FLOODING IN WESTERN QUEENSLAND

JANUARY - FEBRUARY 1997

Bureau of Meteorology
Queensland Regional Office
Hydrology & Severe Weather Sections

August 1997

Flooding in Western Queensland

January - February 1997

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SUMMARY

Very heavy rainfall fell in western Queensland during the period 28 January to 3 February 1997. This resulted in major flooding in several catchments including the Balonne and Maranoa Rivers, Wallam and Mungallala Creeks, Weir River, Moonie River, Warrego River, Paroo River, Bulloo River, Barcoo River and Cooper Creek.

The worst affected towns were Augathella, Charleville and Blackall. In Charleville, major flooding caused the evacuation of about 780 people. About 60 properties were affected by floodwaters above floor level. Repairs to flood damaged buildings in Charleville are estimated to have cost $150000. About 80 people required evacuation in Augathella with 4 houses affected by flooding over floor level. In Blackall, more than 10 houses and 5 business premises were evacuated. The townships of Jericho, Tambo and Bollon were also affected.

Road and rail traffic was severely disrupted and large groups of travellers were stranded at various centres throughout the flood affected area.

Several places on the western and southern side of the Carnarvons recorded over a 350 millimetres of rainfall in the period from 28 January to 3 February 1997. Highest totals were recorded in the upper Warrego River to Charleville and in the Upper Barcoo system. The temporal patterns for selected rainfall stations shows that there were five distinct bursts of heavier rainfalls over 10mm per 3 hours with the most notable being in the 9 hours to 3pm on Wednesday 29 January and the 12 hours to 6am Monday 3 February.

Flooding during the period was the most significant in several catchments in western Queensland since the record floods in April 1990. The Flood Warning Centre (FWC) issued 291 Flood Warnings during this period with the final warning issued being for the Cooper Creek on the 14 April 1997. During this period, in excess of 1100 River Height Bulletins were issued.

The Bureau's network of automatic and manual rainfall and river height stations operated well during this period. In particular the network of automatic rainfall/river height stations installed above Charleville after the 1990 flood performed reliably and was of great assistance in providing warnings for Charleville.

Flood forecasting models were available for most of the affected catchments and gave guidance for river height predictions at key locations.

The computer systems used in the FWC, HYNET and AROS, worked satisfactorily during the event with the telemeter interrogation package, MASTERS, and the ALERT software, both resident on HYNET, performing robustly.

Since the event, the Bureau has conducted internal reviews and participated in meetings with relevant agencies, including Emergency Services and Local Governments, aimed at improving all aspects of the warning services. These activities are ongoing and are not documented within this report.

Flooding in Western Queensland

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1.0 INTRODUCTION

Very heavy rainfall fell in western Queensland during the period 28 January to 3 February 1997. This resulted in major flooding in several catchments including the Balonne and Maranoa Rivers, Wallam and Mungallala Creeks, Weir River, Moonie River, Warrego River, Paroo River, Bulloo River, Barcoo River and Cooper Creek.

The flooding in the Warrego River is significant in that the peak at Charleville is the highest since the record flood of April 1990 and is the second hghest on the flood record which started about 1900.

This report has been produced by the Queensland Regional Office of the Bureau of Meteorology as a record of the severe weather and flooding that occurred in February 1997. It is intended to be an internal report but is available to external agencies under the conditions outlined on the title page.

1.1 Aim of Report

The aim of this report is to document the meteorological and hydrological aspects of the significant weather and flooding in western Queensland during the period February and March 1997.

The report also outlines the warning and prediction services given by the Bureau in the lead-up to and during the event, and provides some review of the performance of the flood warning and forecasting systems operated by the Bureau of Meteorology.

The stations and places named in the report may be located by referring to the map of Western Queensland Rivers, Figure 1.1.

1.2 Impact & Damages

The worst affected towns were Augathella, Charleville and Blackall. In Charleville, major flooding caused the evacuation of about 780 people. About 60 properties were affected by floodwaters above floor level. Repairs to flood damaged buildings in Charleville are estimated to have cost $150000. About 80 people required evacuation in Augathella with 4 houses affected by flooding over floor level. In Blackall more than 10 houses and 5 business premises were evacuated. The townships of Jericho, Tambo and Bollon were also affected.

Road and rail traffic was severely disrupted and large groups of travellers were stranded at various centres throughout the flood affected area.

1.3 Sources of Data

The primary sources of data for this report is the record of meteorological data and analysis held by the Bureau of Meteorology, and the rainfall and river height data collected by the Bureau's Flood Warning Centre (FWC) during the event. The meteorological data set includes surface and upper air weather observations, satellite pictures and digital radar images. The data received in the FWC is from telephone telemeters and manual observer stations reporting through the Remote Observer Collection System (ROCS).

Additional river height information was obtained from the Queensland Department of Natural Resources.

2.0 METEOROLOGICAL CONSIDERATIONS

2.1 Antecedent Conditions

At sea level over the Australian region on the morning of 28 January 1997 a typical summer weather pattern was operating. A moderate northwesterly monsoon flowed into northern Australia with monsoon depressions near Broome in Western Australia and another in the Southeast Gulf Country of Queensland. High pressure centres were located in the Great Australian Bight and over New Zealand with humid tropical northeasterly tropical airflow being directed into Queensland.

2.2 Evolution of pattern over heavy rain period.

Figure 2.1 shows the first three days of the event and at sea level by 9am on 29 January 1997 the Monsoon low near the Gulf had deepened a little and developed a trough down to the Charleville area as a major upper trough moved towards southwest Queensland. The sea level trough can be detected by the sharp clockwise turning of the isobars southeast of the low together with the change in northerly 1 km winds to southerlies at Charleville. This trough was developing to higher levels and can be clearly seen south of Charleville at the 700 hPa and 500 hPa levels. The winds in the general Charleville region (apart from at Charleville itself) backed in direction with height from northerlies at 1 km elevation through north-northwesterlies at 700 hPa to northwesterlies at 500 hPa. Such anti-clockwise turning of the winds with height was associated with large scale ascent of the airmass as the deep trough was developing and the heaviest average rainfall rates occurred just after 12 noon on this day. Charleville lay to the west of the trough at low levels (hence the southerly at 1 km) and the forced ascent was confined to the layers above 700 hPa. Consequently it received less rain than areas to the north and east which were in low level northerly flow.

By 9am 30 January 1997 the low had further deepened as the upper system moved into southwest Queensland. The low now extended up to 500 hPa. Extensive low level northeasterly flow across eastern Queensland was directed into the Charleville area. These winds backed with height up to 700 hPa and another pulse of heavy rain was occurring at this time. The forced ascent was confined to layers below 700 hPa which may explain the lower average rain in this burst.

By 9 am 31 January 1997 the low was reaching its maturity and became more vertically aligned. This tended to somewhat ease the rain in the Charleville region. As it became more vertically aligned there was less backing of the winds with height and consequently little large scale lifting of the airmass. However the moisture content of the air increased at low levels as the strength of the flow from the Central Coast increased. Additionally with the easing of the rain the temperature increased to the mid twenties whereas they had been confined to around 20 degrees. That afternoon thunderstorms developed in this warm humid environment giving another burst of large average catchment falls.

