



Jamieson Flood Scoping Study

Mansfield Shire Council

Final Report

February 2003

SINCLAIR KNIGHT MERZ

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Executive Summary.

The purpose of this scoping study is to:

- investigate and gain an understanding of the nature of flooding through Jamieson;
- identify gaps in the existing information and the need for improved information;
- undertake a preliminary damage assessment; and
- scope mitigation measures.

The available flood data provided a basis of understanding the flood impacts. The data comprised stream flow information, historic accounts of floods, a 1912 flood photo, earlier flood inundation maps and a number of historic flood levels. The data is documented and reviewed in **Section 2** and **Appendix A**.

Of particular importance was the documentation of historic flood levels. Additional levels were obtained and surveyed as part of this study. Four cross sections of the river were also surveyed.

Hydrologic analysis was undertaken for two gauge stations located along the Jamieson and Upper Goulburn Rivers, just upstream of Jamieson, in order to estimate the 100 – year ARI flood flows at Jamieson.

The estimated 100 year ARI flood flows for the two rivers are as follows:

	<u>Jamieson</u>	<u>Upper Goulburn</u>
□ lower 90% confidence limit	13,600 ML/d	19,000 ML/d
□ mean	16,600 ML/d	23,600 ML/d
□ upper 90% confidence limit	20,300 ML/d.	28,000 ML/d.

With the assistance of the four surveyed cross sections, and a steady state hydraulic model, calibrated to September 1998 flood levels, and validated to July 1986 and October 1993 flood levels, 100 –year ARI flood levels were estimated for Jamieson. Because of the limited period of gauge records, a slightly conservative approach was taken, with the flow corresponding to the upper 90% confidence limit used in preference to the mean.

Flood levels along the Upper Goulburn River were found not to influence flood levels at Jamieson, except at the confluence, which is affected by the levels of Lake Eildon. A downstream flood level of 290.20 m AHD was adopted to take into account the effects of the lake.

Field survey was undertaken to delineate the extent of flooding from a 100 year ARI event, and for a flood producing levels 0.5 metres below this. Results are shown in **Appendix B**.

Flood damages and social impacts were estimated using a "Rapid Appraisal Method" (RAM) developed for NRE to assist the rapid evaluation of floodplain management projects in economic, social and environmental terms. Additional information was provided through an earlier study of a caravan park at Nagambie.

The average annual damage (AAD) for Jamieson is estimated at \$341,800 per annum. Approximately half the damages are associated with the Caravan Park.

The average number of people exposed to the effects of flooding each year is estimated to be 41 people per annum. The majority is linked to the Caravan Park.

Recommended flood mitigation options for Jamieson are restricted to non structural measures. Structural measures, such as levees and retardation basins, are not considered appropriate because of their expense and ongoing maintenance costs, the fact that comparatively few people would benefit, and the potentially adverse environmental effects.

The estimated 100 year flood extent and levels produced from this study provide a sound basis for ensuring development on the floodplain at Jamieson is compatible with the flood risk.

It is recommended that:

- the 100-Year ARI flood levels and flood extent map be adopted for planning purposes; and
- the information presented is used to prepare floodway and land subject to inundation zone and overlays for incorporation into the Shire's municipal planning scheme.

It is further recommended that improvements to emergency response arrangements be undertaken for the Caravan Park, in view of the flood risk.

In the longer term (and subject to the availability of funding) further work could be undertaken to improve the flood risk assessment, in particular:

- ground level and floor level survey;
- a joint probability analysis of the two rivers be undertaken in conjunction with investigations into the level of Lake Eildon;
- hydraulic modelling to improve 100 year flood estimates; and
- a review of flood control overlays (Floodway and Land subject to inundation) when better data becomes available.

Provided future planning controls are put into place, and new floor levels are based on an appropriate margin above the estimated 100-year ARI flood levels, it is considered that at the present time, the preparation of a detailed floodplain management plan for Jamieson is not warranted.

