community monitor the flood in combination with the abovementioned communications methods.

3.2.8 Response

According to Manual 21 (page 59), "It is increasingly possible to advise people outside of flood time about their individual flood risk, and where this is done the warnings disseminated as floods are approaching will generally be better understood. In many circumstances, people can be provided with the actual gauge height at which their properties will experience over-ground or over-floor inundation or at which their evacuation route will be cut."

Awareness of flood risk is an important precursor to people taking appropriate safety and damage-reduction actions as a result of flood warnings. People that do not know their property floods will not take action.

However, a large body of research (e.g. Paton, 2006; Grothmann and Reuswig, 2006) shows that risk awareness is a poor causal indicator of preparedness and response to warnings. In other words, it cannot be assumed that those aware of flood risk will do anything about it. There are other factors at play including flood experience, self-efficacy and action coping.

Furthermore, there appears to be three main types of psychological profiles related to flood preparedness and response: people that respond proactively (e.g. self-evacuate); people who are apathetic and will only act when told to do so directly by authorities; and, those that will not respond to warnings and stay put. (Dufty, Taylor and Stevens, 2012)

Without social research into these psychological factors it is impossible to fully understand the potential response to a TFWS at Port Fairy. The social research would identify response issues that could be addressed through tailored community education and community development (e.g. capacity-building, leadership).

There is also a growing body of evidence (e.g. Aldrich, 2012; Chamlee-Wright, 2010) that shows that social capital (networks, norms, trust) are a critical component of appropriate response and recovery leading to resilience. Social network analysis (a form of social research) would give an indication of social capital in relation to warnings and possible gaps that could be filled by community development activities.

There are some indications of community flood vulnerability for Port Fairy that can be gleaned from census statistics (refer to Section 1.3.2). Of particular note is the relatively older population and those requiring assistance (which may impact on their ability to move items to prevent damages and to quickly evacuate), the high percentage of visitors and tourists (with probably no prior community flood education and understanding of the flood risk), and the number of absentee landholders (with implications for property damage and knowing which houses need to be evacuated). The Port Fairy Folk Festival adds to these vulnerabilities and, as noted in Section 3.2.2, emergency management arrangements for this event are not included in the MFEP.

An insight into Port Fairy's general resilience can be obtained from the Department of Planning and Community Development (2010) resilience survey for Moyne LGA. Some of the pertinent indicators that may influence response to flood warnings are provided in Table 2 in comparison to the Victorian average.

Table 2: % responses for indicators of community strength, Moyne LGA, 2008

Indicator	Moyne LGA	Victoria
An active community	76.0%	59%
Can get help when needed	90.7%	91%
Member of organised group	66.6%	61%
Volunteer	49.0%	33%
Feeling of safety	73.5%	59%
Can have a say	48.7%	42%

Source: Department of Planning and Community Development (2010)

The indicators in Table 2, although not directly linked to flood warning, do give a view that Port Fairy is well-connected (e.g. helping others, volunteering) and relatively active (e.g. active community, can have a say). The feeling of safety may be a ‘double-edged sword’: Port Fairy appears to be a safe place (benefit) but a feeling of safety may bring inertia to a warning through lack of risk anxiety.

It should be noted that with no specific social analysis available, the census data and the Department of Planning and Community Development research plus the recent response to the 2010 (albeit minor) flood, were considered in the community response factors used to calculate the potential damages for the existing ‘flood warning system’ at Port Fairy (refer to Section 3.1).

Improvements that would assist response are:

1. Study of social vulnerability and social capital in Port Fairy that would assist emergency managers in deciding where and with whom to place their response efforts.
2. An understanding of vulnerabilities as floodwaters rise, including people that can be cut off from evacuation routes well prior to the flood peak arriving at Port Fairy.
3. The rainfall/flood scenarios that would trigger the cancellation of the Port Fairy Folk Festival.

3.2.9 Review of the TFWS

According to Manual 21 (page 67), “flood warning systems need regular attention to ensure they will function as intended and to continue to improve their performance.” It adds that review should be conducted both at the strategic and operational level.