By 9am 1 February 1997 (Figure 2.2) the now vertical low began moving west. The winds over the Charleville region had little directional change with height and little rain fell during the morning. Low level moisture further increased and daytime temperatures climbed above 30 degrees. In an environment more likely experienced at Cairns, afternoon thunderstorms again developed producing another diurnal burst in the catchment rain.

The last pulse of heavy rain occurred between 9am 2 February 1997 and 9am 3 February 1997. Over this period the low continued to move west and away from the region and the winds at 700 hPa and 500 hPa weakened aloft. However at mean sea level the large scale monsoon flow

converged over Charleville with a strong current which was circulating around a developing ridge over NSW and southern Queensland. Low level moisture increased even more and dew points at Charleville reached 25 degrees. Thunderstorms developed during the afternoon of the second in this extremely humid convergent air mass and spread out into areas of overnight rain.

Figure 2.1 Daily Weather Charts at 9am (EST) 29 January 1997 to 31 January 1997.
Left column is the pressure distribution at mean sea level with wind plots indicating the observed wind at 1 km elevation. (Full/half barb represents 10/5 knots).
Centre column are the height contours (decametres) and winds at the 700 hPa level (just over 3 km elevation).
Right column are the height contours (decametres) and winds at the 500 hPa level (just under 6 km elevation).
Location of Charleville marked by solid circle.

Figure 2.2 Daily Weather Charts at 9am (EST) 1 February 1997 to 3 February 1997.
Left column is the pressure distribution at mean sea level with wind plots indicating the observed wind at 1 km elevation. (Full/half barb represents 10/5 knots).
Centre column are the height contours (decametres) and winds at the 700 hPa level (just over 3 km elevation).
Right column are the height contours (decametres) and winds at the 500 hPa level (just under 6 km elevation).
Location of Charleville marked by solid circle.

2.3 Moisture of Airmass

The moisture content of the airmass over the Charleville region was commented on above. At the start of the event on the 29 January 1997 the dew point at Charleville was between 20 and 21 degrees compared with a January average of 12.5 degrees. During 2 February 1997 it reached 25 degrees or twice the average dew point for Charleville. The maximum dewpoint reached at Charleville during the April 1990 flood event was 22 degrees compared with an April average of 9 degrees.

2.4 Rainfall Forecasts

Numerical computer model forecasts for this event provided extremely good guidance for forecasters. In the Australasian region the situation initially involved a large dominant mean sea level high over New Zealand which over the period was replaced by a similar system over Tasmania. The upper pattern was dominated by the development of two major upper trough systems one over New Zealand longitudes and the other over Central Australia. Such large strong systems are well simulated by the numerical models and as an example the rainfall forecasts generated by the Australian global computer model (GASP) are shown in Figure 2.3. These forecasts were available around 7 pm 28 January 1997 and indicated then that four days of heavy rain could be expected in the Charleville region. Close examination reveals that the heaviest rainfall tended to occur to the east of the forecast area of maximum precipitation but for a global model this was an outstanding forecast.

Twenty four hour forecast from the Australian regional model, Local Area Prediction Scheme (LAPS), are detailed in Table 2.1 and these show excellent forecasts until the last two days when the rain fell from thunderstorms.

Of course other situations are not handled well by computer models and forecasters can recognise the unpredictability of these situations. The degree of predicability of a particular situation undoubtably should become an important part of severe weather forecasts.

Table 2.1
LAPS 24 hour Rainfall Forecasts

Validity time	Location	24 hr Areal Forecast (mm)	24 hr Recorded Rainfall Point (mm)
0000 UTC 29/1/97	Charleville	25	26
	Blackall	30	53
	Tambo	30	18
	Barcaldine	30	15
0000 UTC 30/1/97	Charleville	40	36
	Blackall	50	85
	Tambo	50	81
	Barcaldine	50	69
0000 UTC 31/1/97	Charleville	22	25
	Blackall	30	28
	Tambo	30	88

	Barcaldine	35	31
0000 UTC 1/297	Charleville	15	31
	Blackall	25	11
	Tambo	20	45
	Barcaldine	22	22
0000 UTC 2/2/97	Charleville	7	34
	Blackall	10	47
	Tambo	9	14
	Barcaldine	10	44
0000 UTC 3/2/97	Charleville	15	27
	Blackall	10	9
	Tambo	10	85
	Barcaldine	5	29

Figure 2.3 Numerical computer model forecasts (GASP) of 24 hour rainfall(mm) in the Charleville area with actual 24 hour rainfall registrations(mm).
Location of Charleville marked by large C.

3.0 RAINFALLS

3.1 Rainfall Totals

Table 3.1 gives a table of the notable daily rainfalls for each of the flood affected catchments for the period 28 January to 3 February 1997.

Table 3.1
Daily Rainfalls (mm)

Station Name	January 1997				February 1997			Total
	28	29	30	31	1	2	3	
MARANOA RIVER								
Havelock		4	22	50	30	1	41	148
Mitchell SYN		7	21	53	?	4	36	121
Amby		52	36	33	?	2	27	150
Old Cashmere TM		22	29	66	0	0	0	117
WARREGO RIVER upstream of CHARLEVILLE								
Carnarvon Station	32	8	29	52	26	1	105	253
Chesterton	64	5	28	55	106	8	104	370
Wetlands	24	17	101	118	0	7	100	367
Augathella		13	115	37	36	19	81	301
Augathella TM	10	13	117	39	36	16	78	309
Drensmaine	38	18	62	72	79	6	54	329
Nive Downs	23	54	90	62	44	6	88	367
Biddenham TM	17	11	126	37	42	17	84	334
The 27 Mile Garden	10	23	64	31	33	18	102	281
Charleville TM	1	25	31	24	31	33	17	162
Charleville SYN	0	26	36	25	31	34	27	179
WARREGO RIVER downstream of CHARLEVILLE								
Bayswater	2	56	73	12	56	15	34	248
Oakpark	2	59	31	38	75	50	20	275
Wansey Downs	----------	-----------	----------	-------->	250	12	59	321
Warilda	14	14	33	6	25	62	25	179
Morven PO	3	21	85	40	46	4	40	239
Bakers Bend TM	0	25	16	9	25	34	11	120
Wallen	-------->	11	2	5	8	57	8	91

Cunnamulla SYN	10	11	2	0	1	13	0	37
Rocky	--------->	72	0	0	0	0	0	72
Noorama	13	22	0	0	2	4	2	43
PAROO RIVER								
Humeburn TM	7	5	1	0	1	74	4	92
BULLOO RIVER								
Idalia NP	6	13	44	4	28	28	4	127
Quilpie SYN	0	3	2	0	1	63	0	69
Thargomindah SYN	9	11	0	0	2	4	7	33
THOMSON RIVER								
Torrens Ck		--------->	71	22	30	0	7	130
Woodbine		13	68	42	25	17	5	170
Tiree	7	55	14	25	13	11	2	127
Caledonia		23	62	46				131
Aramac		34	43	45	23	32	0	177
Longreach SYN		14	38	1	1	0	0	54
Evesham			50	----------	----------	--------->	7	57
Westerton	7	13	7	0	0	0	0	27
BARCOO RIVER								
Tambo SYN	14	18	81	88	45	14	85	345
Blackall SYN	9	53	85	28	11	47	9	242
Richmond Hills	17	18	105	56	29	13	0	238
Barcaldine SYN	2	15	69	31	22	44	28	211
Isisford SYN	17	15	47	4	20	?	1	104

Figure 3.1 shows a map of the rainfalls recorded over the period 28 January 1997 to 3 February 1997.

