



Richmond River Flood Warning and Evacuation Management Review

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1 Introduction

1.1 Project Background

Flooding in the Richmond River basin is a recurring natural disaster that poses major risk to both urban and rural communities and property. Major flooding has been experienced in the Richmond Valley, with widespread flooding having occurred in 1954 and 1974. A range of other more localised flood events have occurred since, with different parts of the Richmond having been affected at different times. These floods have greatly impacted on the urban and rural communities of the Richmond River.

Over the last 20 years numerous Flood Studies, Floodplain Risk Management Studies and Plans have been undertaken to help protect emergency service providers, rural communities and urban centres of the Richmond River catchment. These studies have included the whole of the Richmond River floodplain from Kyogle to Ballina and Lismore on the Wilsons River, with particular focus on the urban centres of Kyogle, Casino, Coraki, Lismore, Woodburn, Broadwater, Cabbage Tree Island, Wardell and Ballina.

The Richmond River catchment has five local government areas and a flood mitigation authority, Richmond River County Council (RRCC). Three of the five councils (Ballina Shire, Lismore City and Richmond Valley) are constituent councils of RRCC, however, Byron and Kyogle Shire Councils are standalone Councils. RRCC has identified a critical risk management issue in the understanding of just what flood warning and evacuation planning exists in the Richmond Valley. The SES also has a keen interest in working with local authority's valley wide and in individual council's jurisdictions.

RRCC has identified the need to review the flood gauging and datums used across the Richmond Valley and upgrade and update the Richmond Valley's flood warning, education and evacuation systems to provide an integrated catchment approach. The first step towards reaching the integrated approach is to undertake a review of the Richmond River catchment's flood warning and evacuation systems. This review, presented within this document, includes an assessment of the adequacy of the current system, as well as identification of gaps and recommendations to improve the system to meet the needs of the community.

1.2 Objectives and Deliverables

There are four key objectives to this project:

- (1) Review of flood gauges (rainfall and river), including datums used and spatial coverage;
- (2) Preparation of flood intelligence and communication strategy;
- (3) Review of flood management risk systems and flood evacuation plans; and
- (4) Assessment and development of Richmond River catchment flood model.

The deliverables of this project will include:

Introduction

- A report outlining a roadmap for improvements to the flood gauging, flood warning and evacuation management across the Richmond River;
- A community engagement strategy and plan; and
- An interactive website compiling all flood information and mapping covering the entire Richmond River catchment.

1.3 Committee Participation

RRCC has established a committee for this project, to provide valuable input and guidance to meet the needs of all stakeholders. The committee includes representatives from:

- Richmond River County Council (chair)
- Ballina Shire Council
- Bureau of Meteorology
- Kyogle Shire Council
- Lismore City Council
- Manly Hydraulics Laboratory (NSW Public Works Department)
- NSW Office of Environment and Heritage
- NSW Office for Water
- Richmond Valley Council
- State Emergency Services (Tweed-Richmond and local representatives).

Four committee meetings have been held in Lismore. The minutes of the four committee meetings are included in Appendix A.

1.4 Discussion Papers

To initiate focussed discussion around the key topics to be addressed as part of this project, the project team has presented three discussion papers:

- Discussion Paper 1 – Gauge Datum Review

This paper included:

- Documentation of the outcomes from the Committee meetings regarding datums
 - Presentation of some gauge plate designs
 - Mapping of all gauge plates to be augmented
 - Cost estimates
 - Community engagement strategy
 - Change management plan
- Discussion Paper 2 – Flood Warning Review

Introduction

This paper included a review of rain and river gauges, flood forecasting and flood warning adequacy to meet the needs of the community of the Richmond Valley.

- Discussion Paper 3 – Evacuation Management Review

This paper included a review of evacuation management and flood response plans throughout the Richmond Valley.

The relevant content from the discussion papers has been consolidated and represented in this report. Therefore, this report can be considered a stand-alone document, with no reference to the discussion papers required.

2 Flood Emergency Management Framework

For the purpose of this discussion, flood management is broadly defined according to *flood planning* and *flood response*. *Flood planning* typically involves the identification of flood risk and the implementation of strategies to reduce the risk to the community, and the potential for damage to property. *Flood response* refers to actions undertaken immediately prior to, during, and immediately following an event. These planning and response activities are discussed in the following sections in relation to the Richmond River catchment.

2.1 Flood Planning in the Richmond

The responsibility for land use planning in the Richmond River catchment, including flood prone land, lies primarily with the local Councils. The primary responsibilities of each Council are to:

- Prepare a Floodplain Risk Management Study and Plan, and implement the Floodplain Risk Management Plan;
- Prepare and apply Environmental Planning Instruments (Local Environmental Plans (LEP), Development Control Plans (DCP)) which incorporate the planning provisions outlined in the Floodplain Risk Management Plan;
- Provide flood related information on planning certificates at time of property sale;
- Design, maintain and construct flood mitigation works;
- Promote flood readiness in the community via flood education; and
- Assist the SES in preparation of the Flood Emergency Sub Plan (FESP).

The Councils are supported in this role by a number of other agencies.

The **Richmond River County Council** (RRCC) assists Councils with all facets of the floodplain management process, including provision of guidance relating to floodplain management issues as well as funding certain projects.

The **Office of Environment and Heritage** (OEH) co-fund the studies (along with Council and Federal Government), subsidise flood mitigation works to alleviate existing problems and provide specialist technical advice as part of the technical committee.

The **Department of Planning and Infrastructure** (DoPI) are also engaged in the floodplain management process through the development of regional strategies and plans under the Environmental Planning and Assessment Act (EP&A Act).

The **State Emergency Service** (SES) provides specialist technical advice about emergency planning and development controls throughout the study process. The SES is responsible for implementing the emergency planning and response measures recommended in the Plan.

The **Bureau of Meteorology** (BoM) provides specialist advice regarding flood warning and prediction and is responsible for continuing to support the Plan through continued advice in these areas.

The **Department of Community Services** (DoCS) provides assistance to the community during flood events and is responsible for assisting the SES with emergency planning.

2.2 Flood Response in the Richmond

The flood response process for an event is started by the Bureau of Meteorology. When a high likelihood of extreme weather is forecast by the BoM, a Flood Watch, is issued to emergency responders and the community. As the certainty of flooding intensifies, the BoM issue Flood Warnings. When the initial Flood Watch is triggered, the flood response process commences.

The BoM maintains an operational (hydrologic) model of the Richmond and Wilsons catchments which use forecast rainfall to predict flooding in the catchment. It is estimated that forecast rain in excess of 120 mm per day would trigger a Flood Watch and ongoing monitoring and modelling. Stream gauges actively monitored by BoM for use in the flood warning process are listed in Section 3.

Flood Watches are issued in advance of flood producing rain and are upgraded to Flood Warnings if river levels are expected to exceed pre-defined 'minor' flood levels. Flood classifications of minor, moderate or major relate to the effects of flooding, as per the following BoM definitions:

- **Minor flooding:** Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.
- **Moderate flooding:** In addition to the above, the evacuation of some houses may be required. Main traffic routes may be inundated. The area of inundation is substantial in rural areas requiring the removal of stock.
- **Major flooding:** In addition to the above, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required.

Flood warnings may also be issued for ocean or storm surge flooding. This is one of the main sources of flooding in the Ballina area. For this type of flooding, the Flood Watch may be issued some days prior to the surge, with a Flood Warning most likely issued 12 hours prior to the peak (i.e. on the previous high tide).

The SES begins to prepare for floods upon receipt of Flood Watches or earlier, if the forecast weather is severe. When a Flood Warning is issued by the BoM, the SES Local Controller determines the level of flood risk and is ultimately responsible for issuing general evacuation orders. The SES translates predictions of flood height into likely consequences, such as road or bridge closures. This 'value add' information is included in bulletins which are issued to inform the media and public about the predicted flood risk.

Should the flood risk intensify, the SES may decide to issue an evacuation warning. The SES has identified a number of factors which would influence their decision to initiate evacuation, including:

- Predicted flood level and rate of rise;
- Rainfall situation and rainfall predictions;
- Condition of levee banks;
- Condition of evacuation routes;
- Characteristics of the at risk population;
- Time of day;
- Likely duration of evacuation operations and time available to conduct evacuations;
- Likely duration of any isolation and preparedness of the community to cope with isolation;
- Condition of essential services; and
- Environmental risks posed to evacuees in evacuating.

For areas where the predicted flood risk is high, the evacuation warning may be upgraded to an evacuation order. If the decision to evacuate is made, the SES Richmond Tweed Region Headquarters will issue evacuation warnings to 'at risk' residents, via media outlets. Doorknocking is also likely to issue targeted evacuation warnings. Warnings through either of these methods would indicate the current and (where known) future flood risk and advise residents of the appropriate course of action.

2.3 Roles and Responsibilities

A total flood warning system relies upon input from a number of agencies with specialised roles. In NSW the organisations with specific responsibilities are as follows:

- Flood monitoring and prediction – BoM / Council
- Interpretation – SES / BoM / Council
- Dissemination – SES / BoM / Council
- Response – SES / Council.

It is important that roles are clearly defined to avoid the potential for confusion during a flood event. The roles, of both BoM and the SES in the context of flood warning are expanded on below. It is recognised that many other agencies also have roles to play in the total flood system. However BoM and the SES have the main responsibilities when it comes to flood warning. Their respective roles are expanded on below.

Table 2-1 Key roles and responsibilities

Agency	Responsibilities	Relevant Documents
Bureau of Meteorology	Flood warning	Service Level Specification for Flood Forecasting and Warning Services for NSW Flood Warning Guide for the Richmond Wilsons River
NSW State Emergency Service	Designated Flood Combat Agency Development of State and Local Flood Plans and Flood Safe Guides	Local Flood Plans NSW State Plan Flood Safe Guides
Ballina Shire Council, Byron Shire Council, Kyogle Shire Council, Lismore City Council, and Richmond Valley Council	Liaison with SES Local and Regional Controllers Lead Agency for floodplain risk management Statutory responsibility for land use planning	Local Flood Plans Floodplain Risk Management Plan Development Control Plan & Local Environmental Plan
NSW Office of Environment and Heritage	Technical agency for floodplain risk management	Floodplain Risk Management Plan
NSW Department of Planning and Infrastructure	Lead agency for land use planning	Development Control Plan & Local Environmental Plan
NSW Department of Family and Community Services	Management of evacuation centres	
Richmond River County Council	Flood mitigation	
Local community	Familiarity with local flood risk and Flood Safe Guides	Local Flood Safe Guide Private flood plans, where appropriate

2.3.1 Bureau of Meteorology

The BoM can provide flood warning services for riverine flooding where the time between the rainfall and the flood is greater than 6 hours. A limited number of catchments with faster response times where the warning time is less than 6 hours are also covered.

BoM will issue a 'Flood Watch' when the combination of forecast rainfall and catchment conditions indicates flooding is likely. The aim is to issue a Flood Watch at least 24 hours ahead of the occurrence of flooding.

It should be noted that BoM does not own or maintain any river gauges within the Richmond Basin. Many of the gauges BoM uses to develop its flood warnings are owned and maintained by the following organisations:

- Most non-tidal river level gauges – NSW Office of Water
- Tidal gauges – NSW Office of Environment and Heritage, operated by Manly Hydraulics Laboratory
- Other organisations such as Lismore City Council.

2.3.2 NEW State Emergency Service

The SES is the designated Combat Agency for coordinating the rescue, evacuation and welfare of flood affected communities. With regard to flood warning the SES has responsibility to:

- Prepare prewritten Flood Bulletins for key gauges, flash flood environments and for areas downstream of deficient dams.
- Prepare systems for the communication of warnings and public information regarding flooding.
- Continually review the state's flood warning requirements.
- Assist in the development of official flood warnings by providing data to the BoM from the SES network of river height gauges and private gauges to which it has access.
- Coordinate the development and communication of SES Flood Bulletins to at risk communities.

To enhance the awareness and preparedness of NSW communities the SES has developed a comprehensive education strategy branded FloodSafe. The program has many components including brochures, newspaper supplements, media interviews, public meeting, displays and school visits. Brochures are tailored to local flood prone areas and contain information on the local flood risk and how to prepare for and respond to floods.

2.3.3 Council

Beyond the responsibility for flood planning and overall support of the SES, Councils have the responsibility for:

- Flash flood warnings (i.e. catchments with a response time less than 6 hours);
- Warnings for locations not currently covered by the BoM (i.e. all locations within the Ballina Shire). Forecasts and warnings for these areas may require an agreement between Council and BoM; and
- Community education around the consequences of flooding.

3 Data Collection

3.1 River Gauges

3.1.1 Existing network

Throughout the Richmond River catchment, there is a broad network of river gauges, owned and operated by a range of agencies for a variety of purposes. Many gauges serve multiple purposes. The existing river gauges can be broadly categorised as follows:

- (1) Telemetered gauges:
 - (a) Tidal pool gauges – generally owned and operated by:
 - NSW Office of Environment and Heritage (OEH) (operated by Manly Hydraulics Laboratory(MHL)); and
 - NSW Office of Water (NoW)Refer to Table 2-1 for a complete listing of telemetered river gauges within the tidal limits.
 - (b) Non-tidal gauges – these are the river gauges located upstream of the tidal limits, and are generally owned and operated by:
 - NSW Office of WaterRefer to Table 2-2 for a complete listing of telemetered river gauges upstream of the tidal limit.
- (2) Manual gauges:
 - (a) Tidal pool gauges – these are mostly used by the SES as additional information on local flood conditions. The manual gauge at Lismore (Dawson Street) is also used by the BoM as a secondary gauge for flood prediction. Refer to Table 3-2 for a listing of manual staff gauges within the tidal limits.
 - (b) Non-tidal gauges – similarly, these gauges are mostly used by the SES as additional information on local flood conditions. The manual gauge on the Casino Road Bridge is also used by the BoM as a secondary gauge for flood prediction. Refer to Table 3-4 for a listing of manual staff gauges upstream of the tidal limits.

Note many of the manual gauges are read by the landholder and reported only to Richmond Valley Council for flood intelligence.

As the agency responsible for flood warning in the Richmond River catchment, it is expected that most people seeking real-time gauge data will go to the BoM website. For this reason, Table 2-1 and Table 2-2 list whether the particular gauges are listed on the BoM website.

Refer to Figure 3-3 for locations of gauges, including gauge ownership and whether the data are published on the BoM website. Refer also to Figure 3-4 for method of communication

from each gauge. Refer to Figure 3-1 and Figure 3-2 for examples of information presented on the BoM website.

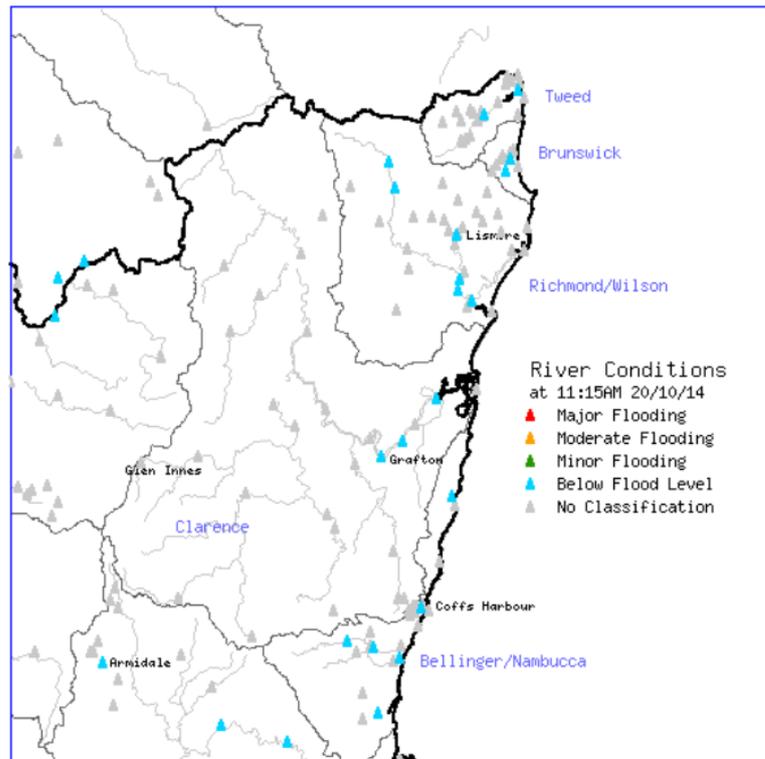


Figure 3-1 Typical gauge network map on the BoM website

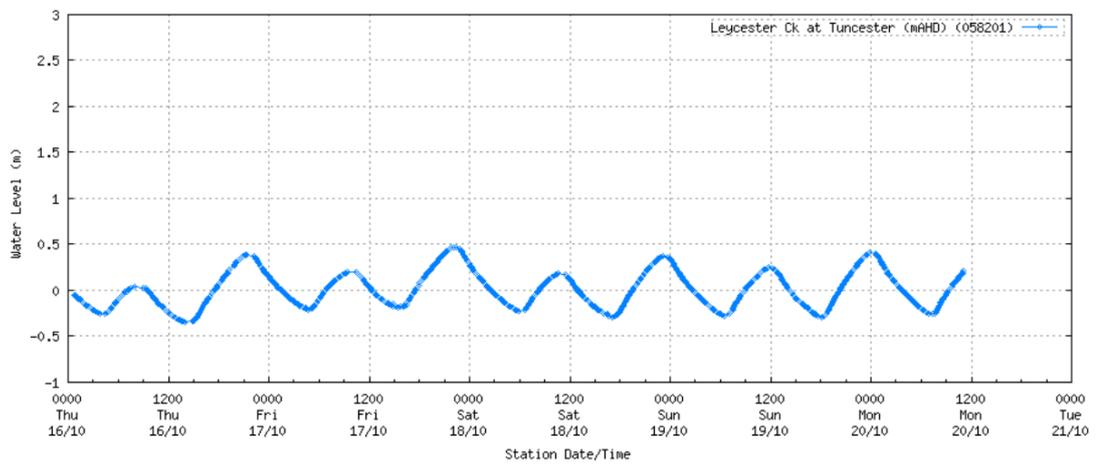


Figure 3-2 Typical gauge data shown on the BoM website as a graph

Table 3-1 Telemetered river gauges within the tidal limits

Gauge Name	BoM Gauge No. (AWRC No.) ¹	Location	River	Owner / operator	Used by BoM for Flood Warning	Reported on BoM Website ²
Ballina Breakwall	558097 (203425)	Ballina	Richmond River	OEH (MHL)	No	Yes
Missingham Bridge	203465	Ballina	North Creek	OEH (MHL)	No	No
Byrnes Point	558044 (203461)	Ballina	Richmond River	OEH (MHL)	No	Yes
Wardell	203468	Wardell	Richmond River	OEH (MHL)	No	No
Woodburn	058061 (203412)	Woodburn	Richmond River	OEH (MHL)	Yes	Yes
Rocky Mouth Creek	558054 (203432)	Woodburn	Rocky Mouth Creek	OEH (MHL)	No	Yes
Tuombil Canal Floodgates	558057 (203434)	Woodburn	Evans River	OEH (MHL)	No	Yes
Tuombil Highway Bridge	558058 (203480)	Woodburn	Evans River	OEH (MHL)	No	Yes
Iron Gates	203475	Evans Head	Evans River	OEH (MHL)	No	No
Evans River Fishing Co-op	558048 (203462)	Evans Head	Evans River	OEH (MHL)	No	Yes
Bungawalbin Junction	58184 (203450)	Near Coraki	Richmond River	BoM?	Yes	Yes
Richmond River at Oakland Drive	203470	Near Coraki	Richmond River	NoW (MHL)	No	No
Coraki	058175 (203403)	Coraki	Richmond River	OEH (MHL)	Yes	Yes
Bungawalbin Creek at Neiley Lagoon Road	2034133	Bungawalbin	Bungawalbin Creek	OEH (MHL)	No	No
Tuckurimba (Baxter Lane)	558076	Tuckurimba	Wilsons River	BoM	No	Yes
East Gundurimba	558047 (203427)	Gundurimba	Wilsons River	OEH (MHL)	No	Yes

¹ AWRC is the Australian Water Resources Management Committee. The AWRC number is prefixed by 203 to identify the gauges as located within the Richmond River (AWRC basin number 203). The following number refers to the operator; 4 = MHL, 9 = BoM.