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1. Introduction

Sinclair Knight Merz has been commissioned by Delatite Shire Council to undertake a scoping study for the township of Jamieson. The purpose of the study is to:

- investigate and gain an understanding of the nature of flooding through Jamieson;
- identify flood impacts and flood risk to the community;
- identify gaps in existing information and the need for improved information;
- undertake a preliminary damage assessment, and
- scope mitigation measures.

This report presents the findings of the scoping study as three main outcomes:

- examination of historic floods and impacts to establish the context for further works or measures if required as a subsequent stage;
- preparation of flood inundation maps and 100-year ARI¹ flood levels for statutory planning purposes; and
- identifying potential flood damages, issues and potential solutions that can be addressed in a detailed Floodplain Management Study if the potential benefits of such a study justify its need.

This study has been prepared under the Commonwealth Natural Disaster Risk Management Studies Program.

1.1 Background

Located at the head of the Goulburn River, where the Upper Goulburn and Jamieson Rivers join Lake Eildon, Jamieson had its origins as a supply town for sending supplies to the more remote working mines, after gold was discovered in the area in 1854.

At its peak Jamieson had a population of 3000 to 4000. Today the permanent population averages around 100 to 125. Many of its historic buildings still remain including the Court House Hotel, which is an elegant reminder of a town that supported fourteen hotels and several breweries in its heyday.

Today, Jamieson is a quiet rural town known for its local trout fishing and gold panning for holiday fossickers (Ref. <http://home.vicnet.net.au/~jdhs/5jamieson.htm> – home page).

Jamieson has experienced numerous floods, although little documentary evidence is available. Details of historic floods are discussed in **Section 2**.

¹ This is the likelihood of occurrence of flooding expressed in terms of the long-term average number of years between the occurrence of a flood of equal or greater magnitude to the flood being considered. For example, a flood with a discharge equal or greater than the 100-year ARI flood will occur on average every 100 years.

Flood behaviour at Jamieson has been influenced by the formation of Lake Eildon (3,390 GL capacity) in the 1950s, which, when full, will affect flood levels in the lower reaches of the Upper Goulburn and Jamieson Rivers. Prior to 1950, a smaller lake existed behind the current lake - Sugarloaf Reservoir (377,000 ML capacity) constructed after the 1912-1914 drought.

The comparatively recent September 1998 flood was the largest flood in recent times. Fortuitously, a number of flood levels were pegged and surveyed. Among other things this study extends this work to provide estimates of 100-year ARI flood levels and the flood extent at Jamieson.

1.2 Scope

The scope of work is summarised from the Study Brief in **Table 1-1**.

■ Table 1-1 Summary of Scope

Terms of Reference	Description
1	History of Flooding and Review of Information: <ul style="list-style-type: none"> • Research studies, reports and any historic newspaper articles and photographs. • Identify available streamflow, rainfall, flood behaviour, level and extent information • Contact stakeholders for flood data • Document findings.
2	Flood Level Survey and General Flood Information: <ul style="list-style-type: none"> • Interview residents for details of nature of flooding, community perception and awareness of flooding • Locate and survey additional flood levels • Survey cross sections at key locations.
3	1998 Flood Profile Analysis: <ul style="list-style-type: none"> • Determine the average recurrence interval for the 1998 flood • Determine peak flow rates for Jamieson.
4	1998 Flood Profile Analysis: <ul style="list-style-type: none"> • Estimate 100-year ARI flood flow and levels • Prepare 100-year ARI flood level contours.
5	Flood Maps: <ul style="list-style-type: none"> • Carry out trace survey for the 100-year ARI flood extent and the 1% flood extent less 500 mm • Prepare flood maps for this information • Describe the nature of flooding throughout Jamieson and estimate frequency of chosen historic floods.
6	Preliminary Flood Risk Assessment: <ul style="list-style-type: none"> • Carry out a preliminary flood damage assessment including damage estimates for the 100-year ARI event and the Average Annual Damage.
7	Future Studies: <ul style="list-style-type: none"> • Identify gaps in existing information • Identify possible risk treatment options • Make recommendations and justifications regarding any future studies or detailed floodplain management study.

1.3 Consultation

Consultation was undertaken with relevant agencies and other stakeholders information, as summarised in **Table 1-2**.