3.2 Rainfall Temporal Patterns

Examination of the temporal patterns for selected rainfall stations shows that there were five distinct periods of heavier rainfalls over 10 mm per 3 hours:

•	9 hours to 3pm	Wednesday	29 January 1997
•	9 hours to noon	Thursday	30 January 1997
•	3 hours to 6pm	Friday	31 January 1997
•	3 hours to 9pm	Saturday	01 February 1997
•	12 hours to 6am	Monday	03 February 1997

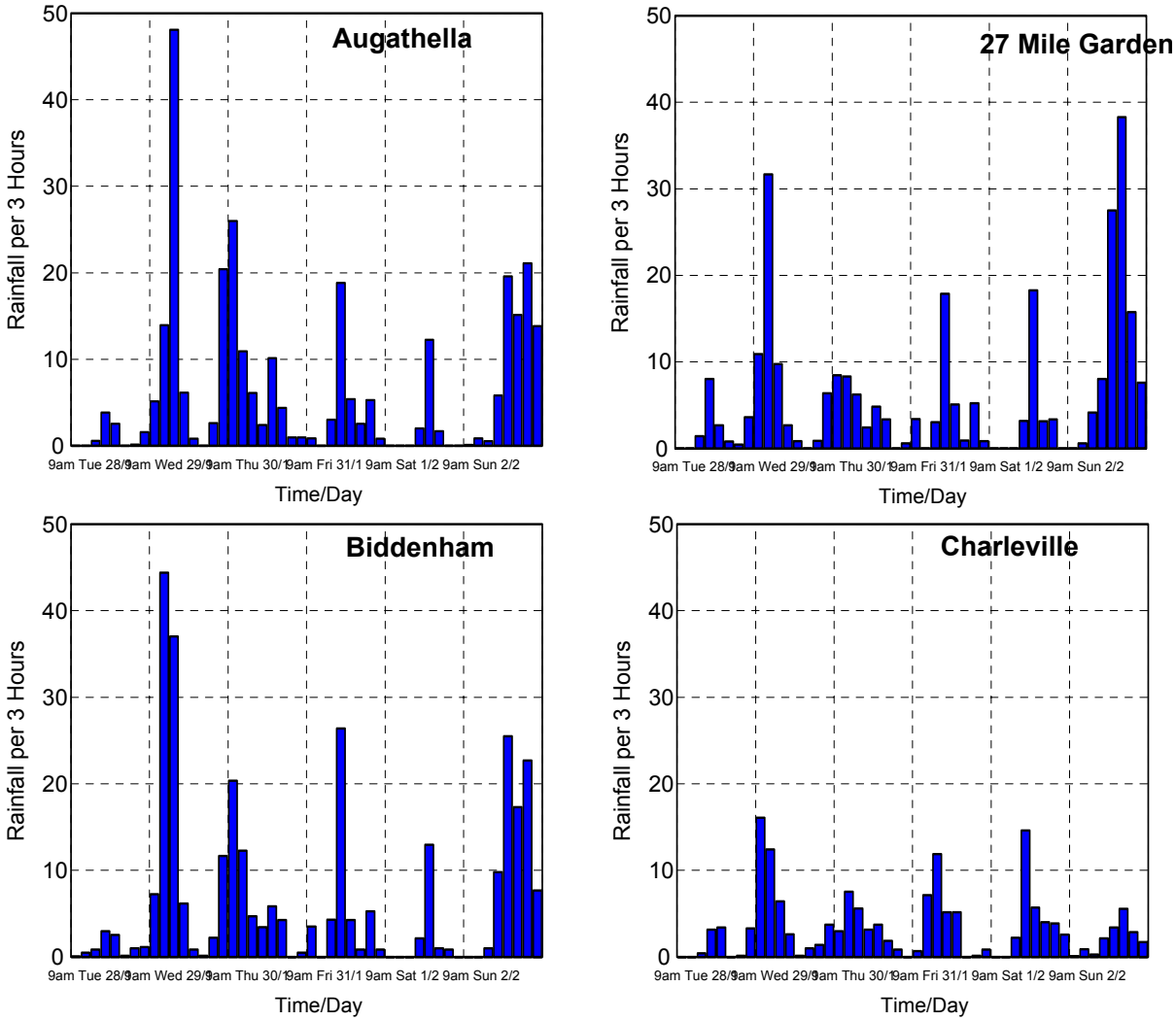

Figure 3.2 Rainfall Hyetographs - Warrego River

Figure 3.2 shows that the three hourly rainfalls in the Warrego catchment were never intense for long periods of time with most bursts above 10 millimetres per three hours lasting only 3 to 6 hours. The most intense period of rainfall was during the first burst with totals in excess of 40 millimetres in the upper catchment at Biddenham and Augathella. The last burst of rainfall on Monday morning was the most intense with three consecutive periods over 10 millimetres at Biddenham, Augathella and The 27 Mile Garden. This intense burst is not reflected in the rainfall pattern at Charleville indicating that the rain was localised above Charleville.

The rainfall hyetographs, Figure 3.3, for Tambo and Blackall show similar patterns to those observed in the Warrego catchment.

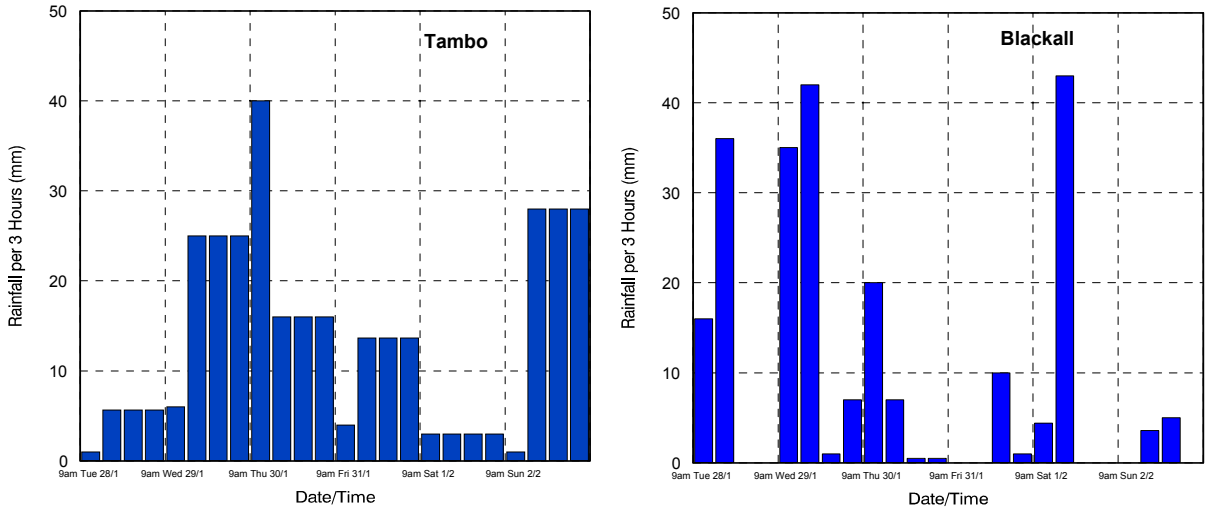

Figure 3.3 Rainfall Hyetographs - Barcoo River

3.3 Rainfall Frequencies

Rainfall frequencies were examined at a number of sites around the affected catchments, namely Tambo, Blackall, Augathella and Charleville (Figures 3.4 to 3.7).