² As checked on 10 October 2014

Lismore	058176 (203904)	Lismore	Wilson's River	BoM	Yes	Yes
Tuncester	58201 (203443)	Lismore	Leycester Creek	OEHL (MHL)	Yes	Yes
Woodlawn College	558012 (203402)	Lismore	Wilson's River	OEHL (MHL)	Yes	Yes

Table 3-2 Telemetered river gauges upstream of the tidal limits

Gauge Name	BoM Gauge No. (AWRC No.) ³	Location	River	Owner	Used by BoM for Flood Warning	Reported on BoM Website ⁴
Bentley	058202 (203009)		Back Creek	NoW	Yes	Yes
Binna Burra	203012	Binna Burra	Byron Creek	NoW	No	No
Casino	558013 (203004)	Casino	Richmond River	NoW	Yes	Yes
Ewing Bridge (Corndale)	058206 (203909)	Corndale	Coopers Creek	NoW	Yes	Yes
Doubtful	558037 (203034)		Eden Creek	NoW	Yes	Yes
Eltham	058200 (203014)	Eltham	Wilson's River	NoW	Yes	Yes
Fairmeadow	203060		Coopers Creek	NoW	No	No
Goolmangar Creek at Nimbin	058180 (203901)	Nimbin	Goolmangar Creek	LCC	Yes	Yes
Goolmangar Creek	558075	Goolmangar	Goolmangar Creek	LCC		Yes
Houghlahans Creek	203057	Teven	Houghlahans Creek	NoW	No	No
Kyogle	558002 (203900)	Kyogle	Richmond River	NoW	Yes	Yes
Lavelles Road	203056		Richmond River	NoW	No	No
Lismore (Dawson Street)	558087	Lismore	Browns Creek	LCC		Yes
Marom Creek at Graham Road	203059	Tuckean Swamp	Marom Creek	NoW	No	No
McNamara Bridge Weir	203061		Goolmangar Creek	NoW	No	No
Nashua	058162 (203902)	Nashua	Wilson's River	LCC	Yes	Yes
Rappville	558015 (203030)	Rappville	Myrtle Creek	NoW	Yes	Yes
Repentance	558000		Coopers Creek	NoW	Yes	Yes

³ AWRC is the Australian Water Resources Management Committee. The AWRC number is prefixed by 203 to identify the gauges as located within the Richmond River (AWRC basin number 203). The following number refers to the operator; 4 = MHL, 9 = BoM.

⁴ As checked on 10 October 2014

	(203002)					
Rock Valley	058199 (203010)		Leycester Creek	NoW	Yes	Yes
Teven	558070 (203039)	Teven	Maguires Creek	NoW	No	Yes
The Channon	058147 (203906)	The Channon	Terania Creek	NoW	Yes	Yes
Toonumbar Dam d/s	203023	Toonumbar Dam	Ironpot Creek	NoW	Yes	No
Toonumbar Dam WL	558039 (203042)	Toonumbar Dam	Ironpot Creek	NoW	Yes	No
Wiangaree	558001 (203005)	Wiangaree	Richmond River	NoW	Yes	Yes
Yorklea	558038 (203041)	Yorklea	Deep Creek (Shannon Brook)	NoW	Yes	Yes

Table 3-3 Manual staff gauges within the tidal limits

Gauge Name	BoM Gauge No. (AWRC No.)	River	SES Unit	Used by BoM for Flood Warning
Bagotville Barrage		Tuckean Broadwater	Broadwater	No
Ballina RSL		Richmond River	Ballina	No
Broadwater		Richmond River	Woodburn	No
Bungawalbin Junction		Richmond River	Coraki & Woodburn	No
Codrington – Bailey Lane		Richmond River		No
Coraki Boat Ramp		Richmond River	Coraki	No
Emigrant Creek Boat Ramp		Emigrant Creek	Ballina	No
Lismore (Dawson Street)	558087	Browns Creek	Lismore	Yes
Swan Bay		Richmond River	Woodburn	No
Tintenbar Road Bridge		Maguires Creek	Ballina	No
Wardell		Richmond River	Ballina?	No
Woodburn – SES Headquarters		Richmond River	Woodburn	No

Table 3-4 Manual staff gauges upstream of the tidal limits

Gauge Name	BoM Gauge No. (AWRC No.)	River	SES Unit	Used by BoM for Flood Warning
Boggy Creek		Boggy Creek		No
Bungawalbin Creek (Sam Robinsons Farm off Whiporie Road)		Bungawalbin Creek		No
Casino Irving Bridge	58179 (203907)	Richmond River	Casino	Yes
Eltham Road - Teven Golf Course		Maguires Creek	Ballina	No
Leeville - Bulmers				No
Moonem				No
Piora – Pylons of Piora Bridge at Hogarths Range				No
Rappville Railway Bridge				No
Wyan – Merv Smalls Farm				No
Wyan – Noel Kinsleys Farm				No

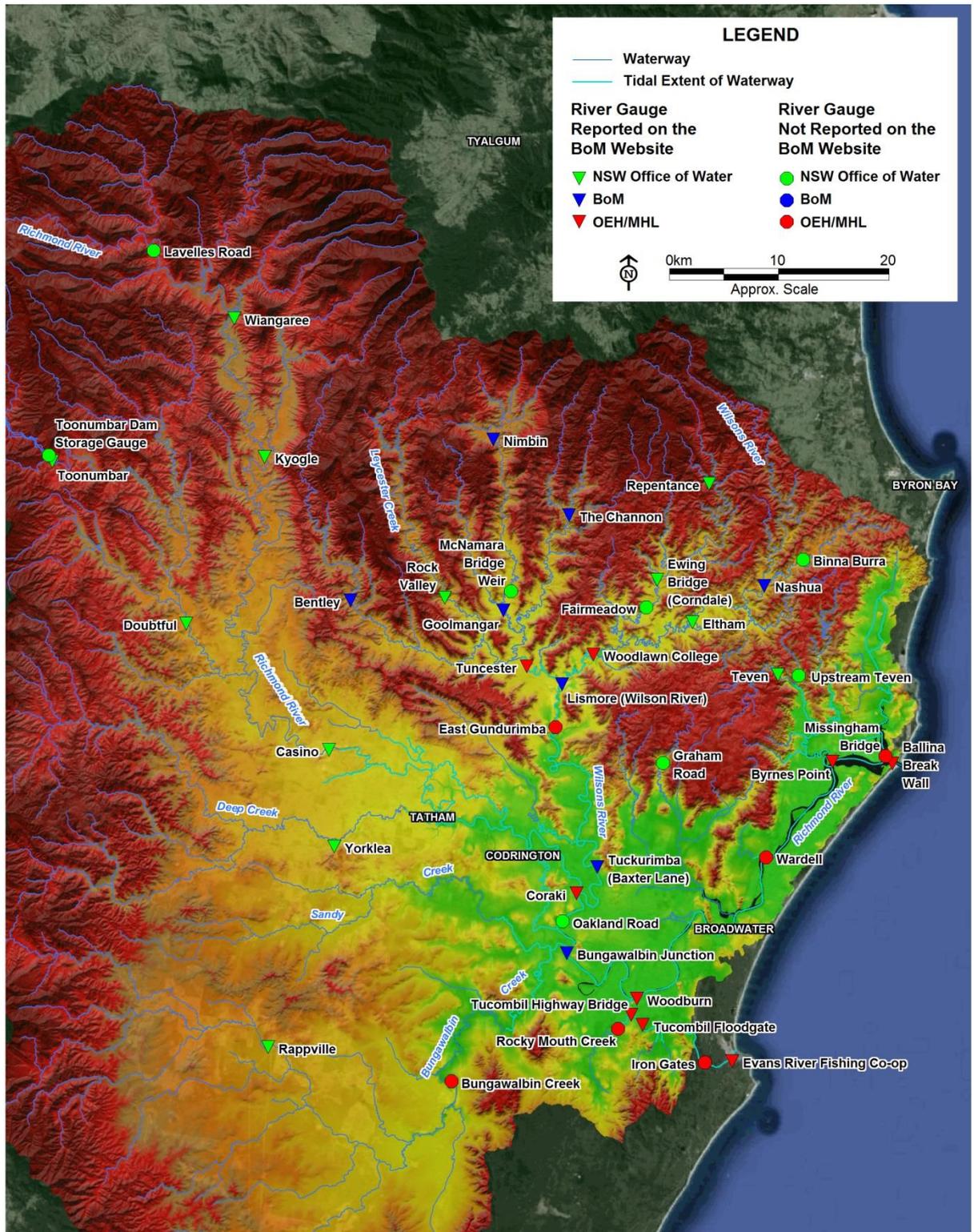


Figure 3-3 Richmond River gauges including ownership and whether reported on the BoM website

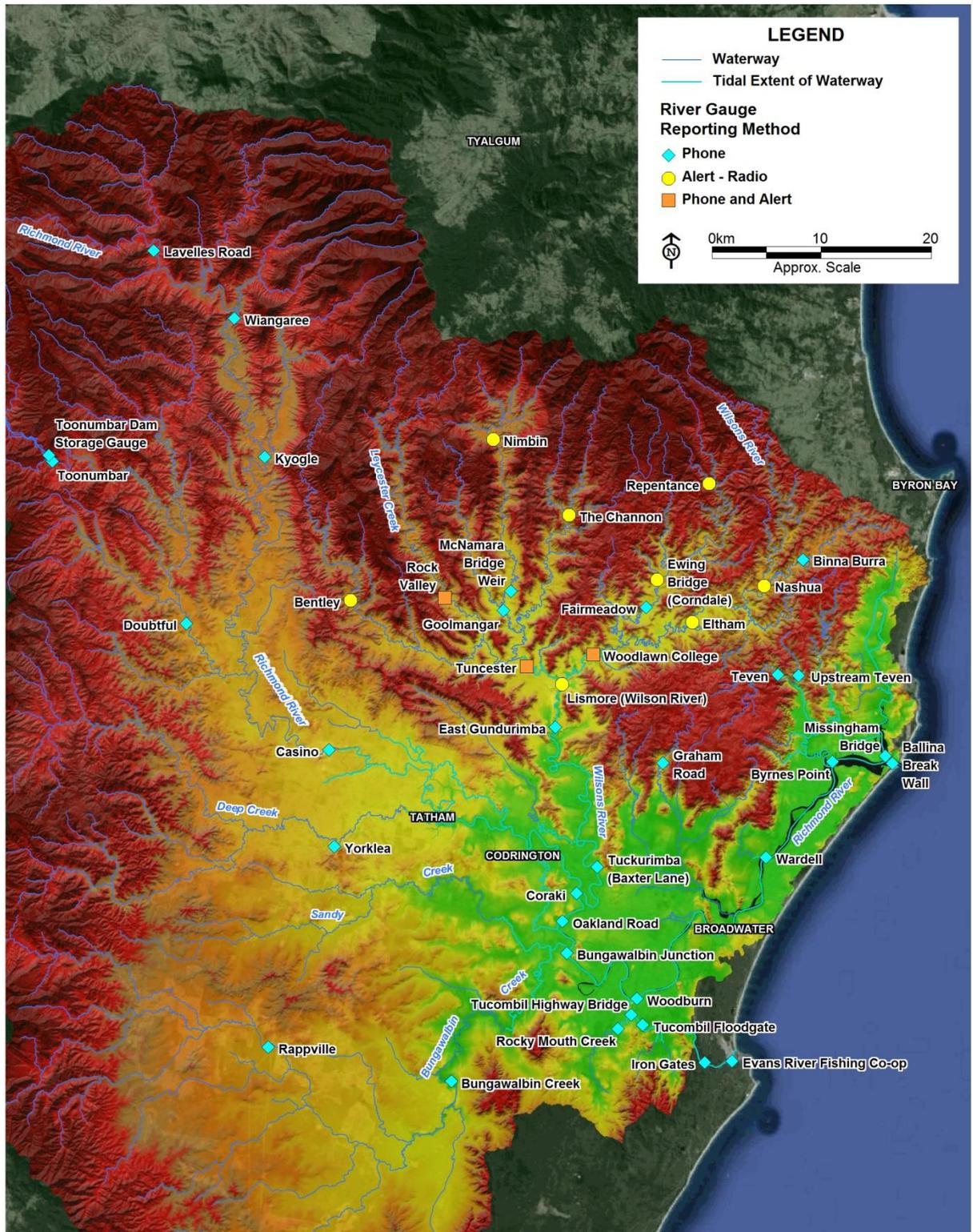


Figure 3-4 Richmond River gauges including method of communication

3.1.2 Gap analysis

Gaps in the river gauge network have been identified by various stakeholders. Whilst the BoM are generally comfortable with the coverage of river gauges, in terms of being able to provide sufficiently accurate forecasts, additional gauges in some locations would assist the SES and community during flood events. Further, additional gauges would, over time, provide additional data for model calibration.

Based on discussions with the committee and knowledge of the catchment, additional river gauges are recommended at the following locations.

- Tatham
- Emigrant Creek at Ballina
- North Creek at Ballina.

3.2 Rain Gauges

3.2.1 Existing network

There is a good network of pluviograph (continuously recording) rain gauges throughout the Wilsons River catchment. Across the remainder of the Richmond River catchment, there is sparse coverage of rainfall gauges. Within the Bungawalbin Creek catchment, there is only one pluviograph rain gauge. Refer to Figure 3-5 for screen shot of the pluviograph rainfall gauges shown on the BoM website.

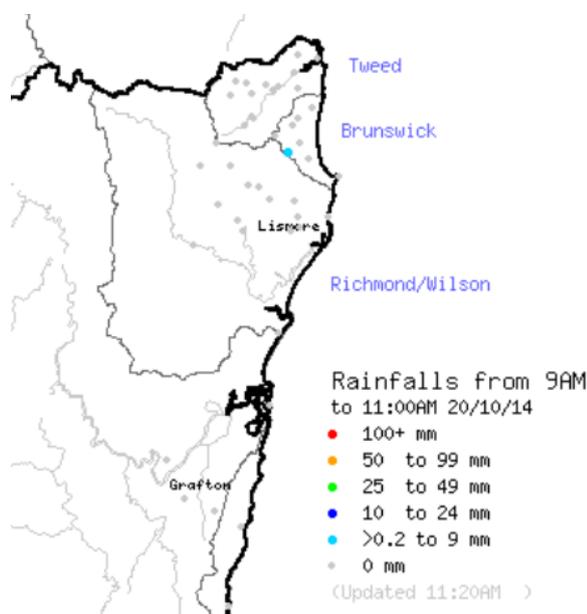


Figure 3-5 Existing continuous recording rain gauges throughout the Richmond as reported on the BoM website

3.2.2 Gap analysis

The two priority areas for densification of the rain gauge network are:

- Bungawalbin Creek catchment - the catchment covers an area of similar size to the Wilsons River catchment (approximately 1,500km²). Whilst there are not any significant population centres throughout the Bungawalbin catchment, rainfall within the catchment can influence flooding in the Mid-Richmond area, including Coraki, Woodburn and Broadwater. Additional rain gauges in this area would provide greater benefit for future refinement of flood models rather than improvements to flood forecasts.
- Ballina local creeks – one of the three major sources of flooding in the Ballina area is from the local catchments. There is a good coverage of rain gauges in the Maguires Creek catchment (as part of the Teven Valley Flood Warning System). However, rain gauge coverage in the Emigrant and North Creek catchment is poor. Additional rain gauges in these catchments will provide pre-warning of potential flooding in Ballina.

4 Gauge Datum Review

4.1 Existing gauge datums

There are four datums used for river gauging throughout the Richmond Valley:

- Australian Height Datum (AHD) – AHD is equivalent to MSL (mean sea level) at Ballina. AHD is used for gauging in Lismore following a conversion from RVD in 2000.
- Richmond Valley Datum – the RVD is equivalent to LWOST (low water of ordinary spring tide). LWOST is assumed by the project team to be equivalent to ISLW (Indian spring low water). The RVD is approximately 0.86m below AHD at Ballina, hence 0m RVD is equivalent to -0.86m AHD. RVD varies between 0.81 and 0.86m below AHD throughout the estuary and is used for all existing tidal gauges. Refer to Table 4-1 for location specific conversions.
- Assumed Datum – all gauges throughout Richmond Valley, upstream of the tidal limits adopt an assumed datum based on the river geometry at that point. Gauge zero typically corresponds to the invert of the river channel at the gauge location.
- Water Resources Commission Datum – the WRC datum is used for Toonumbar Dam.

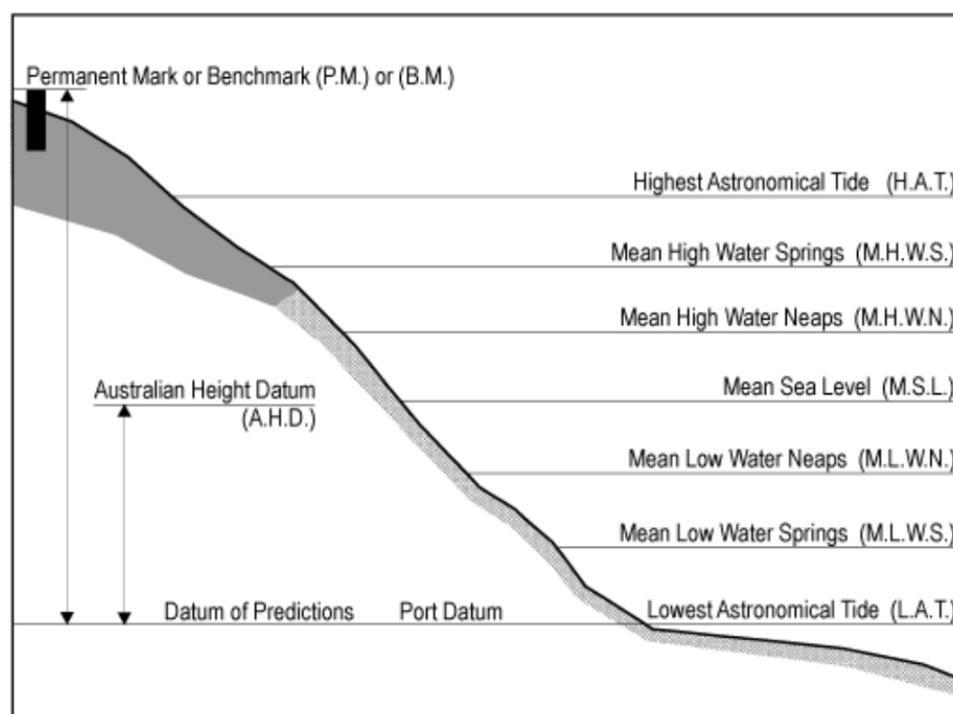


Figure 4-1 Relationship between tidal planes (Maritime Safety Queensland)

Table 4-1 RVD to AHD conversions

River	Station	Datum	Adjustment to AHD
Richmond River	Ballina	LWOST	-0.860
Richmond River	Missingham Bridge	RVD	-0.860
Richmond River	Byrnes Point	RVD	-0.857
Richmond River	Wardell	RVD	-0.824
Richmond River	Woodburn	RVD	-0.815
Evans River	Evans River Fishing Co-op	RVD	-0.809
Evans River	Iron Gates	RVD	-0.819
Tuckombil Canal	Tucombil Highway Bridge	RVD	-0.815
Tuckombil Canal	Tucombil Floodgate	RVD	-0.815
Rocky Mouth Creek	Rocky Mouth Creek	RVD	-0.815
Richmond River	Bungawalbin Junction	RVD	-0.809
Richmond River	Coraki	RVD	-0.815
Wilson's River	East Gundurimba	RVD	-0.831
Leycester Creek	Tuncester	RVD	-0.855
Wilson's River	Woodlawn College	RVD	-0.826

4.2 Gauge Datum Conversion Strategy

During Committee meetings 1 and 2, the conversion of gauges from RVD to AHD was discussed in detail. All stakeholders were given the opportunity to express their preferences and/or concerns. In general, there was agreement that the following strategy should be adopted:

- Retain the Ballina Breakwall and Evans River Fishing Co-op gauges to reference RVD. This is due to these gauges primarily being used for navigation. Use of negative gauge readings for navigation was considered to be undesirable.
- Convert all remaining tidal pool gauges to reference AHD, noting both AHD and RVD are currently shown for all OEH gauges on the MHL public website.
- Retain all gauges upstream from the tidal limit to reference the assumed datum for the particular gauge, including the WRC datum at Toonumbar Dam.

Further to the strategy listed above, the following points were noted:

- Richmond Valley Council is interested in adopting AHD since their property database is relative to AHD. This may require changing the Casino gauge.
- There was general agreement that an extensive community education campaign would be required prior to and following changing gauge datum. This education campaign would need to continue into the long term, as it would likely take multiple floods, or even a generation for the community to adjust.
- A strategy for changing gauge plates would need to be developed to ensure confusion is minimised.
- Consideration needs to be given to rating curves associated with gauges being changed, as well as the management of historic data.
- Consideration needs to be given to published data, in particular the warnings issued by the BoM. There needs to be careful consideration of the wording, including showing what the estimated AHD river height relates to in RVD for people to be able to compare against their knowledge of previous floods. Specifically, the BoM Category 1 flood warning sites at Bungawalbin Junction, Coraki and Woodburn would need to be changed from RVD to AHD (i.e. the levels for minor, moderate and major flooding would need to be reduced by ~0.8m to obtain AHD).