At Port Fairy it will be important to have both agencies and community representatives involved. As Manual 21 (page 68) stresses, “a key point about the review process is that all relevant agencies should be involved to ensure organisational changes can be implemented. Similarly, the process must be open to input from the flood-affected community, members of which are likely to have ideas about how warning systems and services can be more effectively implemented. The views of community members are essential to improving warning systems, and people should be actively encouraged to put forward their opinions on system performance and ways to improve it.”

A possible governance model for review of the Port Fairy TFWS is through the continued use of the Technical Steering Committee for this project (refer to Section 2.1).

There is a need to develop a Port Fairy TFWS monitoring and evaluation plan, possibly using the guidance in pages 71-72 of Manual 21. As Molino and Dufty (2013) stress, as part of this plan it is important to have a mechanism for post-flood review of all aspects of the TFWS to enable continual development.

3.2.10 Community and stakeholder consultation

As noted in Section 3.2.9, Manual 21 advocates the use of community and stakeholder consultation in the review of the TFWS. It also encourages consultation in the development and implementation of other aspects of the TFWS.

One way that people can assist with flood warnings is through either a flood warden or flood observer program. The flood warden program involves trained community ‘leaders’ alerting people to a warning and helping organise property-related and evacuation actions based on guidance from authorities such as VICSES.

The flood observer program is being implemented by the Wimmera CMA and considered by VICSES. It involves trained people particularly in upstream sections of a catchment providing real-time information (e.g. photographs using smartphones) of gauge or marker heights for interpretation by ICCs.

Both of these ideas for community involvement, as well as the idea for governance in Section 3.2.9, could be considered for the Port Fairy TFWS.

3.2.11 Integration of TFWS components

Manual 21 stresses the need for integration of the components of the TFWS. “For a flood warning system to work effectively, these components must all be present and they must be integrated rather than operating in isolation from each other. The view that any one component of the system represents all of it, or is an end in itself, impairs the system's effectiveness". (page 7)

Thus strong and effective linkages (refer to Figure 2) between the TFWS components (as analysed in Section 3.2) should be formed and maintained for Port Fairy.

Linkages that should be in place include:

- Interoperability for emergency service providers involved in warning (noting the changes recommended in the White Paper on Emergency Management).
- Flood warning arrangements are agreed by all agencie and put in places.
- Relationships between the BoM and the ICC relating to forecasting, interpretation and agency communications.
- Community education tailored to the Port Fairy RFS and the needs of the Port Fairy community.
- The BoM using the Port Fairy TFWS, including gauging infrastructure, as part of its flood prediction service for the Moyne catchment.
- The MFEP accurately reflecting community warning vulnerabilities (including the Port Fairy Folk Festival) and the Port Fairy RFS.
- The use of flood warning communication methods appropriate to the Port Fairy community.
- The Port Fairy community consulted and involved in the development, implementation and review of the Port Fairy TFWS.

3.3 RECOMMENDED OPTIONS

Based on the analysis in Section 3.2, the following main options are recommended to develop a Port Fairy TFWS:

- Additional automatic real-time river level gauge at Willatook or nearby upper catchment location (Section 3.2.4)
- Additional automatic real-time river level gauge (prediction location gauge) near Gipps Street Bridge, Port Fairy (Section 3.2.4)
- Additional automatic real-time rain gauge in the vicinity of the proposed Willatook river level gauge
- Upgrading of the existing daily read gauge at Penshurst to an automatic real-time rain gauge (Section 3.2.4)
- Social research into psychological and sociological aspects of Port Fairy community warning response that informs improvements in emergency planning (e.g. MFEP), community education and community development leading to better response (Section 3.2.8).

It is critical that the BoM provides a flood prediction service related to the Port Fairy TFWS (Section 3.2.5)

Other suggested improvements to assist in the development of the TFWS are:

- Conduct hydrologic studies for floods greater than the 200 year ARI (Section 3.2.1)
- Include a social profile and analysis of potential community response to flood warnings in the Moyne Shire MFEP (Section 3.2.2)
- Install an additional automated real-time rain gauge adjacent to the existing Toolong gauge (Section 3.2.4)
- Align the flood intelligence data that is in the Port Fairy RFS with that in the MFEP (Section 3.2.2)
- Include an evacuation plan including a map of evacuation routes in the MFEP (Section 3.2.2).
- Test run the Port Fairy RORB model using the August 2010 flood event to help validate the RORB parameters adopted by Water Technology in the Port Fairy RFS (Section 3.2.5)
- Use the CFA siren located in Port Fairy as a flood alert and 'heads-up' for the community to seek further flood warning information (Section 3.2.7)
- Assess the lead warning times and impacts as floodwaters rise including properties becoming isolated (Section 3.2.8)