Table 3.2
Average Recurrence Intervals of Selected Stations.

Station	Duration (hrs)					
	3	6	12	24	48	72
Tambo	1-2	2-5	10-20	2-5	10-20	20-50
Blackall	1-2	5	5	2-5	5	5-10
Augathella	2-5	2-5	2-5	10-20	10-20	20
Charleville	<1	<1	<1	<1	1-2	2

From the above table, the recorded rainfall intensities were typically less than the 10 year Average Recurrence Interval (ARI) rainfalls for durations up to 24 hours. For longer durations of 2 to 3 days, rainfalls in the Tambo and Augathella area were approaching 20 year falls. The 3 day rainfall totals at Tambo exceed a 20 year ARI. Rainfalls at Charleville were less intense throughout the event.

3.4 Comparison with April 1990 Rainfalls

It is difficult to compare the rainfall totals recorded during this event with those recorded during April 1990. The April 1990 floods resulted from prolonged rainfall over a 20 day period while the February event resulted from a 6 day period of rain. Table 3.3 shows some of the rainfall statistics for each event.

The storm totals for the 1997 flood are significantly higher than the last few days of the April 1990 flood. However, the comparison between the most intense 24 hour period shows that at Augathella and Charleville the April 1990 rainfalls are much higher than those recorded in 1997. On the other hand, the 24 hour totals are similar at Tambo and Blackall for both events.

Table 3.3
Comparison of Rainfall Totals

Station	Rainfall Totals		Most Intense 24 Hr Period	
	5 Days to 20 April 1990	6 Days to 3 February 1997	April 1990	Jan-Feb 1997
Augathella	211	300	146 (20/04/90)	115 (30/10/97)
Charleville	93	179	77 (20/04/90)	36 (30/01/97)
Tambo	175	345	81 (20/04/90)	88 (31/01/97)
Blackall	213	242	72 (19/04/90)	85 (30/10/97)

4.0 FLOODS

4.1 Warrego River

Table 4.1 provides a summary of the flood peaks for the Warrego River during this event and, for comparison purposes, the height of the most recent significant flood at each location. Upstream of Cunnamulla this flood event is the second highest on record after the April 1990 flood. At Cunnamulla and Rocky, there are several other events such as 1890, 1950, 1954, 1956,1972 and 1983 where the reported peak was slightly higher than the 1997 flood.

Table 4.1
Warrego River Flood Peaks

Catchment	Station	1997 Flood		Flood Class	Most Recent Significant Flood		Comments
		Date	Height (m)		Date	Height (m)	
Warrego	Augathella	4th	6.38	Major	April90	7.30	2nd highest on record
	Biddenham	3rd	6.85	Major	April90	7.20	"
	The 27 Mile Gardens	4th	5.84	Major	April90	6.98	"
	Charleville	4th	7.39	Major	April90	8.54	"
	Bakers Bend	5th	11.06	Major	April90	12.10	"
	Wyandra	7th	9.86	Major	April90	10.00	"
	Wallen	7th	10.05	Major	April90	1036	"
	Cunnamulla	9th	9.78	Major	April90	10.15	10th highest on record
	Rocky	11th	5.23	Major	April90	5.32	7th highest on record

Rises were first reported in the Upper Warrego catchment on the afternoon of 29 January and continued for the next six days. Some initial minor flood peaks were reported from stations at Drensmaine on the Nive River and Warilda on the Langlo River but further rain was causing renewed rises generally throughout the catchment. On the Warrego River rises continued at Augathella until a major flood peak of 6.20 metres was reached at 10am on 2 February with renewed rises occurring during 3 February with a second peak reported at 9am on 4 February at 6.38 metres.

Similarly on the Nive River at Biddenham an initial peak of 5.97 metres at 9pm on 1 February was followed by a second major flood peak of 6.80 metres at 5pm on 3 February.

The combined flow from the upper Warrego and Nive Rivers was causing major flooding at The 27 Mile Gardens with the main peak of 5.84 metres occurring at 3am on 4 February. At Charleville initial peaks of 6.46 metres and 6.91 metres were reported during the afternoons of 2 and 3 February. Intense rainfall was reported immediately upstream of Charleville overnight on 2 February and this, combined with the main flood peak from The 27 Mile Gardens, resulted in the major flood peak of 7.39 metres at Charleville at 4pm on 4 February.

Major flooding was also occurring to the west of Charleville on the Langlo and Ward Rivers. Warilda on the Langlo River reported a major flood peak of 6.12 metres at 3pm on 5 February and the peak

at Oak Park on the Ward River was 7.00 metres at 3pm on 4 February. The combined flow from the Warrego, Ward and Langlo Rivers was producing major flooding on the Warrego River at Bakers Bend immediately downstream of the Ward River junction. The river peaked at Bakers Bend at 11.06 metres at 6pm on 5 February. As the floodwaters moved downstream a peak of 9.86 metres occurred at Wyandra at 3am on 7 February and at Wallen the river peaked at 10.05 metres at noon on 7 February. Cunnamulla reported a peak of 9.78 metres at 3am on 9 February and a peak of 5.23 metres occurred at Rocky on 11 February. The main flood peak was near the Queensland/New South Wales border by 16 February.

Figure 4.1 below shows the flood hydrograph at Charleville commencing at 9am on 28 January as well as the 3 hourly average catchment rainfall.