4.3 Gauge Plate Design

4.3.1 Existing gauge plates

In general, there are two styles of gauge plates used in the Richmond Valley:

- Type 1: these gauge plates are either flat plates (refer to Figure 4-2) for mounting onto a flat surface, or 'half-round' plates (refer to Figure 4-3) for mounting onto 80mm diameter posts. Both are black and white with 0.01m (1cm) markings, and text at 0.1m increments. This is a typical design used throughout NSW.



Figure 4-2 Flat gauge plates with 0.01m markings (Rappville)



Figure 4-3 Half-round gauge plates with 0.01m markings (Eltham)

- Type 2: these gauge plates are most commonly used to indicate depth of water across a road (refer to Figure 4-4). The gauge zero represents the lowest level of the road. At the Emigrant Creek boat ramp in West Ballina, this type of gauge is used as a water level

gauge (refer to Figure 4-5). These gauges are black and white and have markers and text at 0.2m intervals. Due to the coarse marker interval, it is harder to read water levels to an accuracy of less than 0.1m. This may be sufficient for some situations, particularly in areas with turbulent flow.



Figure 4-4 Flood depth road marker (Eltham Road)



Figure 4-5 Depth marker style gauge used for water level (Emigrant Creek boat ramp)

4.3.2 Replacement gauge plates

During Committee meeting No.3, the project team gathered feedback from all agencies regarding the new gauge plates to be installed during the change. Consideration was given to the following (as suggested during the previous committee meetings):

- User familiarity – for user familiarity, new gauge plates can be the same design as is currently used, however, could be shown using a different colour to differentiate the datum being used. The community education program can then state that black and yellow gauges are relative to AHD and black and white gauges are relative to an assumed datum (remaining unchanged).
- Colour – the use of colour to differentiate the AHD gauges as discussed above has advantages and disadvantages. The use of red is not recommended since it fades quickly. It has been suggested by a gauge plate supplier that black on yellow may be harder to read, particularly at night.
- Intervals for markers – The existing gauge plates in the Richmond Valley have 0.01m (1cm) or 0.2m markers. It is expected that markers at 0.05m (5cm) or 0.1m should suffice for most emergency response applications. It is likely that waves and turbulence will restrict the ability to take accurate measurements.
- Incorporation of additional information on the gauge plate such as:
 - Historic flood levels – historic flood levels are important reference points for the community. It is especially important to identify where these historical flood levels relate to when changing the datum. Refer to Figure 4-6 showing 20 and 100 year ARI design flood levels.
 - Design flood levels – design flood levels are important to communicate that the floods that residents have experienced in the past are not the largest that can be expected to occur. Refer to Figure 4-6 showing 1996 and 2001 flood levels on an existing gauge plate used in the Clarence Valley.
 - Other consequences of particular flood levels – other reference levels can be shown, such as the commencement of levee overtopping.

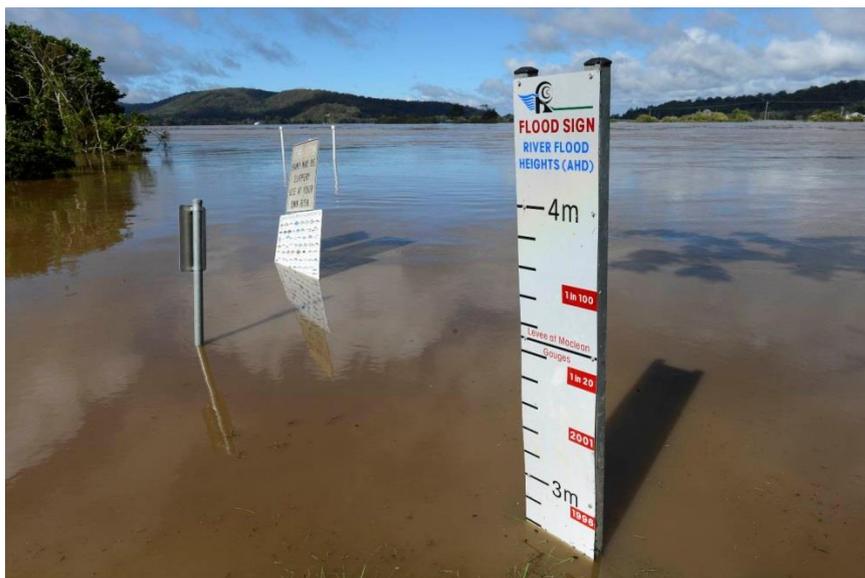


Figure 4-6 Gauge plate used in the Clarence Valley

Based on the strategy presented in Section 4.2, the only gauge plates that will need to be changed will be within the tidal pool. Further, during Committee Meeting No.4, it was suggested to categorise the tidal pool gauges as either:

- Agency (operational) sites – these are gauge sites, generally in rural areas where access is limited. These gauges are generally only used by OEH, NoW and/or BoM; or
- Community (educational) sites – these are gauge sites which are commonly used by the community as well as by the water management agencies. These gauges are typically within the urban areas.

It has been agreed that the general strategy is to install new gauge plates at the community (educational) sites, and not at the agency (operational) sites. The following points summarise the discussions around style of gauge plate:

- Add new gauge plate with clear indication that the datum used is AHD;
- Retain existing gauge plate in its current form at each site;
- Use of black text on yellow background for ease of differentiation with existing RVD gauge plates;
- Use one centimetre increments on markers, with text every 0.1m. The existing style is considered suitable;
- Maintain space on one side for placement of historic flood level markers;
- Use of design flood markers is considered valuable, although may be best left until the revised design storm temporal patterns are released in 2015 as part of the Australian Rainfall and Runoff project, which would likely result in changed design flood levels.

Consistent with the above criteria, the proposed AHD gauge plate design is shown in Figure 4-7. Listed in Table 4-2 are the recommended gauge plate upgrades. Due to the classification of most as ‘agency’ sites where the general public would not use the gauge, only 12 of the 27 manual staff gauge locations are recommended for upgrade. However, all sites (where telemetered) are recommended for presentation of data to AHD, with the exception of Ballina Breakwall and Evans Head Fishing Co-op.

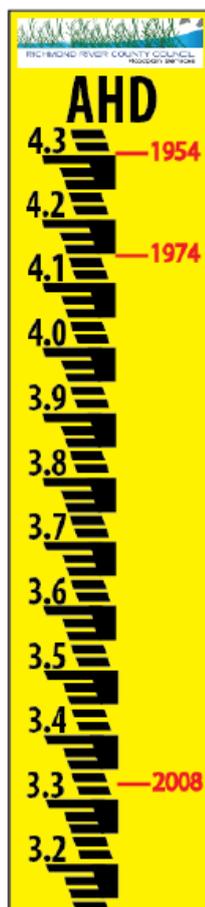


Figure 4-7 Proposed AHD gauge plate design

Table 4-2 Required gauge plate upgrades

Gauge Name	BoM Gauge No. (AWRC No.)	Classification	Existing datum	Proposed datum for data	Upgrade of gauge plates required
Bagotville Barrage		Community	RVD	AHD	Yes
Ballina Breakwall	558097 (203425)	Community	RVD	Unchanged	No
Ballina RSL		Community	RVD	AHD	Yes
Broadwater		Community	RVD	AHD	Yes
Bungawalbin	58184	Agency	RVD	AHD	No

Junction	(203450)				
Byrnes Point	558044 (203461)	Agency	RVD	AHD	No
Codrington – Bailey Lane		Agency	RVD	AHD	No
Coraki	058175 (203403)	Community	RVD	AHD	Yes
East Gundurimba	558047 (203427)	Agency	RVD	AHD	No
Emigrant Creek Boat Ramp		Community	RVD	AHD	Yes
Evans River Fishing Co-op	558048 (203462)	Community	RVD	Unchanged	Yes
Iron Gates	203475	Agency	RVD	AHD	No
Lismore (Dawson Street)	558087	Community	Assumed	AHD	Yes
Lismore (Rowing Club)	058176 (203904)	Community	AHD	Unchanged	Yes
Missingham Bridge	203465	Community	RVD	AHD	Yes
Richmond River at Oakland Drive	203470	Agency	RVD	AHD	No
Rocky Mouth Creek	558054 (203432)	Agency	RVD	AHD	No
Swan Bay		Agency	RVD	AHD	No
Tintenbar Road Bridge		Community	RVD	AHD	Yes
Tucombil Canal Floodgates	558057 (203434)	Agency	RVD	AHD	No
Tucombil Highway Bridge	558058 (203480)	Agency	RVD	AHD	No
Tuckurimba (Baxter Lane)	558076	Agency	RVD	AHD	No
Tuncester	58201 (203443)	Agency	AHD	Unchanged	No
Wardell	203468	Community	RVD	AHD	Yes
Woodburn	058061 (203412)	Community	RVD	AHD	Yes
Woodburn – SES Headquarters		Agency	RVD	AHD	No
Woodlawn College	558012 (203402)	Agency	AHD	Unchanged	No

5 Flood Warning Review

5.1 Introduction to the Total Flood Warning System

The purpose of flood warning is to provide advice on impending flooding so people can take action to minimise its negative impacts. Effective flood warning relies on monitoring and prediction capabilities as well as the ability to convey the warning efficiently and in a targeted way so that the warning is acted upon. Both the science (monitoring, interpretation and prediction), and communication elements of the warning process are of equal importance. One is ineffective without the other.

The concept of a ‘total flood warning system’ combines the science and communication elements with protective actions and system review (lessons learnt). The system is illustrated diagrammatically in Figure 5-1. Each component is described in the following sections in the context of the Richmond River catchment.

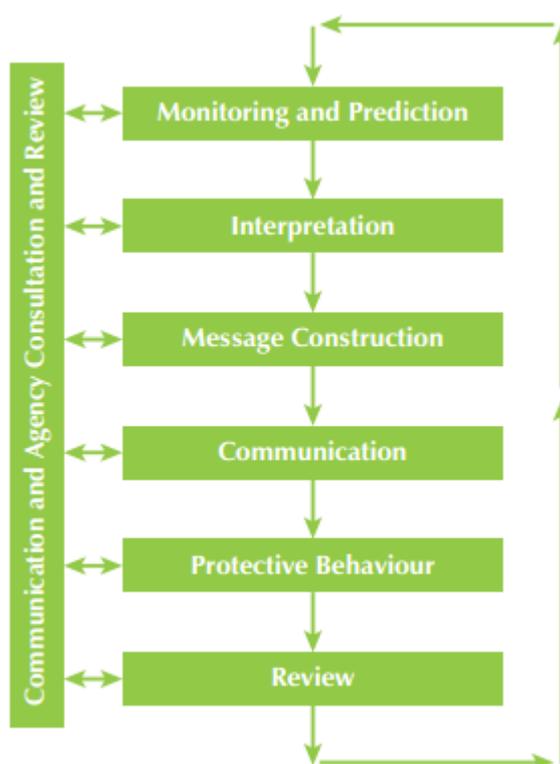


Figure 5-1 Components of the Total Flood Warning System⁵

5.2 Components of the Total Flood Warning System

5.2.1 Monitoring and Prediction

Table 5-1 lists locations (gauges) in the Richmond Basin for which flood warning and/or SES Local Flood Advices are provided. All flood warnings issued by BoM for locations in Table 5-1 are quantitative i.e. have details on predicted levels and timings. Figure 5-2 shows

⁵ Reproduced from Australian Emergency Manuals Series: Manual 21 Flood Warning (Australian Government, 2009).

Flood Warning Review

current operational river level gauges within the Richmond including whether or not they are reported on the BoM website.

A local flood warning system exists for 14 homes and an old school in the Teven Valley, north east of Ballina. The automated system is designed to provide flood warning of flash flooding on Maguires Creek. The system is based on a network of three rainfall and one water level gauge. Council and BoM receive the monitored data into the Enviromon data collection platform via VHF radio. If pre-determined rainfall intensity or water level thresholds are exceeded, the Enviromon Alert Manager will send e-mail and SMS alarms to the BoMs Flash Flood Warning Manager who would then issue a flash flood warning to relevant agencies such as SES and Council.

Table 5-1 Flood Warning Locations in the Richmond/Wilsons Basins

Area	Watercourse	Flood Warnings provided by BoM	Local Flood Advices provided by SES	SES warning lead time requirement
Wiangaree	Richmond	Yes		
Kyogle	Richmond	Yes		6 hours notice required of heights 13.0m and above
Casino	Richmond	Yes		6 hours notice required of heights 9.2m and above
Coraki	Richmond	Yes		24 hours notice required of heights 3.8m and above
Bungawalbin Junction	Richmond	Yes		24 hours notice required of heights 4.5m and above
Woodburn	Richmond	Yes		12 hours notice required of heights 4.0m and above
Broadwater	Richmond	No	Yes	
Cabbage Tree Island	Richmond	No	Yes	
Wardell	Richmond	No	Yes	
Ballina	Richmond	No	Yes	
Lismore	Wilsons	Yes		12 hours notice required of heights 10.0m and above
Bungawalbin Creek	Bungawalbin Creek	No	Yes	
Rappville	Busby's Creek	No	Yes	
Leeville	Deep Creek	No	Yes	
Teven	Maguires Creek	No	Yes	Has Council flash flood warning system
Tintenbar	Emigrant Creek	No	Yes	
Ellangowan	Sandy Creek	No	Yes	

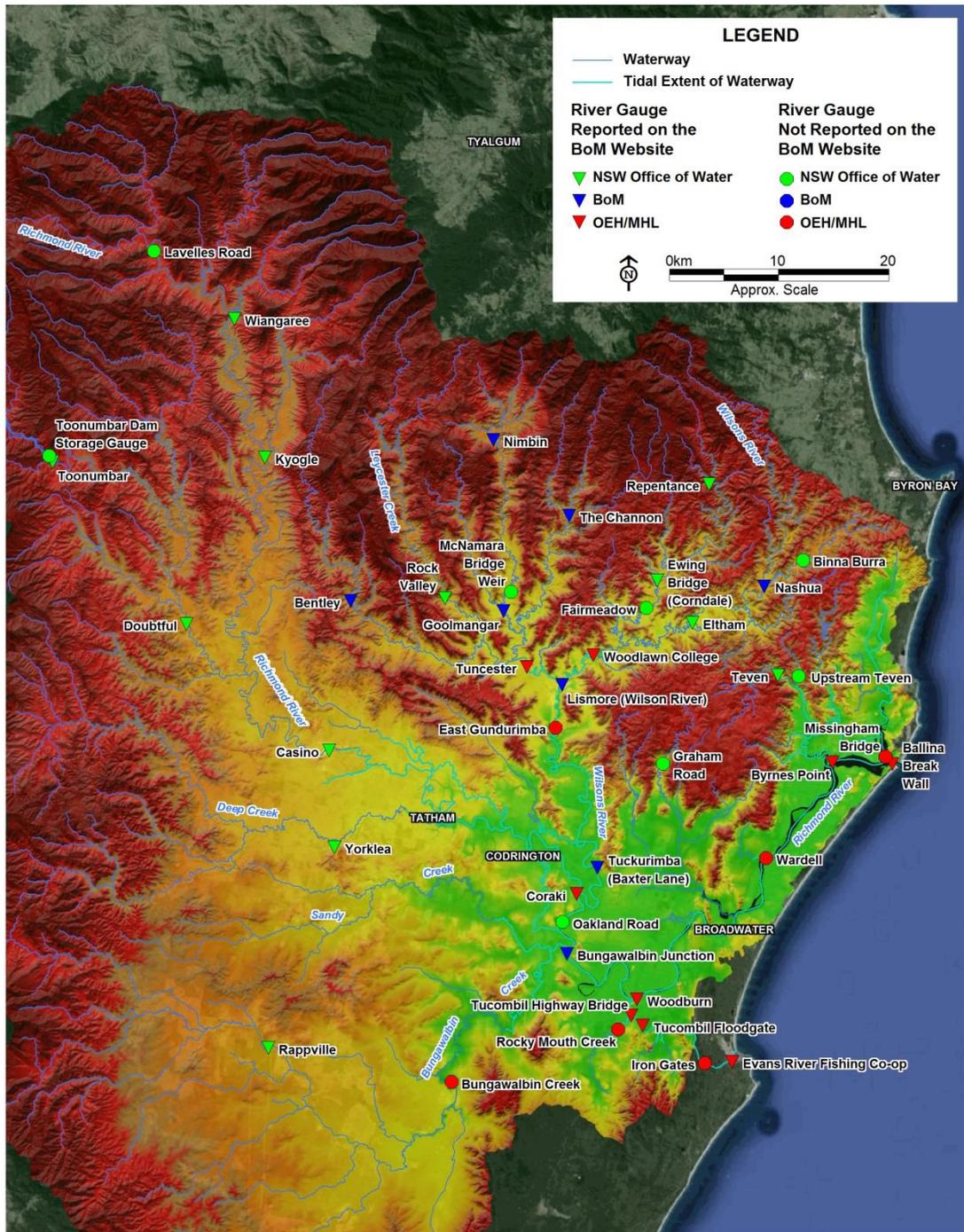


Figure 5-2 Richmond River gauges including ownership and whether reported on BoM Website

5.2.2 Interpretation

Interpretation involves identifying, in advance, the impacts of the predicted flood levels on communities at risk. Predictions of likely flood heights at gauges are of little use by themselves. The meaning of these predicted flood heights needs to be understood in terms of people, properties and infrastructure such as roads which are likely to be impacted.

Flood Warning Review

The Richmond catchment benefits from extensive flood modelling and mapping as well as a good appreciation of flooding within local communities from previous flood events. Flood modelling has been used in Lismore to provide FloodSafe guides to local residents which qualify the flood levels at relevant gauges at which action needs to be taken. A similar process within Ballina and elsewhere on the lower Richmond is hampered by a large degree due to lack of a formal flood warning system. For other communities, increased benefits could be achieved through making additional use of the existing flood model as a tool in relating flood extents and depths to gauge heights. Discussion Paper 3 considers flood interpretation in greater detail.

5.2.3 Message Construction / Communication

BoM issues flood warnings to advise when future flooding is expected. Warnings may be one of the following classes:

- Quantitative – advance warning on the expected flood class (minor, moderate, major) with specific information on expected heights and times.
- Qualitative – advance warning on the expected flood class (minor, moderate, major) and approximate timings (eg morning, afternoon, overnight).
- Generalised – may be issued for areas where no locations exist at which quantitative or qualitative predictions can be made. Warnings contain generalised statements and are generally based on observed or expected rainfall.

Flood Watches and warnings are communicated by:

- Direct issue to stakeholders with emergency management responsibilities;
- Radio;
- Weather warning service – a recorded telephone message; and/or
- Internet.

The SES augments the official BoM flood warnings by assessing the likely consequences of flooding at the predicted heights and suggesting appropriate actions for people in areas expected to be affected and disseminating this information. This can be in the form of:

- Livestock and Equipment Warnings when there is evidence of rises in levels below minor flood heights, and disseminate these within Region Flood Bulletins; and/or
- Local Flood Advices for communities for which the BoM does not issue official flood warnings, and disseminate these within Regional Flood Bulletins.

Quantitative flood warnings carry more information and are more valuable to the SES than non-quantitative warnings as they enable targeted responses with greater certainty surrounding expected times of inundation. It is recommended that the scope for providing additional quantitative forecasting within the Richmond/Wilsons catchments is considered through the installation of additional gauges that increase the density of the existing flood warning network.

5.2.4 Protective Behaviour

Protective behaviour taken at both individual and community level is being addressed in floodplain risk management plans prepared across the region. It is not discussed further in this discussion paper.

5.2.5 Review

LGAs currently hold public meetings with flood affected communities after significant events e.g. Lismore following the 2005 floods.

5.3 Gaps in Current Procedures

The Richmond catchment has an established and relatively dense network of rainfall and river gauges serving the key communities within the region. An assessment has been undertaken to identify any communities which may be vulnerable to flooding and have no, or limited, existing flood warning infrastructure. The assessment recognises that it may not be possible to provide accurate or timely flood warnings to areas subject to flash flooding (generally thought of as having catchment response times less than 6 hours).

5.3.1 Small 'at risk' towns not presently covered by a formal flood warning system

Goolmangar on Goolmangar Creek to the north west of Lismore is located within a zone of high to medium hazard, as shown by the Lismore Rural Flood Mapping. Nearby Blakebrook is largely flood free but is subject to isolation and would benefit from the same flood warning as for Goolmangar. Bexhill, north east of Lismore on the Wilsons River has a few vulnerable properties on the southern periphery of the town. All of these towns do not have flood classifications of minor, moderate and major. Such classifications, coupled with a specific classification warning would improve the warning capability for these towns.