- Assess the possible rainfall/flood scenarios that would trigger cancellation of the Port Fairy Folk Festival (Section 3.2.8)
- Review the Port Fairy TFWS based on the Technical Steering Committee for this project (Section 3.2.9)
- Develop a Port Fairy TFWS monitoring and evaluation plan to ensure the long-term sustainability and effectiveness of the TFWS (Section 3.2.9)
- Consider a flood warden and/or flood observer program for Port Fairy (Section 3.2.10).

4 PART 2 – TFWS OPTIONS ANALYSIS

4.1 OPTION EVALUATION

4.1.1 Benefit-cost analysis of options

A benefit-cost analysis is conducted below of the main options for the TFWS identified in Section 3.3. The analysis is conducted as per the methodology outlined in Section 2.2.1.

Option 1 - New Willatook river level gauge

As noted in Section 3.2.4, it is estimated that an additional automatic real-time river level gauge at Willatook or nearby upper catchment location will provide up to 8 hours of further warning time to that for the Toolong gauge. This could translate into an additional 6 hours of warning lead time for the Port Fairy community. The total warning lead time including that offered by the Toolong Gauge would thus be 12 hours (refer to Section 3.1).

The cost of installing a new upstream level gauge in the vicinity of Willatook costs approximately $22,000 with O&M annual cost $9,500 (source: DEPI). This assumes using Next G communications.

Option 2 - New Gipps Street Bridge prediction location gauge

As noted in Section 3.2.4, a new prediction location gauge would provide no additional benefit in warning time, although it would improve community readiness and response and thus increase the response factors in the damage reduction equation (Section 2.2.1).

The cost of installing a new prediction location gauge in the vicinity of the Gipps Street Bridge costs approximately $20,000 with O&M annual cost $8,000. This assumes using Next G communications.

Option 3 - Additional rain gauges/telemetry

As noted in Section 2.4, at least two automatic real-time rain gauges (suggested locations Willatook and upgrade at Penshurst) are recommended. This would provide an additional 4 hours of flood warning time (estimated 2 hours of warning lead time). The total warning lead time including that offered by the Toolong Gauge would thus be 8 hours (refer to Section 3.1).

The capital cost for the two rain gauges would be $20,000 plus O&M annual cost $6,000, assuming Next G communications.

Option 4 - Social research

The social research would not provide any additional benefit with warning time. However, it would provide an understanding of issues related to response which inform actions leading to an improvement in the response factors in the damage reduction equation.

The cost of appropriate social research (e.g. surveys, focus groups, social network analysis) is estimated at $50,000. It is anticipated that a further $50,000 will be used by VICSES and Council to integrate the findings of the research into relevant emergency planning, tailored community flood education and community development that will improve the response factors.

Analysis

As for Section 3.1, analysis of the existing flood warning system at Port Fairy, damages were firstly estimated for the 100 year ARI flood for each of the above options. They were then related to the initial costs plus O&M annual cost over a 20 year life span (at 2013 prices). The benefit-cost ratios for the four options are provided in Table 3.

Table 3: Benefit-cost ratios for the four TFWS options

Option	Additional Benefit	Additional cost	B-C ratio
Willatook	$169,650	$122,643	1.38
Gipps St	$56,699	$104,752	0.54
Rain gauges	$85,234	$83,564	1.02
Social res	$92,070	$100,000	0.92

4.1.2 Further analysis of options

It should be acknowledged that the benefit-cost analysis only relates to reduction in damages. Public safety would be the main aim of the Port Fairy TFWS and, although this is difficult to measure, it should be factored into the analysis of the TFWS options.

From Table 3, it appears that the addition of an automated real-time river level gauge at Willatook or similar upstream site gives the best benefit-cost ratio. This is due to the considerable additional warning time it provides, which in turn slightly improves the response factors including the ability for warnings to reach the Port Fairy community. This will also provide further time to implement the MFEP and the Gardens Caravan Park EMP thus helping to ensure public safety.