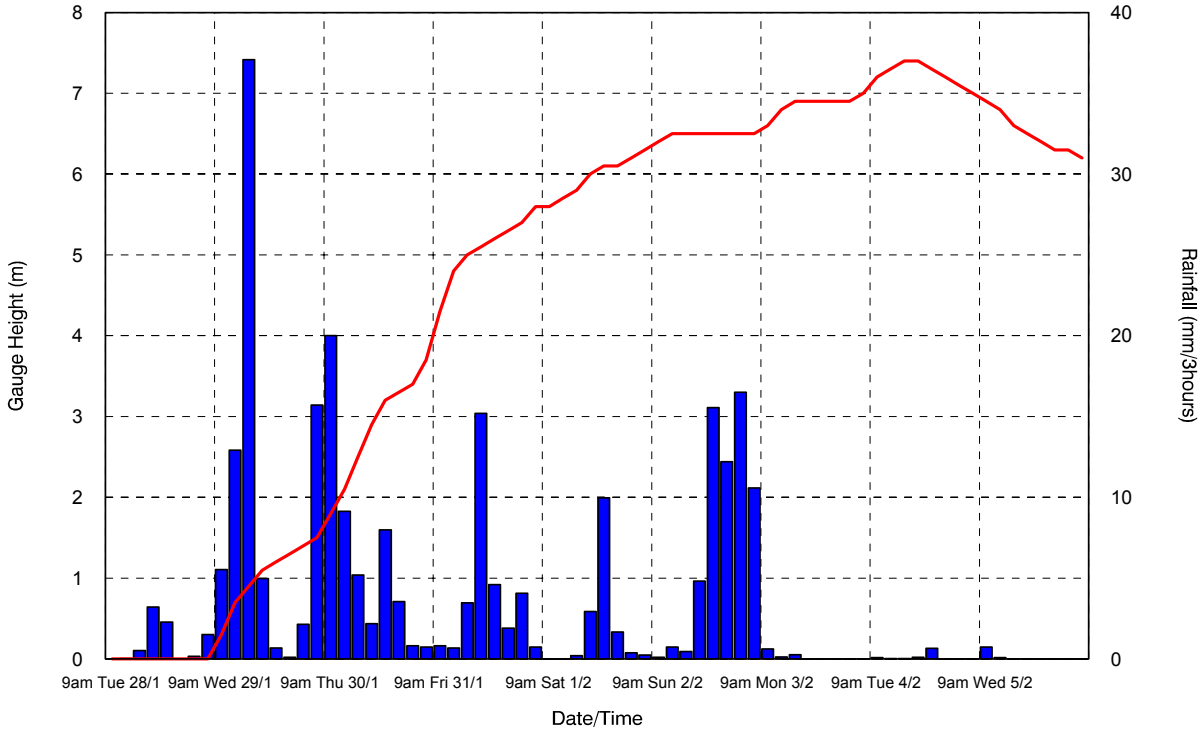

Figure 4.1 Flood Hydrograph for Warrego River at Charleville

4.2 Thomson, Barcoo Rivers and Cooper Creek

Table 4.2 provides a summary of the flood peaks in the Thomson, Barcoo Rivers and Cooper Creek reached during this event and, for comparison purposes, the height of the most recent significant flood at each location.

On the Barcoo River, this flood ranks as the third highest on record at Blackall and Isisford with only the 1963 and 1990 floods being more severe. At Retreat there was another higher flood peak reported in 1989. On the Thomson River the February flood event is not particularly significant when compared to earlier floods. Similarly, on the Cooper Creek at Windorah, whilst major flooding was reported in February 1997, there has been a number of more significant events during previous years.

Table 4.2
Thomson, Barcoo Rivers and Cooper Creek Flood Peaks

Catchment	Station	1997 Flood		Flood Class	Most Recent Significant Flood		Comments
		Date	Height (m)		Date	Height (m)	
Thomson R	Longreach	6th	3.60	Moderate	April90	5.04	Not significant event
	Stonehenge	10th	3.50	Moderate	April90	5.86	"
	Jundah	12th	4.95	Moderate	April90	7.55	"
Barcoo	Blackall	2nd	6.15	Major	April90	7.30	3rd highest on record
	Isisford	5th	8.05	Major	April90	9.20	3rd highest on record
	Retreat	10th	9.45	Major	April90	12.05	
Cooper Ck	Windorah	14th	5.87	Major	April90	7.95	

The worst flooding occurred in the Barcoo River catchment. Initial rises were reported from stations upstream of Blackall on 29 January. At Tambo the river peaked at 5.10 metres at 6am on 31 January with renewed rises producing peaks of 5.10 metres on 1 February and 5.20 metres on 3 February. At Gillespie there was a 7.05 metre peak at 6am on 1 February, a second peak of 7.00 metres on 2 February and another peak of 7.08 metres on 4 February. At Duneira, the river peaked at 3.40 metres at 6pm on 1 February and then at 3.15 metres at 9pm on 3 February with another peak of 3.10 metres on 5 February. Upstream of Blackall moderate flooding was occurring but at Blackall a major flood peak of 6.15 metres was recorded at 6am on 2 February. Subsequent flood peaks were 5.50 metres on 4 February and 5.40 metres on 5 February.

Figure 4.2 below shows the flood hydrograph for the Barcoo River at Blackall TM as well as the 3 hourly rainfall from Tambo. The heights from the Blackall TM site are higher than the Blackall flood warning gauge.

Moderate flooding was also being experienced in Jordan Creek with Jericho recording a peak of 2.9 metres at 6am on 1 February. As these flood waters moved downstream, rises were being experienced in the Alice River in the Barcaldine area. The main flood peak from the upper Barcoo and the Alice Rivers caused major flooding on the Barcoo River downstream at Isisford and Retreat with the peak at Isisford recorded at 8.05 metres at 9pm on 5 February and at Retreat the peak was 9.45 metres at 5.30pm on 10 February.

In the upper Thomson River catchment moderate flood levels were reported from Aramac on Aramac Creek during 30 and 31 January. Camoola Park on the Thomson River recorded a moderate flood peak of 4.05 metres on 2 February and a moderate flood peak of 3.60 metres occurred at Longreach on 6 February. Moderate flooding continued on the Thomson River as floodwaters moved downstream. The river peaked at Bogewong at 5.65 metres on 8 February and at Stonehenge at 3.50 metres on 10 February. The peak at Jundah occurred on the 12 February at 4.95 metres.

The combined flows from the Thomson and Barcoo Rivers produced major flooding on Cooper Creek in the Windorah area. The peak at Windorah was 5.87 metres on 14 February. By early March the main flood peak was in the Durham Downs to Karmona area of Cooper Creek. A minor flood peak of 2.76 metres occurred at Durham Downs on 7 March. The peak of 4.05 metres at Karmona on the 11 March produced major flooding in the Karmona area. By the end of March the flood waters were at Nappa Merrie near the Queensland-South Australia border but levels were below minor flood levels.

4.3 Paroo and Bulloo Rivers

Table 4.3 provides a summary of the flood peaks in the Paroo and Bulloo Rivers reached during this event and, for comparison purposes, the height of the most recent significant flood at each location.

Flooding in the Paroo and Bulloo Rivers is the highest reported since April 1990 but the February flood peaks are considerably lower than the April 1990 peaks.