A number of smaller towns are located upstream from Kyogle. A river level gauge at Wiangaree and rainfall gauges higher in the catchment provide a degree of flood warning. It is recommended that flood mapping is undertaken to understand the flood risk and maximise the effectiveness of any warnings made.

The Tatham community have previously raised concern regarding absence of gauges and flood warnings for their community, which is located downstream from Casino. An additional river gauge, coupled with a forecasted level and time would be of great benefit to this community.

5.3.2 Ballina

A recommendation of the Ballina Floodplain Risk Management Study is to extend the gauge network with 'a minimum of three additional rain gauges (Newrybar Swamp, Brooklet and Cumbalum Ridge) and two river gauges (Emigrant Creek and North Creek)'. A further recommendation of that study is to investigate the potential for installing a dedicated flood warning system for Ballina and environs, since there is currently no formal flood forecasting system that covers Ballina Shire. This should include Wardell.

5.3.3 Bungawalbin Catchment

There remains significant uncertainty regarding the catchment response of the Bungawalbin catchment. Flows which breakout from Bungawalbin Creek near the confluence with the Richmond River have a large influence on levels within Rocky Mouth Creek and the Evans River. Figure 5-3 to Figure 5-6 demonstrate the issue using the RFRMS flood model as a tool in assessing the 2009 flood event.

Whilst the gauged and modelled 2009 flows at the Bungawalbin and Woodburn gauges are comparable, the same comparison at the Rocky Mouth Creek gauge has significant differences. The differences were such that changing parameters in the hydraulic model could not improve the fit to any notable degree. It was therefore concluded that the hydrology of the Bungawalbin catchment is not well understood with current modelling not adequately representing the significant attenuation that occurs with the Bungawalbin catchment. Gauged data would be needed to improve knowledge of the Bungawalbin hydrology.

Whilst, Richmond floods generally result in the largest flood levels at Woodburn, floodwater generated within the Bungawalbin catchment can impact on communities in the Woodburn area in advance of the Richmond flooding. Furthermore a significant, isolated rainfall event over the Bungawalbin catchment has the potential to cause flooding at Woodburn.

Due to very few population centres in the Bungawalbin catchment, the network of gauges is sparse. It is recommended that gauges are installed to improve flood intelligence of this catchment which in turn will improve flood forecasts for downstream communities.

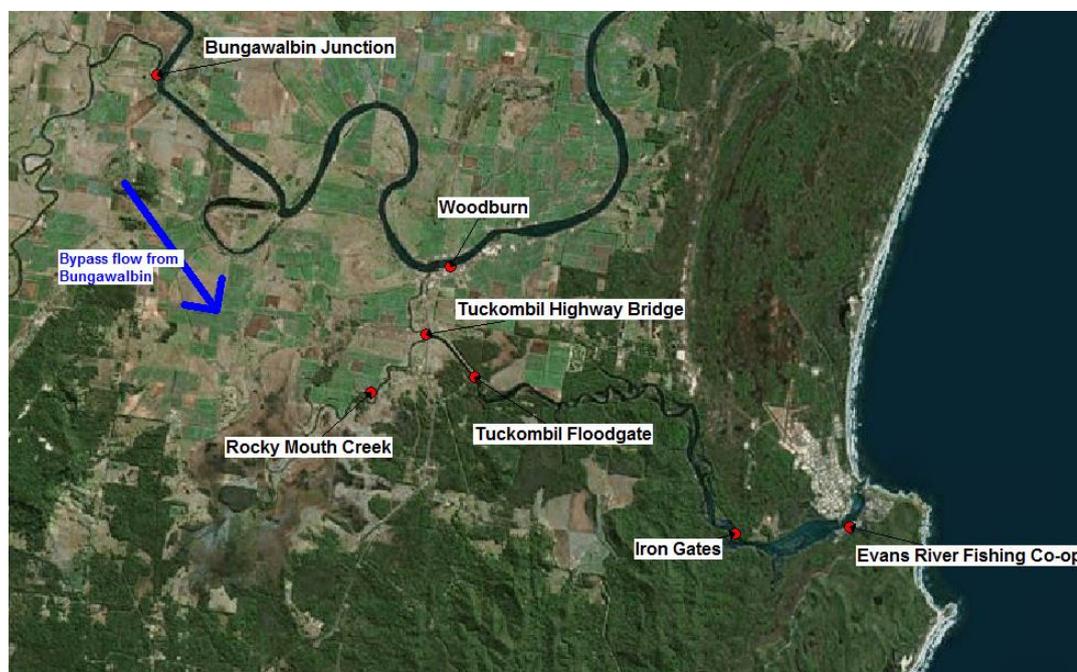


Figure 5-3 Bungawalbin

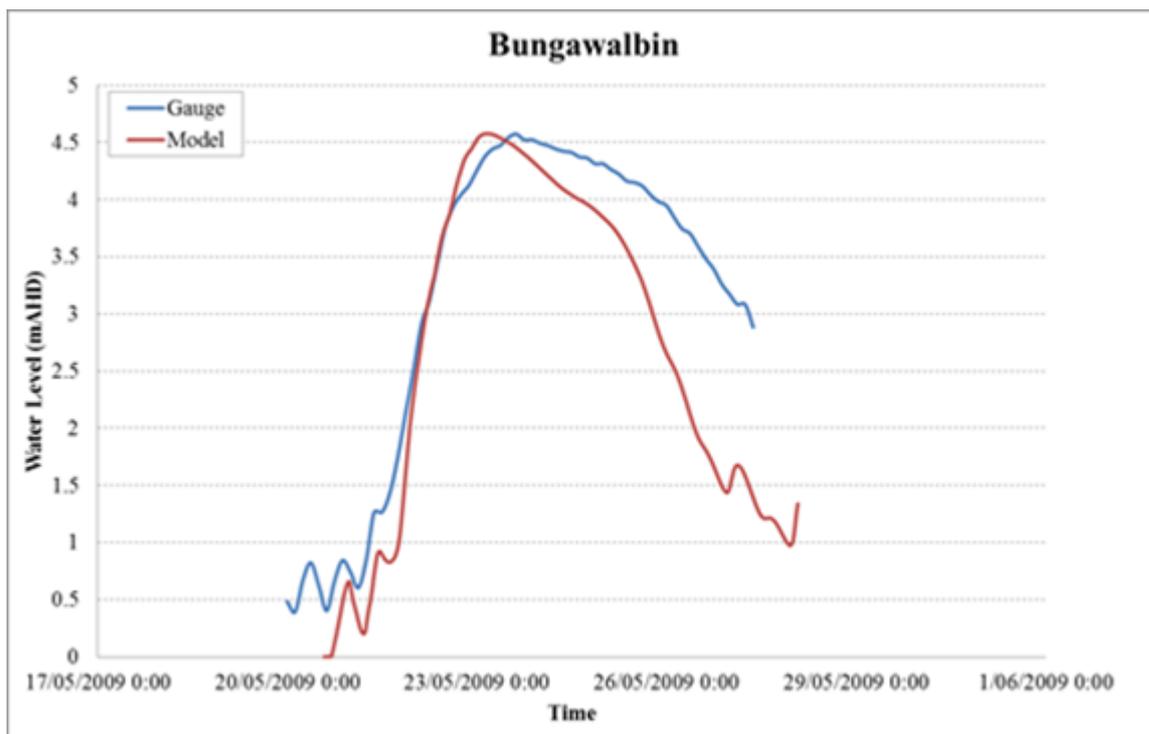


Figure 5-4 Bungawalbin Modelled and Gauged flows – 2009 Event

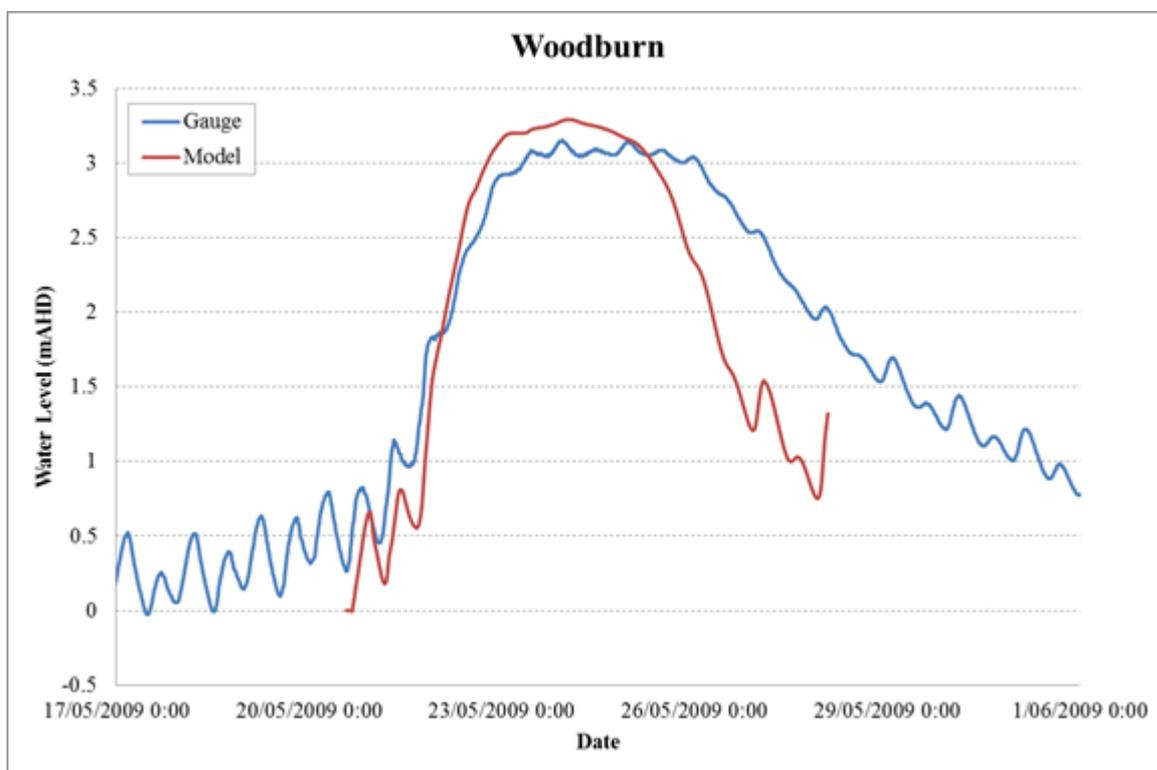


Figure 5-5 Woodburn Modelled and Gauged flows – 2009 Event

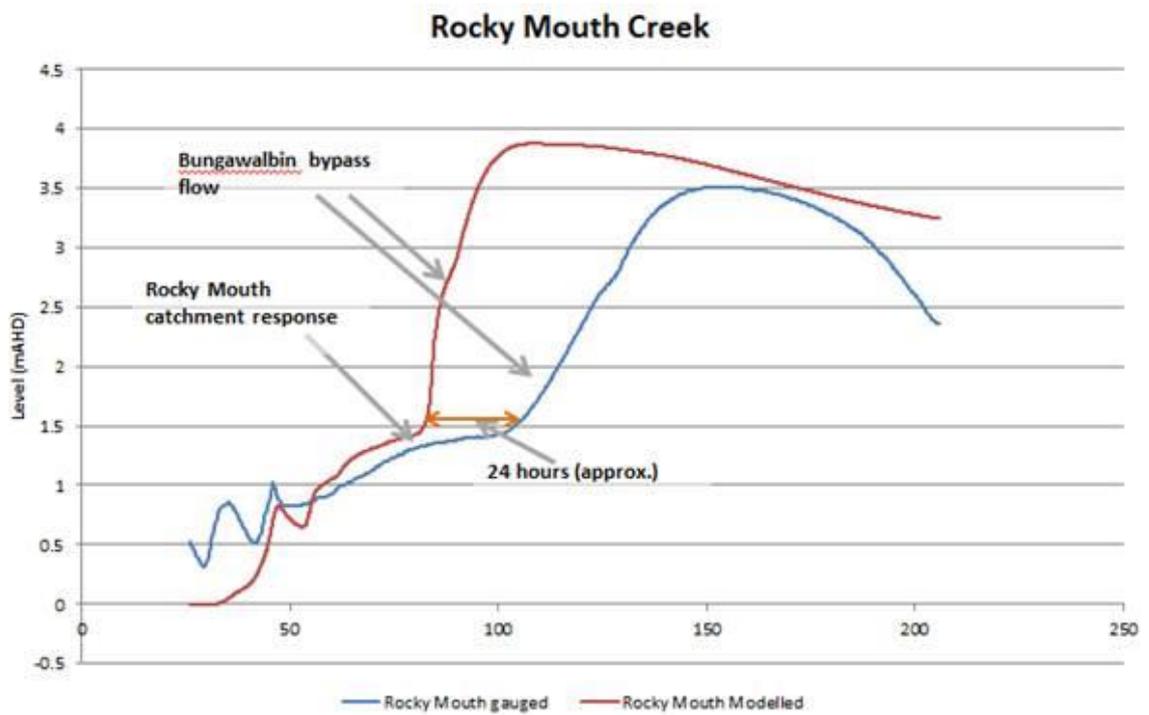


Figure 5-6 Rocky Mouth Creek Modelled and Gauged flows – 2009 Event

6 Evacuation Management Review

6.1 Introduction

Prime responsibility for the protection of life, property and the environment rests with the States and Territories. Subject to the requirements and provisions of the NSW State Emergency and Rescue Management Act, 1989 (as amended), and under the provisions of the State Emergency Service Act, 1989 (as amended), the overall control of operations in response for the emergencies of flood and damage control for storms, including the coordination of evacuation and welfare of affected communities, is vested in the Commissioner of the State Emergency Service (SES).

Part of the role of the SES is to prepare local flood emergency sub plans. These plans detail arrangements for flood preparedness, response and recovery including the management of evacuation operations. They are considered to be sub plans to State Flood Sub Plan. Relevant plans for the Richmond catchment are shown in Figure 6-1.

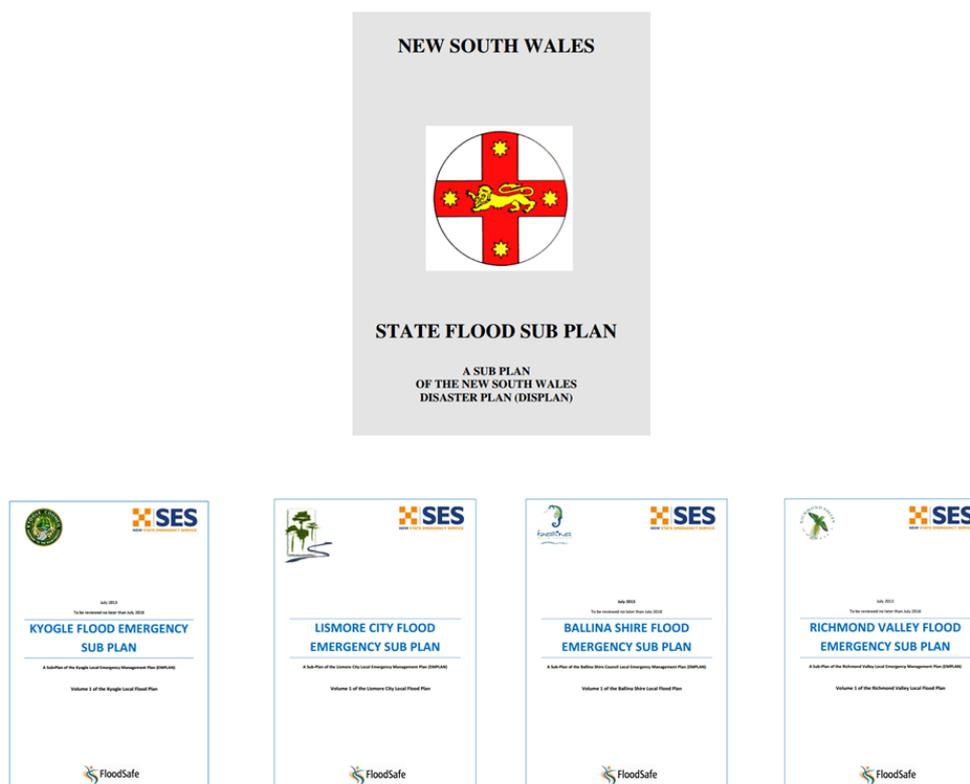


Figure 6-1 Relevant Flood (Emergency) Plans

6.2 Flood Evacuation

The NSW SES Richmond-Tweed Region Headquarters issues Evacuation Warnings and Evacuation Orders on behalf of all local SES units in the region. Existing flood evacuation arrangements within the Richmond Catchment have been summarised from the various flood emergency plans.

6.2.1 Lismore City Council LGA

The Lismore City Council LGA covers Lismore and a number of smaller rural towns including Bexhill, Clunes, Eltham, Nimbin, and The Channon.

Currently the SES evacuates all areas of Lismore, through the CBD to the Southern Cross University. North Lismore is evacuated first, followed by South Lismore and then the CBD itself.

Evacuation advice including relevant trigger levels are contained with the FloodSafe Brochures prepared for North Lismore, South Lismore, and the CBD.

The Lismore City Flood Emergency Sub Plan contains a second volume that details the flood threat. It provides indicative warning lead times based on gauge heights during a rising flood. It also provides details for at what gauge levels, the Browns Creek CBD levee spillway may activate (typically a gauge level of 10.6 to 10.7m AHD). The Plan details the potential consequences of overtopping in a 5%, 2% and 1% AEP event (11.3m AHD, 11.8m AHD and 12.4m AHD respectively at the Rowing Club gauge).

Specific advice on evacuation has been provided for the South, Central and Northern Lismore Sectors. The advice details trigger levels, evacuation arrangements and alternate evacuation centres.

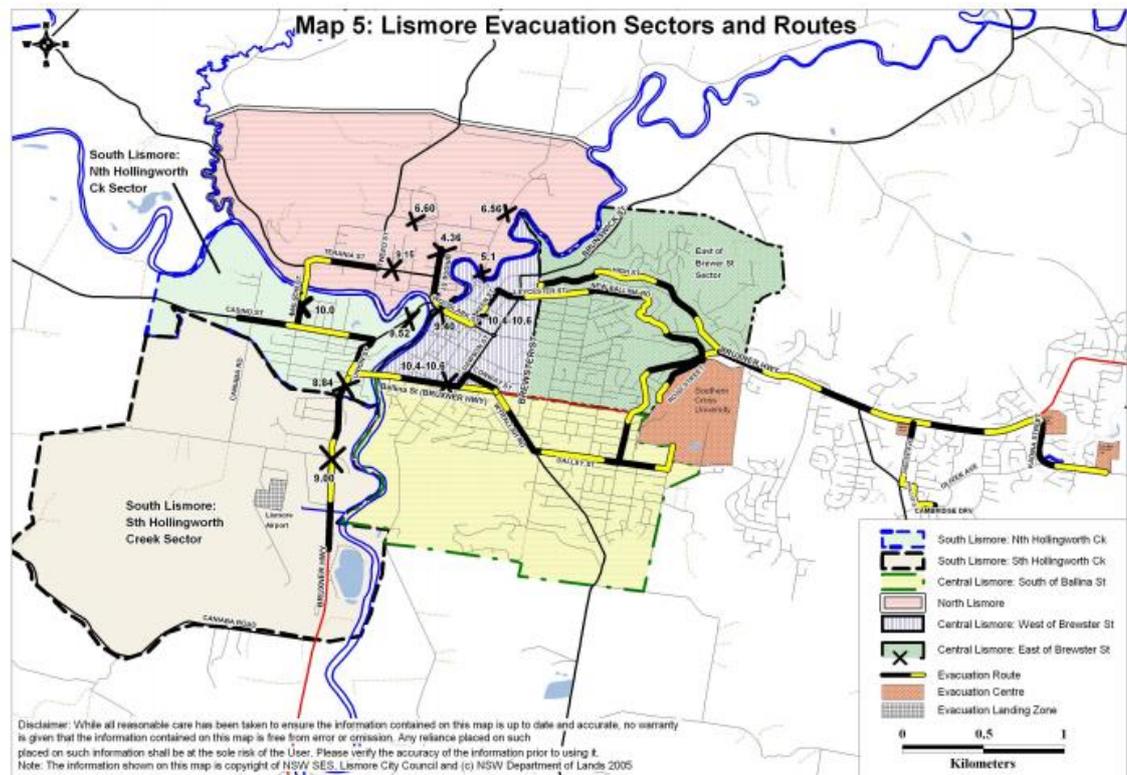


Figure 6-2 Central Lismore Evacuation Sectors and Routes (from Local SES Plan)

6.2.2 Richmond Valley Council

The SES maintains a headquarters at Woodburn with additional operations centres at Casino, Coraki and Broadwater. The Local Flood Plan states that there is a strategy to disseminate flood related brochures and booklets in flood liable areas. At the time of writing no such material is available online. It is recommended that this is undertaken for the principal communities at risk. A number of evacuation centres are listed in the plan. These are located in Casino, Coraki, Woodburn, Broadwater and Evans Head.