The next best benefit-cost ratio is provided by the two automated real-time rain gauges. Again, the increased warning time transfers to some improvement in the response factors in the damage reduction calculations. The gauges also provide a small benefit in additional warning lead time that can also help ensure public safety.

The third best benefit-cost ratio was the option of learning more about the Port Fairy response characteristics and the possible use of emergency planning, tailored community education and community development to improve response. This is the most problematic and risky of the options and is not tangible. However, if the community response is indifferent or inert, then much of the cost of improving the 'upper' levels of the TFWS through installing gauges etc. can be wasted. There are also some community vulnerabilities in Port Fairy (e.g. older population, absentee landlords, people that require assistance) that require further investigation and planning. Furthermore, the social research into response needs will inform the amount of warning time and assistance Port Fairy residents require and their potential behaviours. It can also study the 'outlier' of tourist and festival visitors and examine their needs and behaviours in terms of flood warnings. It should be noted that if agencies and Council took up the additional $50,000 for resultant actions as in-kind, then this option would have a benefit-cost ration of 1.84.

The poorest benefit-cost ratio was the installation of an automated real-time prediction location gauge near the Gipps Street Bridge at Port Fairy. This option provides no warning time benefits but most likely will improve community response as it can be used as a trigger for people's emergency plan response actions. A community awareness totem pole could assist in this process. The prediction location gauge would also be valuable in assessing the attenuation impacts of water bodies (e.g. Belfast Lough) downstream from Toolong Gauge to assist in more timely and accurate flood warnings provided to Port Fairy.

4.2 THE VALUE OF A PORT FAIRY TFWS

The combined effects of the options should also be examined. There would be additional benefits from coupling the additional river level gauge with the two rain gauges and using the existing RORB modelling for forecasting and prediction. As shown in Figure 8, there is up to 36 hours of maximum potential warning time available (i.e. from rainfall onset until the flood peak is reached at Port Fairy). This could be converted to up to 20 hours warning lead time to Port Fairy using these parts of the TFWS. Community response could be improved by social research and resultant actions and the use of a prediction location gauge at Port Fairy.

If all four options were used, the estimated reduction in damages over a 20 year life cycle from the TFWS would be $400,274. This is an additional $323,807 to the $76,466 estimated to be saved with the 'existing' flood warning system.

Although they differ in their benefit-cost ratios, it is recommended that all four options should be implemented (see Section 4.2) to utilise the advantages of their integration. The other suggested improvements (refer to Section 3.3) identified in this report (which are essentially refinements to the 'existing' flood warning system) should also be considered in the development of the new TFWS.

5 PART 3 - DEVELOPMENT PLAN

5.1 BACKGROUND

A flood warning service needs assessment was conducted for Port Fairy and the Moyne catchment. The assessment was conducted by Molino Stewart Pty Ltd in liaison with a Technical Steering Committee consisting of:

- Glenelg Hopkins CMA
- Moyne Shire Council
- DEPI Floodplain Management Unit
- VICSES
- BoM
- Local community stakeholders.

The assessment examined the components of the Total Flood Warning System (TFWS) as per the Australian Government's Manual 21 – Flood Warning. The TFWS components examined were:

1. Understanding of flood risks and hazards
2. Emergency management planning
3. Community flood education
4. Data collection
5. Flood prediction and interpretation
6. Message construction
7. Message communication
8. Response
9. Review of the TFWS
10. Community and stakeholder consultation
11. Integration of the TFWS components.

The assessment identified the following main options to build an effective TFWS at Port Fairy:

1. Installation of an automated real-time river level gauge at a location such as Willatook, upstream from the existing Toolong river gauge
5. Installation of an automated real-time prediction location gauge near the Gipps Street Bridge, Port Fairy
6. Installation of two automated real-time rain gauges in, and close, to the upper Moyne catchment
7. The conduct of a social research study and resultant emergency planning, community education and community development actions to improve potential warning response.

Several other ways of improving the Port Fairy flood warning service were also identified in the assessment.