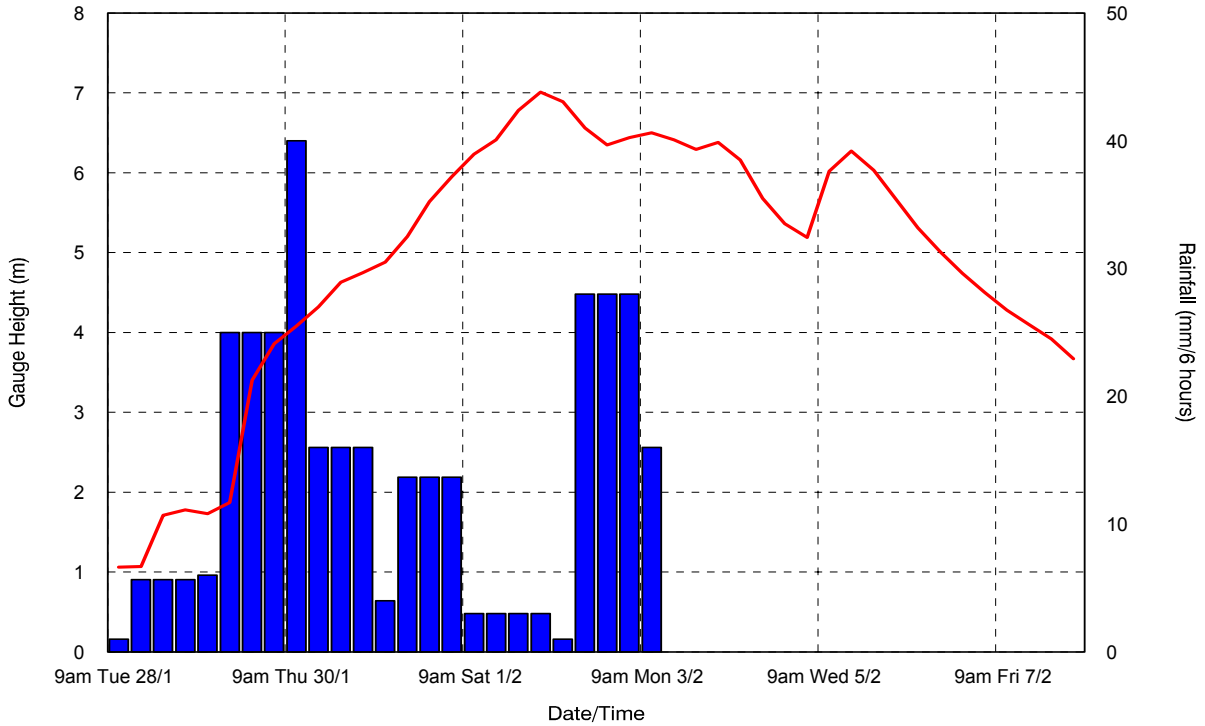

Figure 4.2 Flood Hydrograph for Barcoo River at Blackall

Table 4.3
Paroo and Bulloo Rivers Flood Peaks

Catchment	Station	1997 Flood		Flood Class	Most Recent Significant Flood		Comments
		Date	Height (m)		Date	Height (m)	
Paroo River	Humeburn	2nd	5.47	Major	April90	7.18	Highest since 1990
	Eulo	6th	4.50	Major	April90	5.80	"
	Hungerford	11th	1.96	Moderate	April90	2.92	"
Bulloo River	Milroy	4th	4.80	Moderate	1963	6.52	"
	Quilpie	4th	5.50	Major	April90	6.16	"
	South Comongin	6th	4.50	Moderate	May89	5.40	"
	Thargominda h	12th	5.17	Moderate	May89	6.08	"

Initial rises were reported on the Paroo River at the Humeburn telemetry station on 28 January and a minor flood peak occurred two days later. The river at Humeburn commenced rising again late on 1 February and peaking at the major flood height of 5.47 metres late on 2 February. The river level at Humeburn continued to fall slowly over the next few days. Downstream at Eulo, the river peaked at 4.50 metres early on 6 February with major flooding. At Hungerford a minor flood peak occurred late on 3 February and then the river commenced falling. Rises commenced again on 9 February and the peak of 1.96 metres occurred late on 11 February with moderate flooding.

In the Bulloo River, catchment rises were occurring at Adavale on Blackwater Creek with the first rises on the Bulloo River occurring at Milroy on 1 February and peaking there at the moderate flood level of 4.80 metres on 4 February. This caused a major flood peak of 5.50 metres at Quilpie later that day.

The Bulloo River at South Comongin rose to 4.50 metres on 6 February with moderate flooding. The peak at Thargomindah occurred on 12 February at 5.17 metres with moderate flooding.

4.4 Other Western Rivers

Table 4.4 provides a summary of the flood peaks in other western rivers reached during this event and, for comparison purposes, the height of the most recent significant flood at each location.

Flooding in the Balonne, Weir and Moonie Rivers wasn't as severe during this period and, in fact, there was another more significant flood event later in the month which caused more extensive flooding. At Bollon on Wallam Creek, the February 1997 flood is the second highest on record. In the Diamantina and Georgina Rivers and Eyre Creek flooding was experienced from the middle of January through to late April.

Table 4.4

Other Western Rivers Flood Peaks

Catchment	Station	1997 Flood		Flood Class	Most Recent Significant Flood		Comments
		Date	Height (m)		Date	Height (m)	
Maranoa	Mitchell	3rd	4.15	Moderate	April 90	8.08	Highest since April 1990
	Springfield	4th	8.70	Major	April 90	10.44	"
	Woodlands	5th	6.80	Moderate	April 90	7.25	"
Balonne River	St George	8th 19th	5.91 7.82	Moderate Major	April 90	12.24	
	Whyenbah	9th 21st	6.19 7.35	Moderate Major	April 90	8.06	
	Dirranbandi	9th 22nd	3.92 4.60	Minor Moderate	April 90	5.20	
Wallam Ck	Homeboin	2nd	4.15	Major	April 90	4.00	Highest on record
	Bollon	3rd	1.47	Major	May 83	1.53	2nd highest on record
Mungallala Ck	Deelamon	2nd 16th	5.30 5.90	Major Major	April 90	6.15	
Weir River	Surrey	31st 17th	5.42 5.81	Moderate Major	Jan 96	5.87	
	Talwood	2nd 24th	3.60 4.20	Minor Minor	Jan 96	4.22	
Moonie River	Flinton	3rd 17th	1.34 4.85	Minor Moderate	April 88	5.02	
	Nindigully	1st 20th	2.53 3.83	Minor Moderate	April 88	3.88	
	Thallon	2nd 21st	4.19 5.36	Minor Major	April 88	5.33	

5.0 FLOOD MONITORING SYSTEMS AND WARNING SYSTEMS

5.1 Flood Warning Networks

Table 5.1 indicates the number of rainfall and river height stations in Warrego River, Cooper Creek, Paroo River and Bulloo River catchments and the method used for reporting to the Flood Warning Centre.

Table 5.1
Flood Warning Networks

Basin	Rainfall			River Height		
	ROT	PH	TM	ROT	PH	TM
Warrego R	22	0	6	15	2	8
Cooper Ck	37	0	0	21	0	3
Paroo R	3	0	1	2	0	2
Bulloo R	8	0	0	5	0	1
Total	70	0	7	43	2	14

ROT - Manual station reporting by Remote Observer Terminal
PH - Manual station reporting by telephone
TM - Automatic station reporting by telephone telemetry

Of the total manual rainfall station network there were 60 stations out of 70 (about 85%) that reported satisfactorily during this flood event. All the rainfall telemetry stations reported satisfactorily.

Of the manual river height stations, there were 39 stations out of 43 stations (about 91%) that reported satisfactorily. Of the river height telemetry stations, there were 2 stations in the Cooper Creek catchment that experienced failures.