6.2.3 Ballina Shire Council

The SES maintains a local headquarters at Angels Beach Drive, Ballina. The Local Flood Plan states that there is a strategy to disseminate flood related brochures and booklets in flood liable areas. At the time of writing no such material is available online. It is recommended that this is undertaken for the principal communities at risk. The SES monitors the following problem areas:

- Cabbage Tree Island and its evacuation routes;
- Tintenbar Valley;
- Teven Valley;
- Meerschaum Vale;
- Wardell; and
- Uralba.

Aside from the Teven Valley flash flood warning system there is no formalised warning system for these problem areas or Ballina itself. Woodburn is the nearest gauge on the Richmond River for which flood warnings are supplied by BoM. The SES holds flood intelligence cards for Broadwater, Wardell and Ballina and provides Local Flood Advices. However the flood intelligence would be much improved with the implementation of a flood warning network.

Two evacuation centres are listed; Tintenbar Hall and Ballina RSL Club.

Volume 2 of the Flood Emergency Plan provides further detail on the hazard and risk. Of note it states that the aboriginal community on Cabbage Tree Island is the only community in the region which may require complete evacuation during major flooding (approximately 170 people). Evacuation is triggered by a flood level of 4.2m at the Woodburn gauge and this is equated to 1.4mAHD at the Broadwater gauge. Due to the relatively high level of risk it is recommended that flood warnings are provided specifically at Broadwater.

Further to the Local Flood Plan, the Ballina Floodplain Risk Management Study (BMT WBM, 2012) identified six distinct evacuation zones within the study area⁶ (Figure 6-3). These zones were identified based on consultation with the SES. The study identified that zones A, B, D and E are likely to have insufficient time for all residents to evacuate during a Probable

⁶ The study area extends from Empire Vale in the south to Ross Lane in the north and includes the major tributaries of North Creek, Maguires Creek and Emigrant Creek.

Maximum Flood (PMF). For zones C and F evacuation was assessed as being possible within the permitted times. A number of measures were put forward in the study to improve evacuation capability. These included:

- Improving the flood forecasting system (install a formal flood forecasting system);
- Improving the flood warning system (opting for fast warning methods and increased use of social media);
- Improvements to evacuation planning (checking viability of evacuation centres, sequencing of flood warning); and
- Improving community awareness (brochures, website information).

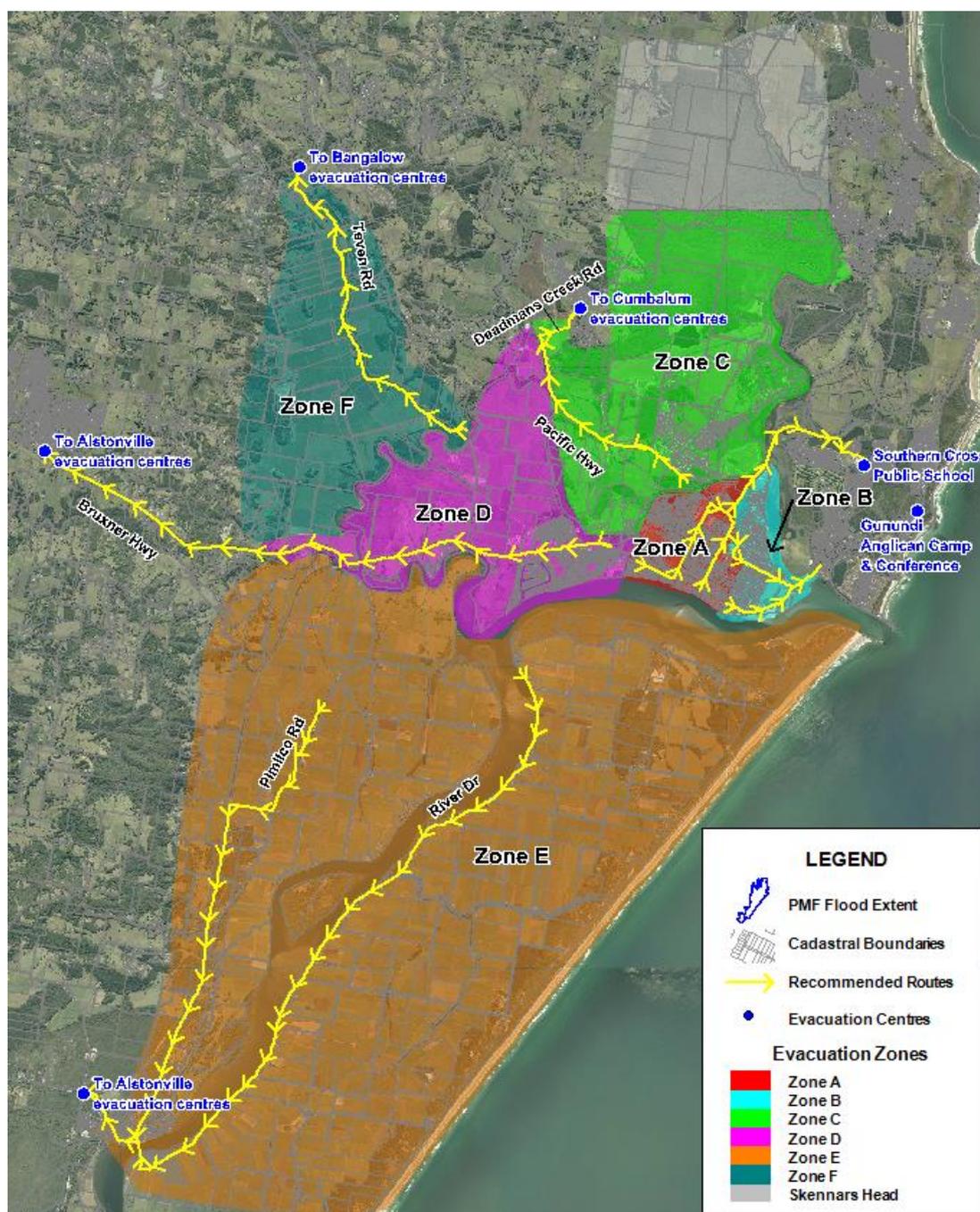


Figure 6-3 Ballina Evacuation Routes and Zones

6.2.4 Kyogle Council

The Kyogle Council LGA straddles both Richmond and Clarence River catchments. This summary relates solely to Richmond catchment. The SES maintains a local headquarters at Etrick Street, Kyogle. The SES monitors the following problem areas within the Richmond catchment:

- Fawcett Creek Bridge and 'The Flat', Kyogle;
- Various parts of Summerland Way;

- Lismore to Kyogle Road;
- Kyogle to Geneva Road (flood gauge height and road closures); and
- Kyogle to Kyogle Road at Fawcett Plain turnoff.

Evacuation centres are located at various locations within Kyogle.

6.3 Evacuation Map Styles and Content

It is important to limit confusion and ensure members of the community can easily identify evacuation routes to safer locations. A degree of standardisation of mapping across the region would assist in this regard, recognising that it may be necessary to add additional detail depending on the nature of the risk. It is recommended that the following information is included for all evacuation plans and that the presentation of these features is standardised across the region.

- Evacuation Zones (clearly identified by colour coding);
- Evacuation routes; and
- Public points of reference to aid local orientation e.g. the local library or park.

This list is not exhaustive and should be discussed between the SES and various local authorities.

7 Best Practice / Literature Review

7.1 Introduction

The concept of a ‘total flood warning system’ combines the science and communication elements with protective actions and system review (lessons learnt). The system is illustrated diagrammatically in Figure 5-1.

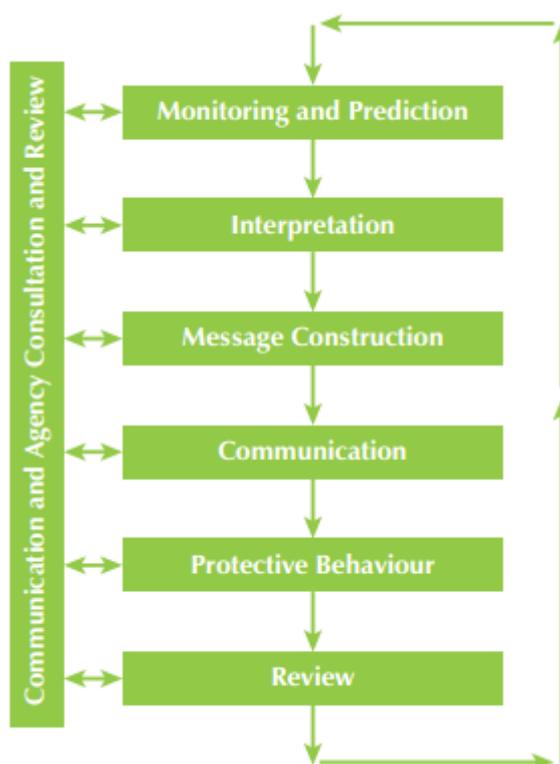


Figure 7-1 Components of the Total Flood Warning System⁷

This literature review focusses on the communication and behaviour aspects of the total flood warning system. Whilst significant sums of money may be invested in a network of flood warning gauges, it needs to be remembered that there is an important difference between provision of warning messages and individual capacity to understand and act on those messages.

7.2 Dissemination of Flood Warnings

Flood warnings can be disseminated by a wide variety of platforms including, door knocking, loudspeaker, siren, radio, television and in recent years, SMS and the internet and social media. In 2011, the Floodplain Management Association (FMA) prepared a submission to the Senate Standing Committees on Environment and Communications into: “Emergency communications – the capacity of communications networks and emergency warning

⁷ Reproduced from Australian Emergency Manuals Series: Manual 21 Flood Warning (Australian Government, 2009).

systems to deal with emergencies and natural disasters (FMA, 2011). The following points are noted from the FMA response.

7.2.1 Radio

Radio is perhaps the most common device used by residents when seeking information on a developing flood, particularly elderly residents. Broadcast operators should be encouraged to be proactive in disseminating warnings and should be required to receive regular briefings by emergency authorities to familiarise them with emergency systems, terminologies and operational procedures. An identified shortcoming of radio was the aggregation of local broadcasters to become part of a syndicated network of stations with broadcast content originating from a remote location. It was recommended that investment was made in technology to enable syndicated programs to be interrupted for real time emergency messages to be broadcast to a relevant local audience.

7.2.2 Television

Television, like radio, is a common method for distributing flood information. As for radio, the issue of syndication may limit the capacity or desire to issue local flood warnings. Television was also noted to focus on the dramatic and shocking events rather than providing the community with meaningful flood information.

7.2.3 Internet / Social Media

Internet access for households across Australia is growing rapidly. The Australian Bureau of Statistics (ABS) state that 7.3 million households in 2012-13 had internet access representing 83% of all households. Furthermore, 77% of all households had access to the internet via a broadband connection. Outside of the capital cities, the proportion of households with internet access was estimated at 79% compared to 85% within the cities.

The FMA notes that many individuals would now consider the internet their key method of locating further material on natural hazards. However shortcomings include the unreliability of transmitting stations during flood events, overload of websites by the volume of internet traffic during extreme events, and power failures. A recommendation is that mobile phone towers should be located above the PMF level wherever possible.

7.2.4 Phone and SMS

Flood warnings and information can be delivered via SMS (text messages) or short voicemails to targeted audiences. These have been successfully used for both flood and bushfire hazards. Call prioritisation was noted as a shortcoming. If a person is making an existing call, as they may well be doing in order to check/warn friends and relatives, then they will only receive the message after the call. A further shortcoming is that the warning will only reach residents and not necessarily visitors to the region.

7.3 Lessons Learnt

Lismore provides a relevant example that highlights the criticality of effective dissemination and understanding of flood warnings.

Best Practice / Literature Review

Lismore benefits from a fairly comprehensive network of automated river and rainfall gauges. Data is received in real time by BoM, Lismore City Council and the SES. The data is also available online. The SES aims to disseminate Flood Watches within 1 hour to the local community. Lismore also has a levee system protecting the CBD and southern parts of the town. The CBD levee system was completed in 2005 and has a design standard of protection of a 10 year ARI.

Significant recent flood events in Lismore have occurred in 2001, 2005, 2008 and 2009. During the flood of 2005 the gauge level at Lismore reached 10.2mAHD. The event was preceded by a Flood Watch issued well before the rain fell followed by quantitative flood warnings. Following a flood warning that predicted a flood height of 10.4mAHD, the SES warned approximately 5,000 people to evacuate as the levee, which protects the town, would come close to overtopping. The predicted flood level was since revised downwards and the wide scale evacuation order was cancelled leaving only 650 people to evacuate from North Lismore. However, only approximately 50 people were accommodated at the evacuation centre (Opper et al, 2007) with many that evacuated choosing to relocate to a friend's relative or neighbours residence and some residents staying in their homes.

The resulting flooding to North Lismore in 2005 was the subject of significant post event analysis. Post event feedback from the community indicated there was little understanding of the flood watch and a mixed response to the flood warnings until there were obvious signs of flooding (McKay 2006).

Key areas of confusion summarised by McKay (2006) were as follows:

- In 2005 the faster than usual rate of rise confused a number of people who used their own previous experience of Wilsons River floods to calculate how much time they had to respond based on the river level gauge.
- There was some confusion regarding floor levels and comparison to gauge levels. Whilst both were available to the same datum (mAHD) the confusion was due to some residents applying the same predicted gauge level to predicted flood levels elsewhere in Lismore i.e. not being aware of a significant gradient in water surface levels through Lismore.
- Many people did not prepare to evacuate when the 'prepare to evacuate' instruction was issued by the SES, only doing so when an evacuation order was issued.

Furthermore Opper et al, (2007) noted that the SES faced considerable uncertainty in 2005 due to:

- A new levee, not tested in any flood and for which the relationship between the various spillways and the key warning gauge, including the issue of flood gradient, were still being determined; and
- Uncertainty in the flood level predictions given that heavy rain was still possible.

Key recommendations put forward by McKay (2006) included providing the community with basic information such as to what extent their property is affected by floods and what they need to do when a flood occurs. He noted that flood level information provided to the public

needs to relate to the equivalent height at the nearest flood gauge for which predictions are available.

The issue of people basing their actions on their own previous experience of floods rather than heeding expert advice is not uncommon. When a flood exhibits different behaviour from a previous, memorable flood there is often the belief that the recent flood was not a 'normal' flood. In the 1998 British floods for example, the speed of onset of the flood caught people unawares and many flood victims were convinced that this was not a "natural flood", its rapid rise and fall being due to some negligent human action (Handmer, 2000).

To enhance the awareness and preparedness of NSW communities the SES has developed a comprehensive education strategy branded FloodSafe. The program has many components including brochures, newspaper supplements, media interviews, public meeting, displays and school visits. Brochures are tailored to local flood prone area and contain information on the local flood risk and how to prepare for and respond to floods.

What happens in Lismore CBD town floods?

12.25	Highest recorded flood, February 1954. Whole CBD flooded, many residents evacuated. No home resisted but today the degree of flooding would be similar to that experienced in 1954
12.14	March 1974 peak flood height
11.20	April 1989 peak flood height
11.05	Bruner Highway closed to all traffic (east and west)
10.60	Overlapping of the CBD levee will typically begin at this height. Overlapping will occur at the Browns Creek Spillway and central Lismore will begin to be flooded. All evacuation routes are lost after the levee overlaps
10.40	February 2001 peak flood height
10.20	June 2005 peak flood height
9.30	Major Flood Warning height
7.40	Lismore to Bargaloo Road cut at Livers Park. Lismore to Kyejale Road cut west of South Lismore levee
7.20	Moderate Flood Warning height
6.50	Brunswick Street near Trinity College Sports Fields closed
6.00	Approximate level at which CBD floodgates closure commences
5.10	Sines Bridge cut. Access to North Lismore via Sines Bridge lost
4.20	Minor Flood Warning height. Lower Rowing Club and Hensle's car parks become flooded

Key heights in metres (AHD) at Lismore Rowing Club gauge

The Bureau of Meteorology provides predictions of expected flood heights in metres (AHD) at the Lismore Rowing Club gauge based on received and forecast rainfall.
 SES Flood Bulletins provide information on what may happen at the predicted flood height and what actions are required to protect yourself and your property. It is important to know the height at which your business may be affected and when evacuation routes may close.

Prepare yourself

Some basic measures you can take right now include keeping a list of emergency numbers near the telephone and assembling an Emergency Kit.

Your Emergency Kit should contain at all times:

- A portable radio with spare batteries
- A torch with spare batteries
- A first aid kit with supplies for your business
- Candles and waterproof matches
- A waterproof bag for valuables
- Emergency contact numbers
- Copies of any business emergency plans

Your business should have a Business FloodSafe Plan. A copy of the 'Business FloodSafe Toolkit' is available on the SES website. Keep a copy of your 'Business FloodSafe Toolkit' handy and ensure that the Business FloodSafe Plan is complete and up to date.

You should decide where you will move stock and equipment to and how it will be transported. Keep backups of important records and store these in a flood-free location.

Check your insurance policy. Where possible ensure shop fittings can be easily moved or are able to resist water damage. Keep a supply of boxes to move stock and records if flooding is likely.

Every family and business should make an emergency kit



How the SES can help you

The State Emergency Service is responsible for dealing with floods in NSW. This includes planning for floods and educating people about how to protect themselves and their property.

During floods the SES will provide flood information, safety advice, evacuation, rescue and essentials to people isolated by floodwaters.

www.ses.nsw.gov.au

FOR EMERGENCY HELP IN FLOODS AND STORMS CALL THE SES ON
132 500

SES web site: www.ses.nsw.gov.au
 Lismore City SES: 02 6621 9400
 Lismore City Council (business hours): 02 6625 0500
 Lismore City Council website: www.lismore.nsw.gov.au
 (For road closure information and floor heights)
 Bureau of Meteorology website: www.bom.gov.au



Brochure printed February 2007



Protecting your business from a flood

Aerial view of Lismore during the June 2005 floods.

Lismore CBD Business

Figure 7-2 SES FloodSafe Brochure: Lismore CBD

Despite significant effort in community education and timely issue of flood warnings it is often quite difficult to get the flood community to respond. Dufty et al, (2012) note that in many cases, communities (or sections of communities) do not respond as expected and can react with apathy, and sometimes with anger or with total disregard for authority. It was noted that flood education, communication and engagement activities in the past have generally been based on the assumption that people will naturally convert risk awareness into preparedness behaviours such as preparing emergency plans. However, a direct relationship does not exist and there are other factors such as action coping, outcome expectancy, sense of community and self-efficacy that also determine preparedness.

The optimism bias or 'it won't happen to me' factor was evident in the Lismore 2005 flood where, following the event, only 6% of 192 respondents to a post flood survey believed that

flooding posed a threat to their personal safety at any point during the floods, even when their properties were being flooded (Oppen et al, 2007). This false sense of security is possibly enhanced by the levees in Lismore but for which a residual risk of overtopping will always remain.

Local authorities recognise that evacuation planning and education are seen as critical to averting disaster for residents and businesses in the CBD and nearby areas due to complacency about the flood risk and the level of levee protection (Moorhouse et al 2014). In the UK a 2008 flood awareness survey of 1,129 at risk respondents confirmed a widespread apathy and tendency for people to deny the risk and assume it will never happen to them (Pitt Review, 2008). The UK Environment Agency estimates that around 75% of people who receive a flood warning currently take some form of action. However this indicates that one in every four people aware of a flood warning do not take effective action.

In summary, despite Lismore having advanced and relatively accurate flood warning predictions along with a widespread flood education system and flood knowledgeable community, it still remains problematic in convincing people to heed flood warnings and evacuation orders. Despite the extensive community education program, only 32% of surveyed residents in Lismore indicated that flood information provided over the past few years influenced their decisions during the 2005 flood (Oppen et al, 2007).

7.4 Improving our flood intelligence

7.4.1 Flood Evacuation

Although Lismore's flood education and awareness programs are generally well regarded and received there is always scope for improvement. As discussed above, understanding people's behaviour during disaster response is complex and informed by many factors such as an individual's tendency or not to be risk averse, aversion to authority, physical and mental capacity, previous experience to name but a few.

Despite the challenge, successful flood warning and evacuation can happen on a large scale. In 1995, rising flood waters in the Netherlands meant that the security of the river dikes could no longer be guaranteed and 250,000 people were evacuated. The evacuation went smoothly and despite the dikes holding, evacuees were overwhelmingly satisfied with the decision to evacuate and with the conduct of the operation. In part this was due to heightened community flood awareness following a flood event two years prior and evacuation was also assisted by a relatively long warning time (Handmer, 2000).