- Conduct hydrologic studies for floods greater than the 200 year ARI
- Include a social profile and analysis of potential community response to flood warnings in the Moyne Shire MFEP
- Install an additional automated real-time rain gauge adjacent to the existing Toolong gauge
- Align the flood intelligence data that is in the Port Fairy RFS with that in the MFEP
- Include an evacuation plan including a map of evacuation routes in the MFEP
- Test run the Port Fairy RORB model using the August 2010 flood event to help validate the RORB parameters adopted by Water Technology in the Port Fairy RFS
- Use the CFA siren located in Port Fairy as a flood alert and 'heads-up' for the community to seek further flood warning information
- Assess the lead warning times and impacts as floodwaters rise including properties becoming isolated
- Assess the possible rainfall/flood scenarios that would trigger cancellation of the Port Fairy Folk Festival
- Review the Port Fairy TFWS based on the Technical Steering Committee for this project
- Develop a Port Fairy TFWS monitoring and evaluation plan to ensure the long-term sustainability and effectiveness of the TFWS

- Consider a flood warden and/or flood observer program for Port Fairy.

5.2 PRIORITIES

The four main TFWS options should be implemented together as the core of the Port Fairy TFWS:

1. Installation of an automated real-time river level gauge at a location such as Willatook, upstream from the existing Toolong river gauge
2. Installation of two automated real-time rain gauges in, and close, to the upper Moyne catchment
3. The conduct of a social research study and resultant emergency planning, community education and community development actions to improve potential warning response.
4. Installation of an automated real-time gauge for prediction location near the Gipps Street Bridge, Port Fairy

5.3 COSTINGS

The four main options were costed (2013 prices) as follows:

- The cost of installing a new automated real-time upstream river level gauge in the vicinity of Willatook costs approximately $22,000 with O&M annual cost $9,500. This assumes using Next G communications.
- The capital cost for the two automated real-time rain gauges would be $20,000 plus O&M annual cost $6,000, assuming Next G communications.
- The cost of appropriate social research (e.g. surveys, focus groups, social network analysis) is estimated at $50,000. A further $50,000 should be allocated for resultant actions to improve community response particularly relating to vulnerable parts of the Port Fairy community.
- The cost of installing a new automated real-time prediction location gauge in the vicinity of the Gipps Street Bridge costs approximately $20,000 with O&M annual cost $8,000. This assumes using Next G communications.

A cost of $10,000 per year should be allocated for a Port Fairy Flood Warning Committee to guide the establishment, monitoring and review of the TFWS.

5.4 OWNERSHIP AND COST SHARING ARRANGEMENTS

The likely ownership and cost sharing arrangements for new rain and level gauge sites is as per Arrangements for Flood Warning Services in Victoria February 2001 Appendix A5. Data Collection Networks Monitoring Roles & Responsibilities.

The ownership and cost-sharing arrangements for the proposed new river level gauge and rain gauge in vicinity of Willatook, upgraded rain gauge at Penshurst, and new river level gauge at Gipps Street, Port Fairy will be the subject of negotiation between the beneficiaries and stakeholders in the data that these new gauges will provide.

These stakeholders will include Moyne Shire Council, GHCMA, DEPI and possibly Southern Rural Water seeing as they currently share the ongoing costs for the river level gauge on the Moyne River at Toolong.

The arrangements would be implemented under the umbrella of the Victorian Regional Water Monitoring Partnership arrangements coordinated by DEPI.

The BoM is also finalising new national arrangements for flood warning network systems across Australia which may have some relevance for cost-sharing arrangements for Port Fairy and other similar projects in Victoria. These are due for completion toward the end of July 2013.

It should be noted that it will take time for the warning system to ‘mature’ as real-time flood data is related to the flood studies.

5.5 ACTION PLAN

The following actions are recommended to establish and implement an effective TFWS at Port Fairy:

1. Commence a Port Fairy Flood Warning Committee for the governance of the remaining actions.
2. Request that the BoM provide a flood prediction service to Port Fairy using the TFWS once established.
3. Seek financial support for the four TFWS options.
4. Ask emergency agencies to agree on TFWS arrangements for Port Fairy and put them in place.
5. Consider the other suggested improvements to the existing flood warning system at Port Fairy.
6. Implement the TFWS options and advise the BoM, VICSES and Port Fairy community.
7. Refine other components of the new Port Fairy TFWS accordingly including communications and community education.
8. Develop and implement a TFWS monitoring and evaluation plan to review and improve the TFWS as required.

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ENVIRONMENT & NATURAL HAZARDS

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