5.2 Flood Warning Models

The most common technique used for forecasting floods in the western rivers is the peak stage relationship, which graphically represents the relationship of historical peak heights between adjacent river height stations.

Several hydrologic models, shown in Table 5.2, were used during the event for assistance in predicting heights and/or degree of flooding.

Table 5.2
Flood Forecasting Models

Basin	Catchment	Model
Condamine/Balonne R	Lower Balonne & Maranoa R	URBS River Routing Model
Warrego River	Upper Warrego R to Charleville Lower Warrego R	URBS Runoff-Routing Model

Thomson/Barcoo River	Thomson R Barcoo R Cooper Ck	URBS Runoff-Routing Model
Paroo	Paroo R to Hungerford	URBS River Routing Model
Bulloo	Bulloo R to Thargomindah	URBS River Routing Model

The models on the whole were an effective way of assembling and displaying data and gave guidance for river height predictions at many locations. However, the models do not always give accurate answers, primarily due to the lack of real time data and the difficulty of modelling complex catchment behaviours.

Figure 6.1 below show the results of the URBS model for the Warrego River at Charleville. Note while the model predicts the rising limb quite well, it does not show the impact of the last period of heavy rainfall which resulted in the peak.

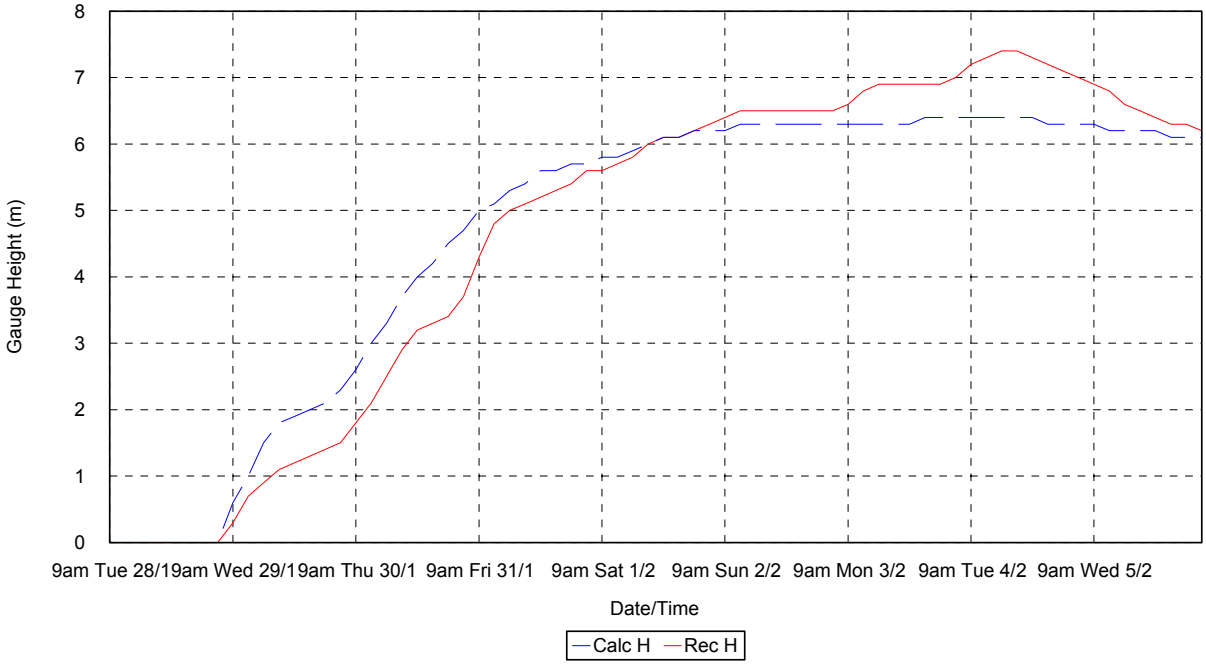

Figure 5.1 URBS Model - Warrego River at Charleville

Since this flood the models used in the FWC have been revised and updated.

5.3 Flood Warning Centre Computer Systems

The computer systems used in the FWC remained operational during the event with little down time. The telemeter interrogation package, MASTERS, and the ALERT software, both resident on HYNET, worked very well.

However, the only systems failure came at a critical time on Saturday morning 1 February. At this time, the link between ROCS and HYNET failed which 24 hour 9am rainfall data not finding its way

into the ALERT database and resulting in an incomplete database for modelling.

6.0 FLOOD WARNING SERVICES

6.1 Overview

The FWC issued over 218 Flood Warnings, summarised in Table 6.1, for rivers in western Queensland as a result of the heavy rainfall event in late January-early February 1997. There were 128 Flood Warnings where forecast heights were included for 16 locations in the flood affected catchments.

Table 6.1
Flood Warning Summary

Catchment	Initial Warning	Final Warning	Number of Warnings	Number of Predictions
Warrego River	4pm 29/1/97	10.00am 27/2/97	52	59
Thomson and Barcoo Rivers and Cooper Creek	4.40pm 30/1/97	9.55am 11/4/97	79	6
Paroo and Bulloo Rivers	10.40am 2/2/97	9.10am 3/3/97	33	35
Balonne-Maranoa Rivers and Wallam/Mungalla Creeks	5.20pm 2/2/97	9.55am 2/3/97	37	22
Weir River	10.30am 30/1/97	9.35am 6/2/97	17	06

6.2 Warrego River

The initial flood warning for the Warrego River was issued at 4.10pm on 29 January. This warning reported the heavy rainfalls in the upper Warrego catchment and warned of minor to moderate flooding.

Further warnings were issued on 30 and 31 January as more rain was recorded and river levels continued to rise.

The warning issued at 10.15am on 31 January contained the first height prediction for Charleville with a height expected of between 5.5 and 6.0 metres during the weekend causing moderate flooding. Further warnings were issued at 4.20pm on 31 January and 6.15am on 1 February.

At 10.20am on Saturday 1 February, the forecast height for Charleville was amended to 6.0 to 6.5 metres as a result of further rain and continued rises upstream. This warning also reported fast rises and minor flooding downstream of Charleville to Cunnamulla. Further warnings were issued at 4.30pm on 1 February, 6.50am on 2 February and 9.55am on 2 February. Major flooding was also forecast downstream to Cunnamulla.

The warning issued at 3.45pm on Sunday 2 February forecast a peak at Charleville of 6.6 metres later that day.

The next warning issued at 6.35am on 3 February reported falling flood levels at Charleville after an overnight peak of 6.5metres. However, at 10.40am, the warning reported further rain and renewed rises with the height at Charleville now expected to be about 7 metres the next morning with further gradual rises possible. Forecast heights were also issued for Wyandra and Cunnamulla.

The warning issued at 1.10pm on 3 February forecast a height in Charleville of 7.2 metres with further gradual rises. This warning was renewed at 3.20pm and 9.55pm and then at 6.35 am on the 4 February with amended forecasts for downstream locations at Wyandra and Cunnamulla.