Following the 2005 event, Lismore resident's suggestions for improving flood warning services included more extensive use of door knocking and more face to face information regarding the flood situation. It would appear that this face to face contact has a greater impact on people's decision making than information or instruction from other sources. It makes it 'more real'. However even with door knocking, some people will still make the decision not to evacuate. In New York, following the mandatory evacuation order preceding the landfall of hurricane Irene in 2011, ABC news estimated that more than 20% of people living in the mandatory evacuation zone had refused to move, despite police and city officials going door to door.

For a flood emergency response plan to be effective, the predicted water level on site needs to be referenced back to the location for which predictions are made by the Bureau of Meteorology or the relevant local authorities. Such information can be relatively easy to present if a modelling study exists and is a powerful way to convey flood information, recognising that the information is indicative and no two floods are the same.

The Western Downs Floodplain Risk Management Plan (BMT WBM, 2013) presented a series of maps showing estimated flood extents for different gauge heights at the main reporting gauge in Dalby (see Figure 7-3). Where floor level survey exists, the presented output can be improved to indicate at what gauge levels, roads and properties may be affected. An example of such a system was prepared for the SES at Tumbulgum (see Figure 7-4).

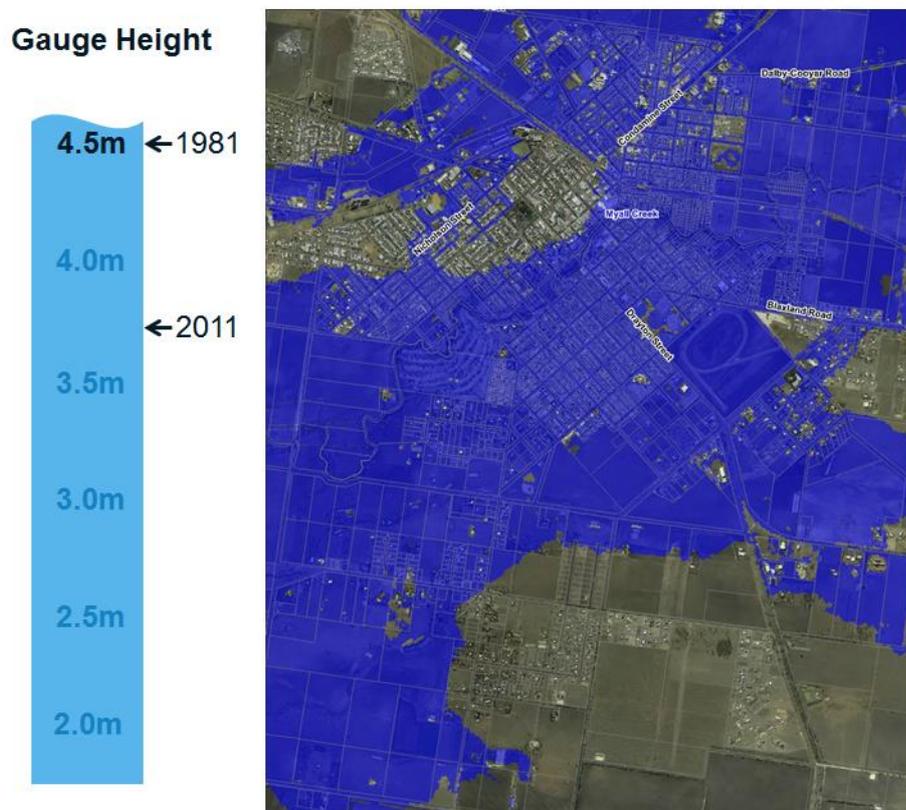


Figure 7-3 Predicted flood extents at nominated gauge levels (Dalby, Queensland)

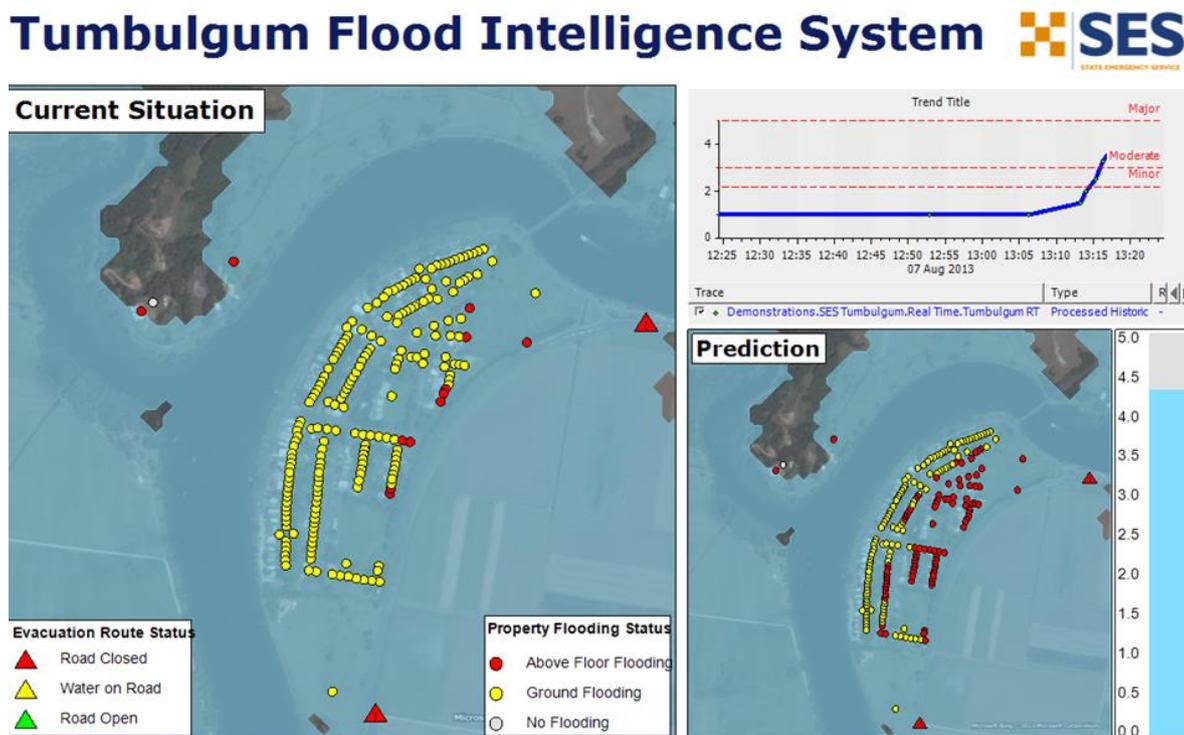


Figure 7-4 Tumbulgum Flood Intelligence System

7.4.2 Flood Education

Flood education is key in ensuring long term community awareness of flooding, particularly when there have been no significant floods in recent memory. Maintaining such awareness improves the ability of a community to respond to a flood event.

Research submitted to the UK's Pitt review into the 2007 floods (Pitt Review, 2008) indicated that children have the capacity to perceive high-risk, low probability disasters, such as flooding, and that they are able to communicate those risks in a way that can influence the actions of those around them. The review highlighted a pilot study undertaken by Essex County Council's emergency planning unit which involved working with a primary school and teaching children about the dangers of flooding through a week of fun activities spread across the whole curriculum. A second pilot was conducted in a secondary school and involved a day of learning about the role of different agencies in emergencies and ways of preparing. The pilots were well received and crucially, when tested a year after the events, the children retained much of the information.

The SES FloodSafe program (see section 7.3) provides information online for both primary and secondary schools which includes resource packages and case studies. The uptake by schools of this material is not known but based on the findings from the UK it should be encouraged.

Increasing the flood awareness of adults within the community can be facilitated using public participation exercises. One example from the UK has been to promote community memory of flooding by encouraging a community group to compile a diary of flood events over the

past 150 years; this 'picture of the past' is helping to raise local flood awareness (Pitt Review, 2007). Similar exercises have recently been undertaken in Dalby and Chinchilla in Queensland as part of the evidence gathering process to support the flood study.

Good practice, but something which is rarely done due to perceived implications on house values is to make home buyers and tenants aware of the potential flood risk and history of flooding as they are purchasing/leasing a property. Currently home buyers may only become aware of such issues when they go to purchase flood insurance and find their application is refused or subject to abnormal excesses. Communities may be strongly against such measures because of the aforementioned implications on house values. Perhaps this can only be overcome through changes in government policy and legislation. Where such obstacles exist, an alternative and frequently used approach is to provide flood markers, or totems at strategic locations within a community (Figure 7-5). Flood totems can form a significant focus for both community preparedness and flood warning. They can allow the SES to effectively communicate the expected peak level of a flood in a way that all can understand and readily apply to their own situation. This is in contrast to only reporting an expected river gauge level, which, for some residents, can be difficult to interpret in terms of flood risk at their property.



Figure 7-5 Temporary Flood Totem

7.4.3 Role of Social Media

Social media has great promise in providing insight into the psychological characteristics of flood affected communities (Dufty et al, 2012). They transform people from content consumers to content producers. Six main ways in which social media can be used in emergency management are:

- (1) Providing intelligence to emergency managers through 'crowdsourcing';

- (2) Engaging with people to help them prepare for events;
- (3) Providing information (e.g. warnings) to communities during events;
- (4) Providing support to people during and after a disaster;
- (5) Coordinating response and recovery; and
- (6) Post-event learning.

Handmer (2000) notes that informal personal networks may reinforce, undermine or deflect official communications. Any of these outcomes may be amplified through social media communications and so care needs to be taken that official messages promoted through social media are clear and concise so that they are not easily confused or misunderstood.

Due to its rapid uptake throughout the general population and continuing advancement it is worth discussing social media in more detail for its potential for use in flood warning, dissemination and awareness. Charlwood et al (2012) describe the use of social media during the flood events in Victoria in early 2011. Flooding in 2011 was the most significant on record for Victoria and the SES responded to more than 17,500 requests for assistance and over 320,000 individual Emergency Alert messages were issued. In a post event analysis using data extraction of key words Charlwood identified distinct social media behaviours.

- Overall the study found that the social media comments relating to the floods were rarely random or meaningless, and were generally highly informational and valuable in their content. The kind of ironic or cynical comment evident in many other topics in social media was not evident in commentary relating to the floods.
- One of the key social media behaviours evidenced was message spreading which comprised 43% of the total dataset. However most of this message spreading was in regard to the relief and donations with only 7.5% of the total dataset relating to spreading flood warnings. The author notes that this comparatively low proportion may have been due to lack of official agency use or social media warnings.
- During the floods, community members also established social media websites of their own accord to share information without involvement from emergency services. Some of these pages had several thousand 'fans' and high levels of engagement.
- A key social media behaviour identified was the strong willingness in the social media community to assist both official emergency management agencies and the wider community. This includes a willingness to spread official messages and further disseminate flood warnings.

The Charlwood study also noted general differences in the communication content depending on the type of social media platform being used. The study found that Twitter was most often used for spreading news, information and warnings whereas Facebook was most strongly used for commentary by people who were directly involved in the floods. YouTube was also used for posting eye-witness accounts of flood situations.

7.5 Summary

This literature review highlights a number of initiatives which have the potential to be implemented or improved within the Richmond River catchment. Some of these initiatives are direct feedback from previous flood events whereas others are borne out from emerging research. Some of the key aspects highlighted in the review are listed below.

- Flood education to promote awareness is a key factor in raising community resilience to flooding. Education of early age groups has been demonstrated to be effective and has long lasting community benefits.
- Residents should be made aware of the degree of flood risk to which their house may be exposed. This should include floor levels, guidance on their nearest flood level gauge including how the gauge level relates their house level and details on evacuation routes and centres. Home buyers and tenants should be made aware of this information when moving into a property at potential risk of flooding.
- It is key for the response agencies to have clearly defined roles and to provide consistent and reliable information during a flood. For information on, for example, gauge heights to be effective, it needs to go hand in hand with long term flood education and awareness initiatives.
- Social media has an increasingly important and rapidly evolving role in increasing flood awareness and aiding in the event itself. Effective use of the main social media platforms to disseminate flood warnings and information should be maintained and advanced wherever possible.

No matter how effective a flood education and awareness is, there will always be a proportion of the general population that fails to evacuate, either by choice or impediment. This issue may be particularly acute in flash floods where warning times are less than 6 hours. An important part of the pre event planning is therefore to allow for a rescue contingency. Rescue is not an alternative to evacuation but is an outcome of failing to evacuate (Oppen et al, 2011).

8 Community Engagement Strategy and Plan

The shift from an RVD to AHD datum presents a risk of misunderstood flood warnings and delayed flood response. Real or predicted flood levels quoted in AHD will appear to be more than 80cm lower than levels quoted in RVD and hence appear to be a less serious threat. It is recommended that the risk of misunderstanding is minimised via a comprehensive education campaign (e.g. 10m AHD = 10.8m RVD).

The following communication plan has been developed in consultation with the Richmond-Tweed SES.

The plan has been structured into three distinct phases to address the introduction of the gauge boards, the transition period when both datums are used, and the future, when only the new datum will be used.

- **Introduction phase.** The most important and intensive phase of the campaign will be prior to the installation of new gauge plates. This phase will focus on explanation of the changes, including how information about the new datum can be accessed.
- **Transition phase.** The transition phase exists as a bridge between the introduction phase, which introduces the new datum, and the future phase, when only the new datum is quoted. During the transition phase, both datums will be quoted. This will need to be workshopped with the BoM who have expressed a preference to only display warnings to one datum.
- **Completion of transition phase.** The completion of the transition phase will be used to confirm to the general public that future gauge readings will only use the AHD datum, and the RVD datum will no longer be quoted. Ongoing passive information will be provided to assist with gauge translations.

It is essential that the campaign message is delivered to all residents within the Richmond Valley community in a way that is engaging, easily accessible and suitable for the end-user's needs. To better target the messages, four audience sectors have been identified:

- **General public**, including sub-groups including businesses, schools, community groups such as lions and rotary, the indigenous population, and farmers;
 - **Frequent lay users** of the gauge boards, particularly residents in rural or remote areas who are likely to read gauge boards directly;
 - **Emergency responders**, primarily the SES, but also key members of Council and other support agencies such as Department of Community Services (DoCS) who may be involved in planning for and responding to flood events; and
 - **The media**, including regular print, radio, television and online outlets.
- There are a number of underlying aims for all aspects of the education campaign:
- Raising awareness of gauge plate design (which gauges have been changed and which ones remain unchanged), including how to identify the different gauge plate designs;

- Identifying the AHD equivalent flood levels of historic floods; and
- Publicising where information about the change can be found.

To achieve these aims, the general messages must be tailored to each identified target audience and modified for each phase of the campaign, provided in Table 8-1.

The delivery of these messages will also change to reflect the needs of the audience and the phase of the campaign. Richmond-Tweed SES has identified a suite of general awareness measures which they typically use to target the general public, shown in Table 8-2. These measures are further refined for sub-groups within the community, such as businesses, schools and farmers [NB: the SES has indicated they will refine these measures further to include targeted measures for community groups, such as Lions and Rotary, and for the indigenous population].

In addition to the general awareness measures typically used by the SES a number of additional measures have been recommended for inclusion in this particular campaign, which are modified for each target group and phase of the campaign. These measures are provided in Table 8-3.

A review and feedback process has been built in to the campaign to ensure that the campaign can be modified if necessary. During the transition phase of the campaign, the general public measures will include information regarding how to provide feedback on the new gauge datums. It is recommended that the SES collect this feedback and in conjunction with their own observations of community response and understanding, decide with Council how long the transition phase should last, and whether any additional measures are required to ensure that the changes are well understood.

Table 8-1 Education Messages

Target Audience	Introduction Phase	Transition Phase	Completion of Transition Phase
General public	<ul style="list-style-type: none"> Datums are being changed in a number of locations Why they are being changed Which locations are changing How the changes will impact flood emergency planning, including warning messages How to access information about the datum changes Levels will be quoted in both datums during the upcoming transition phase 	<ul style="list-style-type: none"> Abbreviated version of the introduction phase messages Reminder that during the transition phase both datums will be quoted Reminder that the transition is for a limited period How to provide feedback on the transition 	<ul style="list-style-type: none"> Gauges will henceforth be reported using the new datum. Where to find information about the datum changes
Frequent (lay) users of gauge boards	<ul style="list-style-type: none"> As for the general public plus detailed information about the local gauge (e.g. a figure showing conversions) 	<ul style="list-style-type: none"> As for the general public 	<ul style="list-style-type: none"> As for the general public
Emergency responders	<ul style="list-style-type: none"> As for the general public plus information about what internal documents will be changing, where to access the information and what actions are required to brief the public / media etc. 	<ul style="list-style-type: none"> As for the general public plus reminders to assess and report on the effectiveness of the transition 	<ul style="list-style-type: none"> As for the general public plus details about internal documentation
Media	<ul style="list-style-type: none"> As for the general public, plus emphasis on the importance quoting the gauge datum and using the transition phase media release template 	<ul style="list-style-type: none"> Reminder of the importance of quoting the gauge datum and using the transition phase release template 	<ul style="list-style-type: none"> Reminder of the importance of quoting the gauge datum and using the post-transition phase media release template

Table 8-2 General Awareness Measures (source SES)

Target Group	Strategies	Responsibility for delivery	Responsibility for funding
Businesses	Business Breakfasts	Council/SES	Council
	Door knocks	SES	SES
	Chamber of Commerce BAH	SES	Council
	Chamber of Commerce Newsletters	Council/SES	SES
Schools	Newsletter inserts	Council	Council
	Bus Company Morning Tea/Education	Council	Council
	Meeting with School Education Directors from Public Schools and Catholic Education systems	Council/SES	SES
Community	Community meetings in key areas	Council/SES	Council
	Door knock in high risk flood areas	SES	SES
	Include info on Council websites	Council	Council
	Community BBQs in high risk areas	SES	Council/SES
	Include info in Rates notices	Council	Council
Farmers Broadwater Sugar Mill, NSW Farmers Association, Cattle Farmers	DPI newsletters	Council	Council
	Community meetings – Piggy back onto existing DPI community meetings	Council/SES	Council
Media	TV ads	Council	Council
	Radio interviews/ads	SES/Council	Council
	Ads in papers	Council	Council

Table 8-3 Targeted Awareness Measures

Target Audience	Introduction Phase	Transition Phase	Completion of Transition Phase
General public	<ul style="list-style-type: none"> • Tied to general awareness measures • • Media outlets • • Council's website 	<ul style="list-style-type: none"> • Same as introduction phase 	<ul style="list-style-type: none"> • Media outlets • • Council's website
Frequent (lay) users of gauge boards	<ul style="list-style-type: none"> • Doorknocking (supported by pamphlets) 	<ul style="list-style-type: none"> • Mail out 	<ul style="list-style-type: none"> • Mail out
Emergency responders	<ul style="list-style-type: none"> • Information session • • Provide users with hard copy information with conversions between datums and map of updated gauge boards • • Update flood intelligence / awareness cards 	<ul style="list-style-type: none"> • Information session 	<ul style="list-style-type: none"> • Information session
Media	<ul style="list-style-type: none"> • Media briefing • • SES to update media release template for transition phase 	<ul style="list-style-type: none"> • Mail out 	<ul style="list-style-type: none"> • Media briefing or mail out • • SES to update media release template for post-transition phase

9 Flood Information Website

As the internet has become more accessible, particularly via mobile devices, emergency responders and the public are using the internet to access flood related information. Flood information can be categorised as:

- Planning and building – this is information relating to design flood behaviour and/or historic flood information. Users will typically use this information for planning purposes.
- Preparedness, response and recovery – this information is intended to empower the community to better prepare for flooding, respond appropriately when flooding occurs, and assist with recovery once flood waters have receded.
- Flood warnings and real-time data – this information is generally accessed immediately prior to, or during, a flood event. Real-time data are the observation recorded throughout the rainfall and river gauge monitoring network, as well as via radar.

The concept of a ‘one-stop-shop’ for flood information has been discussed amongst the Richmond River flood management stakeholders for many years. A website has been produced for Richmond Valley Council, which contains the published flood mapping for the Richmond.

9.1 Rural Flood Hazard Mapping

In a large, largely rural catchment there is significant potential for towns and villages to become isolated in times of flooding. The isolation may continue to some degree following a flood due to damage to roads and other infrastructure. Much of the Richmond Catchment downstream from Kyogle and the Wilsons catchment downstream from Lismore has relatively detailed flood mapping available which can be used to identify communities which may potentially become isolated during large flood events. Furthermore Lismore City Council have undertaken additional flood hazard mapping across rural areas using relatively coarse scale modelling to gain a broad understanding of flood hazard in the area. It is recommended that a similar exercise is also undertaken for other parts of the Richmond catchment with limited or no flood mapping, particularly for the communities upstream from Kyogle.

The outputs from such a mapping exercise would assist with understanding the flood hazard, speed of onset of flooding, evacuation constraints and assist with the planning of resupply operations.

10 Recommendations

Recommendations have been circulated amongst the Committee within the three discussion papers. The feedback received has been used to refine the recommendations as presented here. The recommendations are provided categorised into the following themes:

- Monitoring (implementation by: BoM, OEH and RRCC)
- Flood Forecasting and Warning (implementation by: BoM)
- Flood Response (implementation by: SES, RRCC and Councils)
- Community Education and Flood Information (implementation by: SES, RRCC and Councils).

10.1 Monitoring

10.1.1 Gauge Datum (GD)

The following recommendations relate to the gauge datum conversion.

- GD1 – Conversion of the gauge datum at the locations listed in Table 10-1. This refers to the presentation of data on existing internet sites. Note that clear reference to data being relative to AHD is recommended and where practical, water levels are presented in RVD and AHD. RRCC shall coordinate implementation by BoM, recognising that the MHL site already shows data in both datums.

Table 10-1 Recommended gauge datum conversions

Gauge Name	BoM Gauge No. (AWRC No.)	Existing datum	Proposed datum for data
Bagotville Barrage		RVD	AHD
Ballina RSL		RVD	AHD
Broadwater		RVD	AHD
Bungawalbin Junction	58184 (203450)	RVD	AHD
Byrnes Point	558044 (203461)	RVD	AHD
Codrington – Bailey Lane		RVD	AHD
Coraki	058175 (203403)	RVD	AHD
East Gundurimba	558047 (203427)	RVD	AHD
Emigrant Creek Boat Ramp		RVD	AHD
Iron Gates	203475	RVD	AHD
Lismore (Dawson Street)	558087	Assumed	AHD
Missingham Bridge	203465	RVD	AHD
Richmond River at Oakland Drive	203470	RVD	AHD
Rocky Mouth Creek	558054 (203432)	RVD	AHD

Swan Bay		RVD	AHD
Tintenbar Road Bridge		RVD	AHD
Tucombil Canal Floodgates	558057 (203434)	RVD	AHD
Tucombil Highway Bridge	558058 (203480)	RVD	AHD
Tuckurimba (Baxter Lane)	558076	RVD	AHD
Wardell	203468	RVD	AHD
Woodburn	058061 (203412)	RVD	AHD
Woodburn – SES Headquarters		RVD	AHD

- GD2 – It is recommended to install AHD gauge plates at the locations listed in Table 10-2. The existing RVD gauge plates shall remain at these locations indefinitely. The new AHD gauge plates shall be yellow with black text as per design shown in Section **Error! Reference source not found.** RRCC shall coordinate implementation with OEH.

Table 10-2 Recommended AHD gauge plate installations

Gauge Name	BoM Gauge No. (AWRC No.)
Bagotville Barrage	
Ballina RSL	
Broadwater	
Coraki	058175 (203403)
Emigrant Creek Boat Ramp	
Evans River Fishing Co-op	558048 (203462)
Lismore (Dawson Street)	558087
Lismore (Rowing Club)	058176 (203904)
Missingham Bridge	203465
Tintenbar Road Bridge	
Wardell	203468
Woodburn	058061 (203412)

10.1.2 Proposed River Gauges (RV)

Additional river gauges are proposed at the following locations. RRCC shall coordinate implementation with OEH.

- RV1 – River Gauge at Tatham
- RV2 – River Gauge on Emigrant Creek at Ballina

- RV3 – River Gauge on North Creek at Ballina

10.1.3 Proposed Rain Gauges (RN)

Additional rain gauges are proposed at the following locations. RRCC shall coordinate implementation with OEH.

- RN1 – Rain gauges throughout the Upper Richmond River catchment (up to 4)
- RN2 – Rain gauges throughout the Bungawalbin Creek catchment (up to 4)
- RN3 – Rain gauges throughout the Emigrant and North Creek catchments (up to 3)

10.2 Flood Forecasting and Warning

10.2.1 Additional Flood Forecasts by BoM (FF)

To improve emergency response and community preparedness, it is recommended that the BoM provide additional forecasts at the following locations:

- FF1 – Tatham (level and timing)
- FF2 – Goolmangar (classification)
- FF3 – Bexhill (classification)
- FF4 – Wardell (level and timing)
- FF5 – Ballina (level and timing)

10.2.2 Flood Warning Wording (FW)

- FW1 – To reflect the changed datum from RVD to AHD, additional text shall be included in the BoM's flood warnings to reflect the difference.

10.3 Flood Response

10.3.1 Flood Intelligence (FI)

The following recommendations are provided in relation to flood intelligence.

- FI1 – SES update of Flood Intelligence Cards to Flood Action Cards. This is the responsibility of the SES.
- FI2 – Mapping of flood consequences (i.e houses affected by flooding for different gauge levels). This can be included on the interactive flood website.
- FI2 – Communication of flood consequences i.e gauge level of Xm will result in inundation of properties along Y road. This can be included on the interactive flood website.
- FI4 - Use existing flood models to develop dynamic flood intelligence systems. The systems will incorporate information on property floor levels (where they exist) and use flood modelling to relate gauge levels to indicative flood levels at properties. Lismore has this already to some degree but rather than being linked to a flood model, the intelligence is based on fixed model

output. Use of the dynamic system would allow for any combination of events to be modelled and should greatly assist with evacuation planning.

It is recommended that a similar system is developed using existing modelling for Kyogle, Casino, and Ballina. All systems should be designed in conjunction with the SES to ensure the potential benefits of the system are maximised.

10.3.2 Post Flood Review (FR)

Following each flood event, local Councils shall conduct an information gathering exercise to collate and store flood information for future reference.

- FR1 – Collect flood information following each flood event for review and refinement of flood warnings
- FR2 – Collection of flood information in a central database

10.4 Community Education and Flood Information

10.4.1 Community Education (CE)

- CE1 – It is recommended to implement the Community Engagement Strategy and Plan presented in Section **Error! Reference source not found.**

10.4.2 Flood Information (FL)

- FL1 – The website being developed for this project shall be implemented, including interactive flood mapping for the whole Richmond River catchment.

10.4.3 Rural Flood Hazard Mapping (HM)

Rural flood hazard mapping is recommended for the following locations. These works shall be coordinated by RRCC and/or local Councils.

- HM1 – Bungawalbin Creek – the mapping extents shall extend the current flood mapping upstream to Rappville and Whiporie.
- HM2 – Upper Richmond River – the mapping extents shall extend upstream from Kyogle.

10.4.4 Evacuation Mapping (EM)

- EM1 - It is recommended that flood evacuation plans and maps are standardised across the region. The consistency will benefit community education programs and people that transit through or move around the region. The standardisation will also assist SES volunteers when resources are shared between units during different events.

11 References

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Appendix A Minutes of Committee Meetings

RICHMOND RIVER VALLEY FLOOD WARNING AND EVACUATION PLANNING SYSTEM

Committee Meeting 1 Minutes 13th May 2013

Meeting Chairperson	Michael Wood (MW)
List of Attendees	Bill Moorhouse (BM) – RRCC Mel Mapstone (MM) – SES (Lismore City) Lindsay Matterson (LM) – SES (Lismore City) Phil Lalor (PL) – SES (Richmond Tweed) Janet Pettit (JP) – SES (Richmond Tweed) Paula Newman (PN) – Lismore City Council Toong Chin (TC) – NSW Office of Environment and Heritage (OEH) Paul Busmanis (PB) – Ballina Shire Council Brian Eggins (BE) – Richmond Valley Council Mark Hopper (MH) – NSW Office for Water Ben Caddis (BC) – BMT WBM
Apologies	Jim McCormack (JM) – SES (Richmond Valley) Gerry Burnage (GB) – SES (Ballina) ?? - Kyogle Shire Council

Discussion and Action Items

Item	Notes	Actions
Introductions	<ul style="list-style-type: none"> • Introductions by Michael Wood 	
1. Current Mapping by BMT WBM	<ul style="list-style-type: none"> • BC gave a brief overview of flood mapping in the Richmond Valley. Key points are: <ul style="list-style-type: none"> ○ During the past 18 months, all previous flood models throughout the Richmond Valley have been combined and homogenised. ○ This reduces the uncertainty of mapping at the boundaries of previous flood models, thus providing a consistent output. Also rural areas between previous urban models have been mapped. ○ Model is modular in form, so areas can be isolated for reducing simulation times when only interested in a certain area. ○ Mapping now covers whole floodplain from Kyogle to Ballina, Lismore to Coraki, Evans River and Evans Head, Newrybar Swamp, Nimbin to Lismore, Eltham & The Channon 	BMT WBM to deliver all flood mapping by end of June 2013.
2. Datum LWOST, Richmond Datum, AHD	<ul style="list-style-type: none"> • MW opened discussion around consistency of gauge datums throughout the Richmond Valley. BM issued a list of non-tidal gauges including parameters measured and datums. Currently the following datums are used: <ul style="list-style-type: none"> ○ RVD – Tidal areas, as monitored by MHL ○ AHD – Lismore and most gauges in the Wilsons River ○ WRC – Water Resources Commission Datum at Toonumbar Dam ○ Assumed datums for various gauges throughout the Wilsons River and Upper Richmond • MH advised that the Office for Water had surveyed most gauges to establish height difference between gauge datum and AHD. MH clarified 	Mapping to be created by appointed Consultants

	<p>that reporting was still relative to gauge datum, not AHD.</p> <ul style="list-style-type: none"> • MH advised all rating curves currently relative to gauge datum, and advised they had no plans to change to AHD, although could see the benefits. • A move towards an AHD approach was supported and agreed by all attendees. • BM questioned whether to leave 2 gauge plates in-situ at each location; 1 for AHD and 1 for historic datum. BM showed examples of gauge plates with red and black numbering that could be used for each. Alternative ideas discussed and presented in photos were different sized numbering. • BM noted that Kyogle want to keep using the local datums, as well as AHD. • BE advised that RVC would support AHD approach as their property survey was all relevant to AHD. • PL noted the need for consistency • All agreed that any shift towards AHD would require significant community education. • TC noted that community will need some time to transition and suggested about 2 floods. 	
3. Gauges	<ul style="list-style-type: none"> • BM presented a map showing gauges downstream from Woodlawn and Tuncester. • TC suggested mapping all gauges and noting all datums used. • BM agreed that the objective of this project was to deliver such mapping. • TC also suggested identifying where BoM provide warnings. • LM questioned about gaps between gauges. • BM noted some gauges important for modelling, but not necessarily for the SES • PL advised that gauging was an issue state-wide, particularly responsibility for maintenance. • MW noted there were 3 separate gauge plates in Browns Creek. • BM said there were 2 in the Browns Creek car park. • PB noted that the Ballina Floodplain Risk Management Study had identified shortfalls in gauges around Ballina. • PB also noted that Gerry Burnage (Ballina SES) currently uses the only 2 gauges in Ballina • PB noted that BSC wish to improve predictive tools for aiding SES. • BE noted there is a 7m fall in levels across Casino, so community education was critical. • MW commented that the Insurance Industry was working off existing mapping, but in some areas they were incorrectly informed, such as Evans Head. • BM commented that insurance premiums will dictate who can live where, i.e. South Lismore. • JP enquired whether each Council had a community liaison officer / rep.whom she could work with. All Councils agreed. 	BE, PB, PN to provide contact details of community liaison officer / rep. to JP
4. Flood Warnings	<ul style="list-style-type: none"> • MW praised the BoM for warnings previously provided. • PL & JP identified the need for providing local context to BoM predictions. • PB? noted the BoM do not make predictions downstream from Ballina 	
5. Review of	<ul style="list-style-type: none"> • BM noted that reporting locations are based on history (i.e. pre-Lismore levee). There is a need now to report at critical locations (i.e. 	PL to provide all

format of warnings	<p>levee overtopping locations).</p> <ul style="list-style-type: none"> • BM suggested requesting the BoM to provide forecasts at the critical locations to reduce the need for interpretation. • MW & BM noted the need for a river gauge at Browns Creek. • BC noted that a rating curve would be required to be able to make level predictions at the critical locations. • MH advised you'd need to have a new gauge at the critical locations, as BoM will only predict levels for gauge locations. • ?? noted this project provides an opportunity to raise this issue with the BoM. • MW? Noted that Gordon McKay (BoM) was willing to assist. • TC noted that 1989 flood was ~100yr in Leycester Creek, so it is important to recognise the difference in flood behaviour between floods. • BM noted that Lismore mapping for evacuations was preferred. • LM noted that the Lismore Flood and Floor Levels book was invaluable during a flood. • BC requested from the SES locations where SES Flood Intelligence Cards were available. • PL advised all gauge locations. PL advised that FICs could be provided. • PL advised that FICs can have actions for inclusion of specific information in warnings. • BE commented that the FICs refer to Minor / Moderate / Major. Would be good to fit flood return periods in as well so that mapping can be used to estimate flood extents for that particular gauge level. • BE noted that RVC were developing a 'one-stop-shop' website for flood information in the RVC LGA. • PL noted that this committee / project will provide a good opportunity to update Emergency Plans. • TC mentioned the MyRoads website was a good source of info on road closures. • BM noted the need for hard copy mapping and documents as power is often cut during events. • PL noted the importance for awareness of the difference between resilience and community reliance. • LM stated that evacuation routes need road heights. LM questioned who has this info. • MW and BC advised this info was currently available from aerial / ground survey throughout the Richmond Valley. This information needs to be published in a suitable format. 	<p>Flood Intelligence Cards for Richmond Valley.</p>
6. Education and Evacuation Planning	<ul style="list-style-type: none"> • All agreed that this item had been covered in previous discussion. 	
7. Other Opportunities	<ul style="list-style-type: none"> • All agreed that this item had been covered in previous discussion. 	
8. Points not raised above	<ul style="list-style-type: none"> • None identified 	
9. Closure & Next Meeting	<ul style="list-style-type: none"> • The next meeting is scheduled for 11am on Friday 14 June 2013. • BoM and MHL are anticipated to be in attendance. 	

RICHMOND RIVER VALLEY FLOOD WARNING AND EVACUATION PLANNING SYSTEM

Committee Meeting 2 Minutes 14th June 2013

Meeting Chairperson	Michael Wood (MW)
List of Attendees	Gordon McKay (GM) – Bureau of Meteorology Kaylene Jones (KJ) – SES (Richmond Tweed) Mel Mapstone (MM) – SES (Lismore City) Lindsay Matterson (LM) – SES (Lismore City) Janet Pettit (JP) – SES (Richmond Tweed) Wayne Pettit (WP) – SES (Richmond Tweed) Jeff Spash (JS) – SES (Richmond Tweed) Paula Newman (PN) – Lismore City Council Toong Chin (TC) – NSW Office of Environment and Heritage (OEH) Mark Hopper (MH) – NSW Office for Water David Griffin (DG) – Manly Hydraulics Laboratory Ben Caddis (BC) – BMT WBM
Apologies	Bill Moorhouse (BM) – RRCC Paul Busmanis (PB) – Ballina Shire Council Brian Eggins (BE) – Richmond Valley Council

Discussion and Action Items

Item	Notes	Actions
Introductions	<ul style="list-style-type: none"> Introductions by Michael Wood 	
Previous Minutes	<ul style="list-style-type: none"> KJ noted she may raise some questions throughout the meeting since she was not present at the first meeting GM noted a type on page 3 – should read ‘to Ballina’ The minutes of Meeting Number 1 were accepted by all 	
	<i>Generally, the agenda was not followed. Rather everyone around the table was given a chance to raise concerns and ideas regarding the project, opening up general discussion</i>	
RRCC	<ul style="list-style-type: none"> MW initiated the discussion regarding datums and proposed move to AHD. The project intent is to: <ul style="list-style-type: none"> Review gauges and align datums to AHD Develop a website to collate and distribute all flood related information 	
BOM	<ul style="list-style-type: none"> GM noted: <ul style="list-style-type: none"> he’d originally objected to the AHD move in Lismore as it ‘changed the goal posts for the community’ it is not a level pool across a gauged area the best thing for the community is knowledge of historical flood levels BoM do not object to changing to AHD so long as effectiveness of service is not reduced Change would be required across the board (websites, gauges, etc) With respect to warnings, often people think they know better and 	

	<p>chose to ignore the warnings</p> <ul style="list-style-type: none"> • GM noted a bad example of datum change was in Kempsey, where the adjustment was about 0.5m. During the Albury FMA conference, there was a flood and the local controller confused the datums and hence the scale of the flood event • GM noted good examples were Taree and Maitland
MHL	<ul style="list-style-type: none"> • DG noted that within MHL there was a push to move to AHD • TC questioned whether it was only the Richmond Valley that used datums other than AHD • MH and DG advised Tweed also used alternative • DG advised that only Ballina would not change to AHD due to: <ul style="list-style-type: none"> ○ All NSW river entrances are in LWOST ○ Navigation ○ Negative tide levels not acceptable for navigation • BMC later clarified whether 'Ballina' was just the River Entrance tide gauge, and not Missingham Bridge and Burns Point • DG confirmed just the tide gauge • DG noted that change would be more than a few events, but rather a generation • MW noted that has previously had an extensive education campaign regarding this
Office of Water	<ul style="list-style-type: none"> • MH advised that OW were not keen to move to AHD as it would affect: <ul style="list-style-type: none"> ○ Ratings ○ Data ○ Gauges • MH noted there's be lots of work to change, but they would do if required • GM noted that above the tidal pool, 20m gauge level generally corresponds to 20m in the river, so it has a meaning. In upstream areas, levels such as 85m were meaningless
SES - KJ	<ul style="list-style-type: none"> • KJ noted she didn't see value in change above the tidal pool • KJ noted there is a need to show a clear correlation between new datum and historical datum • KJ also noted the change could be very risky for the community • DG noted it was particularly important as the level is being moved down, i.e. a 5m flood level would become a 4.2m flood, which could give the community a false sense of security • MW emphasised community education must be a combined effort as funding is limited • JS questioned how much funding is being set aside for community education. An indication of budget could be helpful as JP knows costing for brochures and other material • JS noted that in the past, funding has run out, such as during 2001 in Lismore. This must be avoided • MW noted RRCC will ensure there is always funds for flood education • DG stated that such a change must be a 'one-off' • MW noted that education must continue throughout droughts • PN identified that the farming community needs to be targeted • KJ agreed that there needs to be consistent messages and they need to be targeted • PN emphasised that the farmers are local experts, and their knowledge is valuable • TC advised that education was a critical aspect of this project as

detailed in the funding application

SES - JS

- JS noted that history is generally 'tied' to a gage, and when gauges are moved then a lot of intelligence is lost. Moving gauges is not a good idea. Barneys Pt in the Tweed is an example where a gauge was moved and the history was lost
- MW confirmed that there was no plan to move any gauges
- PN, MW and others all noted the need for more gauges
- MW identified the need for a gauge at Tatham and Kyogle Shire Council want more gauges
- GM handed out a list of gauges BoM use, including their priority for FW ops
- KJ identified that Casino is a problem as the telemetered gauge is downstream of the historic bridge
- GM agreed that Casino was a problem, but it could be changed
- JS enquired whether there was funding for new gauges and who is responsible
- MW raised the issue regarding maintenance and who was responsible
- JS noted the urgent need for gauges at Ballina as there's lots of issues at Ballina
- JS also noted the need for a gauge at Tatham as per MWs earlier comment
- MW noted that OW have their own budget for gauges and OEH fund the tidal pool gauges operated by MHL
- GM noted that 'no-one' accepts the responsibility for maintenance
- GM quoted a cost of \$10k - \$20k for a new gauge, although tended towards \$30k where vandalism was a problem
- GM quoted \$4k - \$5k per gauge per year for maintenance
- MW highlighted a gauge was once stolen from the Tuckombil Canal MW advised that this project will prepare a budget for new gauges, including how, who and when

SES - LM

- LM commented on the pseudo gauge at Browns Ck which has a digital readout. LM advised this was generally good
- MS noted it wasn't that good when everyone is out watching it
- LM noted that evacuation times are reduced as people first wait to see what happens
- GM commented about webcams for Council's website
- LM noted that the Dawson St camera is excellent for overland runoff
- LM noted the need for an additional gauge at Browns Ck
- PN supported this
- MW advised RRCC are looking into that
- DG noted that there was so much importance given to the rowing club gauge in Lismore, but there was no redundancy. The community is becoming so reliant upon data. The farmers are even watching the data
- DG highlighted the need to address redundancy in the system
- DG identified that there is variability in levels, therefore the variability needs to be communicated
- MS advised the SES also have 'spotters'
- LM added that the SES also have wardens amongst the community
- GM noted that the prediction is not the current level and that needs to be communicated. There is over reliance upon what is happening now, opposed to what will happen
- MS noted the need to be more proactive