In the 10.50am warning, the peak at Charleville was forecast to peak between 7.2 and 7.5 metres that afternoon. This warning was renewed at 3.30pm that afternoon.

The warning issued at 9.20pm reported a peak of Charleville of 7.45 metres at 5pm and the level was expected to fall slowly. Flood levels were at or near their peak upstream at Augathella and The 27 Mile Gardens. Peak forecasts of 9.5 metres at Wyandra and 10.0 metres at Cunnamulla were also re-issued. This warning was renewed at 6.35am and 10.25am on 5 February.

The warning at 4.20pm forecast peaks at Wyandra of 9.7 metres and at Cunnamulla of 10.0 metres. At 7.05am the next day, the Cunnamulla forecast was amened to 10.1 metres and this forecast was renewed at 3.20pm that day.

The warning issued at 6.45am on 7 February reported a Wyandra peak of 9.78 metres. The warning was renewed at 3.30pm that day and again at 6.35am and 4.00pm on 8 February.

At 7.00am on 9 February, a peak of 9.8 metres was reported from Cunnamulla. Further warnings were issued as floodwaters moved downstream from Cunnamulla to the New South Wales border. There were also some renewed rises at Charleville which caused moderate to major flooding downstream.

The final flood warning for the Warrego River was issued at 10.00am on 27 February.

6.3 Thomson and Barcoo Rivers and Cooper Creek

The initial warning was for the Barcoo River at 4.40pm on 30 January. Moderate flooding was predicted in the Blackall to Retreat area. The next warning at 7.20am on 31 January advised of rises in the Thomson and Alice Rivers.

This warning was renewed at 10.20am and 4.30pm on 31 January and at 7.10am, 10.20am and 4.55pm on the 1 February. Further warnings were issued on 2 February with moderate flooding reported in the Thomson River above Longreach and major flooding in the Barcoo River downstream of Blackall. The warning issued at 7.05am on 3 February reported further rain and renewed rises in the upper Barcoo River. Moderate flooding was also reported from Cooper Creek at Karmona.

On 4 February, the 10.20am warning forecast moderate flooding in the Thomson River from Longreach to Jundah. Major flooding on the Barcoo River was expected to extend to the Retreat area.

The warnings issued on 5 February reported renewed rises and major flooding on the Barcoo River in the Blackall area. On Cooper Creek, moderate to major flooding was expected in the Windorah area. River levels were peaking in the Blackall area that afternoon and also in the Isisford area.

On 6, 7 and 8 February, the warnings reported falling flood levels in the Blackall area and the main flood peak on the Barcoo River in the Isisford to Retreat area. Minor flood levels continued on the Thomson River between Longreach and Jundah.

The warning issued at 7.45am on 9 February forecast a peak at Windorah on Cooper Creek of

between 6 and 7 metres by the next weekend. The main flood peak on the Barcoo was expected at Retreat in the next day or so. This warning was renewed on 10 February.

At 9.55am on 11 February, the peak forecast for Windorah was about 6.5 metres. The Barcoo River had peaked at Retreat and on the Thomson River, there was moderate flooding at Jundah.

On 12 February, the forecast for Windorah was amended to 6.0 metres. This warning was renewed on 13,14 and 15 February.

Warnings continued for Cooper Creek for several weeks as the floodwaters moved downstream and was eventually finalised on 14 April.

6.4 Paroo and Bulloo Rivers

The initial warning was issued for the Paroo River on 2 February at 10.20am with flooding expected in the Humeburn to Eulo areas. The afternoon warning forecast a major flood height of height of 4.50 metres at Eulo.

The next warnings on 3 February included the Bulloo River with minor to moderate flooding reported at Milroy and minor flooding expected at Quilpie.

On 4 and 5 February, major flooding was expected to extend downstream from Eulo.

The warning issued on 6 February forecast a major flood peak on the Paroo River at Hungerford of about 2.2 metres by 9 February. On the Bulloo River minor flooding was expected to extend downstream to Thargomindah.

The warning on 7 February amended the peak forecast for Hungerford to 2.0 metres. The peak at Thargomindah was forecast to be 4.7 metres on 10 February.

This warning was renewed on 8 and 9 February. The warning on 10 February amended the Hungerford forecast to 1.90 metres on 11 February and another peak was expected the following weekend due to renewed rises at Eulo. Thargomindah forecast peak was 4.80 metres on 11 or 12 February.

In the warning on 11 February, the Thargomindah peak forecast was 5.20 metres on 12 February. On 12 February, the Paroo River at Hungerford was near its peak but renewed rises to 2.0 metres were expected. On the Bulloo River, Thargomindah was at 5.12 metres and near its peak.

On 13 February, the major flood peak at Hungerford was expected to be 2.1 metres on about 16 February. The Bulloo River at Thargomindah had commenced to fall with moderate flooding.

By 14, 15 and 16 February, renewed rises were reported from the upper Paroo River and on the Bulloo River.

Further warnings were issued during February as these floodwaters moved downstream. The final warning for the Paroo and Bulloo Rivers was issued at 9.10am on 3 March.

6.5 Other Western Rivers

The initial flood warning for the Weir River was issued at 10.30am on 30 January. Fast river rises

were occurring in the Weir River downstream of the Yarrill Creek junction. Moderate flooding was expected downstream to the Talwood area. Warnings of moderate flooding continued for several days with the final warning issued on 6 February.

The first flood warning for the Maranoa and Balonne Rivers and Wallam and Mungallala Creeks was issued at 5.20pm on 2 February. Moderate flooding was expected downstream of Mitchell on the Maranoa River extending to the Balonne River downstream of St George. Flooding was occurring on the Wallam and Mungallala Creeks.

By 5 February, the warning was reporting major flooding in the Maranoa River with a peak forecast of 7 metres at St George late on 8 February with major flooding in the lower Balonne River.

By 6 February, there was moderate flooding in the Maranoa River. Moderate flooding was easing at Bollon on Wallam Creek and on Mungallala Creek.

The flood warning issued on 7 February forecast a peak at St George of between 6 and 7 metres.

On 8 February, the flood warning was issued for the lower Balonne River. Major flooding was expected downstream of St George and peak forecasts were issued for Whyenbah and Dirranbandi.

By 10 February, the warning included a forecast of minor flooding at Hebel in 5 to 7 days which was re-issued for several days.

On 17 February, some heavy rainfall caused renewed rises in the Maranoa and Balonne River with major flooding reported in the Bollon area. Flood warnings continued for the rest of February with the final warning for the lower Balonne issued on 2 March.

7.0 CONCLUDING REMARKS

Since the event, the Bureau has conducted internal reviews and participated in meetings with relevant agencies, including Emergency Services and Local Governments, aimed at improving all aspects of the warning services.

In particular,

* Meetings have been held with Murweh Shire aimed at improving liaison during floods
* Flood warning information and data have been provided to Murweh and Blackall Shire
* The Bureau and Murweh Shire have agreed to again upgrade the flood warning network above Charleville.
* The flood forecasting model for Charleville has been extensively reviewed and updated.
* Additional river height stations have been installed in the Alice and Barcoo River systems.

Activities such as these are ongoing and are not fully documented within this report.