	<ul style="list-style-type: none"> • MW added that the community will always question data and decisions – every flood is different
SES - JS	<ul style="list-style-type: none"> • JS advised that the SES are moving towards Flood Action Cards • JS advised that climate change can create some localised problems • JS warned that we have to be careful with what information is distributed as false alarms are a problem • MW noted that we need to be Richmond River focussed as all areas have unique issues and weather patterns
BoM	<ul style="list-style-type: none"> • GM advised the following regarding Flood Warnings: <ul style="list-style-type: none"> ○ Format of warnings – the BoM target the onset of flooding above the levee ○ There's 0.2m difference between the rowing club and Browns Ck based on past events, therefore 10.6m is the target for onset of flooding ○ This is mostly for the SES to commence response operations ○ Specific terms are used, i.e. 'exceed' and 'reach', which cannot be confused with 'peak' ○ Key messages are often lost though media ○ BoM usually note that it is difficult to predict peak flood heights due to uncertainty of how much rain has fallen • MW noted we need to avoid rescues
OEH	<ul style="list-style-type: none"> • TC advised that the shift to AHD should be limited to the tidal pool • TC agreed that changing gauges and datums has impacts on the community • TC listed 'where to from here' <ul style="list-style-type: none"> ○ Need mapping of gauges ○ Identify gaps ○ Bungawalbin needs a gauge • GM advised BoM have tried to model the Bungawalbin as this has an influence on flooding in the Mid Richmond, although the major volumes come from the Wilsons and Upper Richmond • MW advised that in 2001, the Bungawalbin flooded the Richmond • GM noted the BoM have also modelled Shannon Brook • MW commented that Shannon Brook has 2 names (also Deep Ck), and maybe the name could be verified under this project • TC noted that Tatham needs a gauge
	<ul style="list-style-type: none"> • KJ noted there is a financial and time cost for the SEs to update records and there is no budget for such above the standard budget • PN noted the change would need a staged and structured implementation. A staged action plan is needed • MS questioned MHL decision to move to AHD • DG advised the program was in its infancy • MS questioned whether there has been a process to follow • DG advised they had never had to do this before • MW noted there are 3 gauges in the Browns Ck well • MW questioned who owned the Tomki Ck gauge – no-one knows • GM questioned how the Lismore community have adapted to using AHD • LM advised they have made progress, and are reasonably happy with the progress • LM also warned not to lose focus and ignore flash flooding in Lismore • JS noted the need for consistency of messages delivered by Council, SES, Police. Need to define roles and responsibilities. Raise awareness

	<p>of who the lead combat agency is</p> <ul style="list-style-type: none"> • DG advised a staged roll out would need to start at Tuncester and Woodlawn • BC noted a staged roll out could put the community at risk, as people are unsure which gauges have been changed • GM noted that people always rely on radio for information, however since there is so much information, the critical information gets lost • MS advised the SES have been reviewing evacuation notices
Terms of Reference	<ul style="list-style-type: none"> • MW requested feedback from the Committee on the Terms of Reference
Closure & Next Meeting	<ul style="list-style-type: none"> • The next meeting is scheduled for approximately 1 month

RICHMOND RIVER VALLEY FLOOD WARNING AND EVACUATION PLANNING SYSTEM

Committee Meeting 3 Minutes 13th December 2013

Meeting Chairperson	Michael Wood (MW)
List of Attendees	Gordon McKay (GM) – Bureau of Meteorology Mel Mapstone (MM) – SES (Lismore City) Lindsay Matterson (LM) – SES (Lismore City) Jeff Spash (JS) – SES (Richmond Tweed) Trevor Reynolds (TR) – SES (Richmond Tweed) Paula Newman (PN) – Lismore City Council Graeme Kennett (GK) – Kyogle Shire Council Toong Chin (TC) – NSW Office of Environment and Heritage (OEH) Martin Fitzhenry (MF) – NSW Office of Environment and Heritage (OEH) David Griffin (DG) – Manly Hydraulics Laboratory Bill Moorhouse (BM) – RRCC Brian Eggins (BE) – Richmond Valley Council Jamie Fleeting (JF) – Ballina Shire Council Ben Caddis (BC) – BMT WBM
Apologies	Paul Busmanis (PB) – Ballina Shire Council Kaylene Jones (KJ) – SES (Richmond Tweed) Janet Pettit (JP) – SES (Richmond Tweed) Wayne Pettit (WP) – SES (Richmond Tweed)

Discussion and Action Items

Item	Notes	Actions
Introductions	<ul style="list-style-type: none"> Introductions by Michael Wood 	
Previous Minutes	<ul style="list-style-type: none"> No amendments to the minutes of Meeting Number 2 were requested, so general acceptance is presumed. <p><i>Generally, the agenda was not followed. General discussion around the project was held.</i></p>	
SES Flood Forecasting Tool	<ul style="list-style-type: none"> JS introduced Trevor Reynolds (TR) who gave an overview and demonstration of a flood forecasting tool for Lismore. The tool is currently an Excel macro, using an approach originally developed by Fred Barlow. The following points were noted: <ul style="list-style-type: none"> Used for forecasting heights in Lismore TR converted original tool into Excel Tool checks rainfall to see if flood is likely to overtop levee 86% of floods do not exceed the critical levee level of 10.6m Historically, when Lismore exceeds 10.6m, the 5 upstream gauges exceed the 86%ile Tool hasn't been released publically since it's still in trial form Once rain has ceased, the tool should be able to predict floods at Lismore to within 0.8m, 90% of the time The tool gives 8 hours of lead time for Lismore The purpose is to see if the levee will overtop in Lismore 	

BOM	<ul style="list-style-type: none"> • GM noted that 12-15 hours lead time is required for Lismore. (<i>The BoM Flood Warning Directive for the Richmond / Wilsons notes 12 hours</i>) • GM advised that when floods exceed 10m at Lismore, BoM has in the past issued the SES with warnings up to 24 hours prior to the peak • GM advised that the new Axis numerical prediction models are improving accuracy, thus should improve upon the current rainfall predictions which is where the greatest uncertainty in flood predictions lies • GM also noted that improvements to lead time are not associated with more river gauges. The river gauges tend to give only 3 hours of lead time • GM noted that in many cases, it's still raining when flooding is occurring. The rainfall models are good enough to give a good indication of further rainfall, but they are not perfect • GM affirmed that the key piece of intelligence is whether the flood will exceed 10.6m at Lismore or not. In the past, a few 10.5m events have been well predicted, although the SES still make the call to evacuate
	<ul style="list-style-type: none"> • Referring to the tool, JS noted that it provides an additional source of information, as it contains more than 20 years' worth of historical data
	<ul style="list-style-type: none"> • GM advised there are different rating curve for different gauges. The most accurate ratings are from the hydrologic modelling, with ratings up to the PMF
	<ul style="list-style-type: none"> • MM noted the SES generally take information from the BoM
	<ul style="list-style-type: none"> • LM noted 5mm/hr is critical • GM responded that 5mm/hr would not be likely to cause flooding. 70mm in 3hrs or less plus more rain expected will be likely to cause flooding • GM emphasised that it is important to assess in the context of the wider event. API has an influence. Thunder storms have a low volume but high intensity, so are more of a threat for localised flooding
	<ul style="list-style-type: none"> • Referring to the draft mapping issued by BMT WBM, GM advised a list of gauge ownership had been e-mailed. The list contains details where there is joint ownership. Bungawalbin Junction was an example. GM noted the BoM do not use '9' series gauge numbers
	<ul style="list-style-type: none"> • MW noted that TC and MW had observed a 'sophisticated' gauge at Tomki Creek (ownership uncertain)
	<ul style="list-style-type: none"> • MW advised a deliverable of this project will be an 'app' that will 'push' data and provide links to all major websites
OEH/MHL	<ul style="list-style-type: none"> • MF noted that most data is relative to AHD and RVD. Hydrosurvey data is output in AHD. MHL generally use AHD, although are currently dealing with some legacy issues • MF noted AHD is more accurate than RVD. RVD is +-70mm throughout the catchment, where AHD is +-20mm • MF advised MHL have no issues regarding staff gauges • GM queried whether MHL was still going to publish data in AHD • MF responded that there was a lag following conversion of Lismore

	<ul style="list-style-type: none"> • GM recommended against publishing 2 sets of data • MF noted there was no problem with changing the datum • PN and GM questioned when MHL will change • MF noted that a couple of different surveyors came up with different levels of LWOST • GM noted there was no problem associated with changing the datums, provided the process was supported by a thorough community education campaign
SES	<ul style="list-style-type: none"> • JS advised he and KJ had estimated \$250k for community education, covering all LGAs.
RVC	<ul style="list-style-type: none"> • BE noted there was a 7m drop in flood levels across Casino
LCC	<ul style="list-style-type: none"> • PN emphasised there was a need for something meaningful for the community with reference to levels
SES	<ul style="list-style-type: none"> • JS emphasised that Ballina needs community education • TC queried how long the community education campaign should last • JS suggested 2 years coinciding with release of the local flood plans
	<ul style="list-style-type: none"> • PN noted LCC already has an education flyer for urban areas, but not rural
	<ul style="list-style-type: none"> • GK suggested running dual gauge plates for a period
	<ul style="list-style-type: none"> • DG queried how many people are actually reading the gauge plates. High visibility locations are important • GK seconded the comments about whether sites are high visibility in terms of the need for dual plates
KSC	<ul style="list-style-type: none"> • GK advised that KSC were looking towards a single datum in Kyogle to reference all levels around town • GM advised the BoM website only has one gauge location, and warnings are only provided for a single location
	<ul style="list-style-type: none"> • MW noted that there are lots of people moving to the Northern Rivers, most of whom do not understand RVD
	<ul style="list-style-type: none"> • MF noted that levels and times need to be clear on websites (referring to daylight savings)
	<ul style="list-style-type: none"> • PN noted the majority of the community do not care about levels, but are more interested in consequences • GK disagreed noting that communities in flood prone areas know the levels that are critical to them • MW and PN noted different community groups have different requirements
	<ul style="list-style-type: none"> • TC expressed concern over 'cross over' location downstream of Casino (i.e. tidal pool to upper catchment) • DG advised not to change above the tidal pool
	<ul style="list-style-type: none"> • MW emphasised the need for targeted information for different areas and communities
	<ul style="list-style-type: none"> • BM noted the need for different gauge plates and ongoing community education program
	<ul style="list-style-type: none"> • MW agreed with the need for change in the tidal pool • MW also noted the need for a river gauge at Tatham • GM noted the community do not need to look at a river gauge to see what flooding is occurring
	<ul style="list-style-type: none"> • JS advised not to proceed with the change if the funding for education is not available

	<ul style="list-style-type: none"> • GM suggested getting the community to look at the web before the web service gets cut off in an event
	<ul style="list-style-type: none"> • JS suggested feeding data from Enviromon into WaterRide
	<ul style="list-style-type: none"> • BE suggested mapping will remove the datum confusion
	<ul style="list-style-type: none"> • LM advised the use of Minor / Moderate / Major was particularly useful for education
	<ul style="list-style-type: none"> • GM noted that the BoM are making significant advances in storm surge modelling
	<ul style="list-style-type: none"> • BC noted this project will pilot an interactive mapping application
	<ul style="list-style-type: none"> • BC noted that Committee Meeting #4 needs to wrap up Discussion Paper 1, and present DP2 and DP3
	<ul style="list-style-type: none"> • MW and GM suggested the need for a Gantt Chart for roll out
	<ul style="list-style-type: none"> • BE highlighted the need to address rural as well as urban areas • PN noted the rural community are usually more resourceful
	<ul style="list-style-type: none"> • MW advised the type of floods need consideration
	<ul style="list-style-type: none"> • MW suggested a 'mythbusters' page for community education
	<ul style="list-style-type: none"> • JS queried MHL on whether they could display 2 datums
	<ul style="list-style-type: none"> • BM noted the 1974 flood markers around Lismore which account for the hydraulic gradient through Lismore
	<ul style="list-style-type: none"> • BC and MW confirmed the need for a transition period where 2 gauge plates will be used
	<ul style="list-style-type: none"> • GM suggested 0.1m gradings would be appropriate • BE noted the need for AHD labelling • BM added the need for past floods to be shown
	<ul style="list-style-type: none"> • TC advised OEH would fund the gauge plates • GM noted it should be under asset refurbishment
	<ul style="list-style-type: none"> • DG advised the need to identify which gauge plates need replacing
	<ul style="list-style-type: none"> • JS noted the need to consult the local flood plans as evacuation procedures reference key gauges
Draft Reporting	<ul style="list-style-type: none"> • MW advised the draft reporting will be available mid to late Feb
Closure & Next Meeting	<ul style="list-style-type: none"> • The next meeting is scheduled for 7 February 2014

RICHMOND RIVER VALLEY FLOOD WARNING AND EVACUATION PLANNING SYSTEM

Committee Meeting 4 Minutes 20th August 2014

Meeting Chairperson	
List of Attendees	<p>Gordon McKay (GM) – Bureau of Meteorology Mel Mapstone (MM) – SES (Lismore City) Chad Ellis (CE) - SES (Richmond Tweed) Lindsay Matterson (LM) – SES (Lismore City) Jeff Spash (JS) – SES (Richmond Tweed) Gerry Burnage (GB) – SES (Ballina) Toong Chin (TC) – NSW Office of Environment and Heritage (OEH) Martin Fitzhenry (MF) – NSW Office of Environment and Heritage (OEH) David Griffin (DG) – Manly Hydraulics Laboratory Bill Moorhouse (BM) – RRCC Brian Eggins (BE) – Richmond Valley Council Ben Caddis (BC) – BMT WBM Barry Rodgers (BR) – BMT WBM Karey Patterson (KP) – Ntech Media</p>
Apologies	<p>Paul Busmanis (PB) – Ballina Shire Council Kaylene Jones (KJ) – SES (Richmond Tweed) Janet Pettit (JP) – SES (Richmond Tweed) Wayne Pettit (WP) – SES (Richmond Tweed) Paula Newman (PN) – Lismore City Council Graeme Kennett (GK) – Kyogle Shire Council</p>

Discussion and Action Items

Item	Notes	Actions
Introductions	<ul style="list-style-type: none"> • Introductions by Michael Wood and each attendee 	
Previous Minutes	<ul style="list-style-type: none"> • No amendments to the minutes of Meeting Number 3 were requested, so general acceptance is presumed. <p><i>Generally, the agenda was not followed. General discussion around the project was held.</i></p>	
	<ul style="list-style-type: none"> • KP gave an overview from NTech Media on options for the Flood information Systems website <ul style="list-style-type: none"> ○ System 1 will be a flood information system available to the public. Already delivered to RVC with plans to roll out across entire catchment. ○ System 2 will be a Flood Response Toolkit website with restricted access and for use by emergency responders. It will be developed so it is 'standalone' and will not rely on the internet. ○ SES (CE) advised that the SES is in the process of 	

developing a toolbox themselves which they are likely to be committed to use. They saw a lot of potential use from the information that BMT WBM / NTech Media can provide through.

- BC provided an overview of information that can be included in the systems. A demonstration was shown which combines flood level results with information on property floor levels. A slider bar allowed flood levels at a gauge to be increased and for each gauge level, properties were colour coded based on whether or not they were flooded with a distinction between flooding on the property and above floor level flooding.
 - BC mentioned that on the actual system it would be possible to 'zoom in' on the display but GM queried whether this was advisable as information may be taken out of context.
 - TC asked if there was scope to include evacuation centres and routes. BC advised this was possible.
 - GM noted that in Nepean and Hawkesbury they use similar information.
 - MW concluded that the overall consensus was positive and asked if anyone had any concerns about information being made available to the public.
 - GM was keen for all information to be made available to the public.
 - SES advised that they currently have evacuation plans online but only the first volume.
 - MF advised that the state is moving towards putting all the information out for public viewing.
 - KP asked for contacts from the represented organisations that he could liaise with in regard to data and technical issues associated with the data.
 - KP emphasised that the project is about presenting existing data and not interpreting it.
 - MW advised the RVC has a website and consistency will need to be made with this.
 - SES emphasised that it is essential that information has to be available 24 hours a day. KP advised that the data feeds would be updated as and when received.
 - OEH advised that gauge data gets sent from the gauge directly to MHL but that the gauge has the ability to send the information to anyone.
 - MW advised that a website would serve a useful function

SES will advise on what information can be released.

<p>as a community education tool.</p> <ul style="list-style-type: none"> ○ GM made the observation that people are likely to complain more if information is not there than if it is there but incorrect. ○ SES advised that use of the word 'response' should be reserved for their use due to its definition in the legislation. BC confirmed that the toolkit was only for responders. ○ GM advised that reproducing data that is presented on the BoM website would not be supported. 	
<ul style="list-style-type: none"> ● Some minor comments were received on Discussion Paper 1. <ul style="list-style-type: none"> ○ Tuckombil Highway Bridge not included ○ MHL use gauge prefix '04' and BoM use '09'. However BoM also label council gauges and therefore some council gauges have the BoM prefix. ○ Ballina Breakwater gauge number is incorrect (old one). BMT WBM to correct. 	
<ul style="list-style-type: none"> ● A discussion took place on Discussion Paper 1 (gauge boards). <ul style="list-style-type: none"> ○ MHL noted that Grafton boards are only useful in high visibility locations. ○ MHL would like cm increments shown on boards. ○ GM would like numbered increments (Clarence Valley Council boards don't have these) but thought that cm increments is only really required for technical matters ○ All were in agreement that a board with a yellow background was suitable for new boards shown to AHD. ○ All were in agreement that old gauge boards should be retained at priority sites. 	<p>BMT WBM will circulate a list of priority sites as a starting point for further discussion.</p>
<ul style="list-style-type: none"> ● There was some debate about existing gauge locations. <ul style="list-style-type: none"> ○ There was uncertainty about whether the gauge at Casino was automated. ○ SES (LM) thinks there may be an unofficial gauge at Browns Creek and that it would be very useful to know if this is the case. He thought that there was one on the wall of a pump station. 	<p>GM will confirm. Bill McDonald will advise.</p>
<ul style="list-style-type: none"> ● There was debate about the Browns Creek Spillway. <ul style="list-style-type: none"> ○ GM advised that 10.7mAHD at the rowing club gauge will result in levels that are very close to overtopping the Browns Creek spillway. 10.7mAHD at the rowing club is approximately equivalent to 10.95 at the Browns Creek 	

spillway.

- GM noted that BoMs predictions are based on the rising limb rating curve.
- SES queried the situation in which there is a predominantly Leycester Creek flood event and how that affects the spillway overtopping predictions. GM responded that it predominantly affects the degree to which the northern and southern parts of the town flood.

- Discussion Paper 2 was discussed (additional gauges).
 - GMs view was that none of the proposed river gauges will help BoM with forecasting.
 - A discussion was had about Cabbage Tree Island and the need for it to have tidal as well as riverine flood warnings.
 - GM advised that BoM has developed prototype storm surge models of the area.
 - GM advised that whilst the flood warning service provided by BoM is free of charge, the investigations associated with setting up a new system entail a cost.
 - SES advised that the Sandy Creek crossing in Bungawalbin is a good location for a gauge. There is an area where the creek is a bit wider just upstream of the crossing.
 - GM advised that BoM use a gauge at Rappville in the Bungawalbin to a degree to assist with flood warnings.
 - MHL advised that typical river gauge maintenance costs are \$4-5k per year with the gauge cost itself around \$15-20k (for a river gauge).
 - MW said that RRVC are in the process of installing an additional rain gauge in North Creek.
 - MHL noted that there may be scope to move some existing gauges. This is following a review in 2010 which noted that some gauges (eg Tuckombil Floodgates) are somewhat redundant. There may therefore be scope to place a new gauge in the Bungawalbin.
 - . GM noted there may be an automated gauge at Whiporie but this needs determining.

SES will provide feedback on what they would like at this location after discussing with colleagues.

GM will provide further detail on costs for setting up an operational system.

SES will supply information on what they desire (in terms of gauges) for North Creek and Emigrant Creek.

GM and BC will liaise and advise on recommendations for rain gauge locations in the Bungawalbin

- Discussion Paper 3 was discussed (Evacuation Management) recognising that most of the points had been covered in discussion earlier in the day.
 - BC asked the SES on the status of their flood intelligence card updates. SES advised that they have just been

completed for Lismore and are now focussed on the Tweed region. SES advised that the cards cannot be released externally.

- BR mentioned the rural flood hazard mapping that BMT WBM has completed between Kyogle and Casino.
- There was general agreement that rural flood hazard mapping was useful information and should ideally be undertaken for areas north of Lismore. BE asked if indicative velocity information could also be provided. BR advised that it can as this is one of the model outputs.
- General agreement that linking gauge heights to property floor levels in a flood intelligence system was a good idea. It was noted that around 4000 properties have been surveyed in Lismore already.

BMT WBM will advise the status of the rural flood mapping information and whether it can be provided to council.

Draft Reporting • The revised timeframe for draft reporting is early October

Closure & Next Meeting • No date has been set for the next meeting



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