■ **Table 1-2 Consultation**

Date	Persons/Agencies Consulted	Notes/Issues
26/06/02	Guy Tierney, GBCMA	Guy handed over flood data and files at inception meeting held at the Sinclair Knight Merz Armadale Office.
26/06/02	Barbara Bateson, Secretary, Jamieson & District Historic Society	Barbara advised that no data was available. Flood photographs may be available at the museum, but these were not inspected. They are of limited value to the study.
25/09/02	Matthew Woodward, Senior Planning Officer, Delatite Shire	Provided flood information.
31/07/02 & 29/08/02	Ian Barry & Lynne Maxwell, VicRoads	Ian and Lynne were contacted for bridge information.
3/02/2003	Bill Viney, Goulburn-Murray Water	No information available.
17-19/07/02 & 20-22/11/03	Local residents	Provided flood marks for survey.

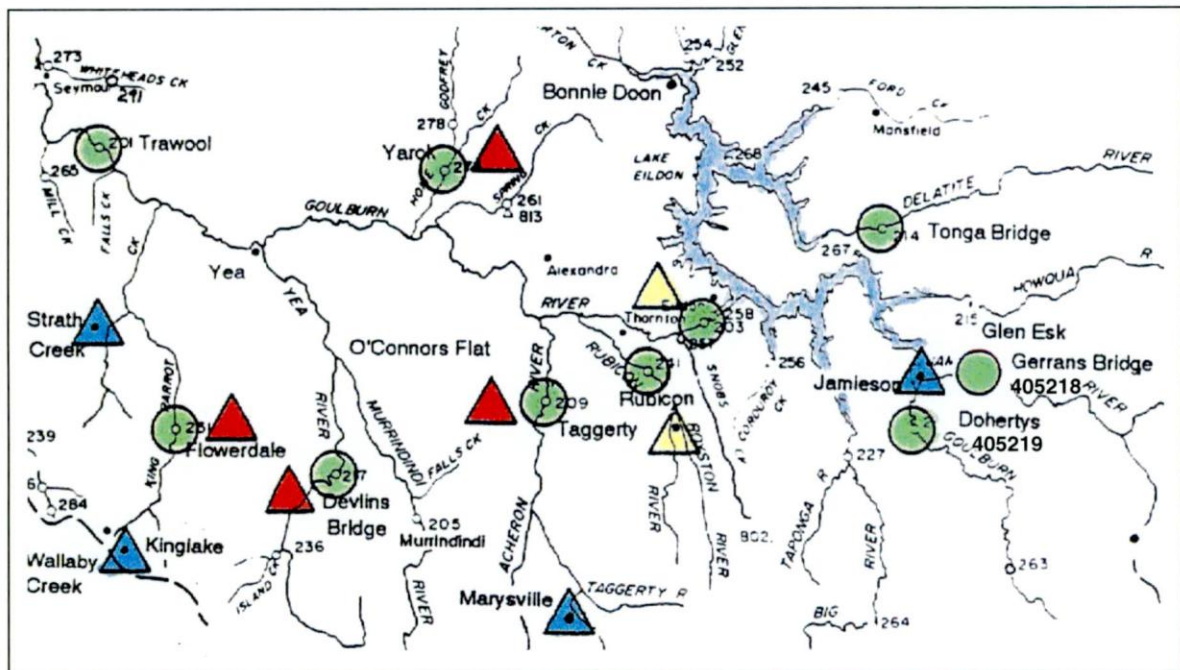
2. Flood Information

2.1 Hydrological Data

Available rainfall and streamflow data for the upper part of the Goulburn River is presented in **Figure 2-1**. There are two gauge stations of relevance to Jamieson, Upper Goulburn River at Dohertys (405219) and Jamieson River at Gerrans Bridge (405218). Both gauge stations were installed in 1954, and one needs to go to the Goulburn River gauge stations at Eildon (405203) or Trawool (405201) for a longer record. Details of these four gauge stations are listed in **Table 2-1**.

■ **Figure 2-1 Data Collection Network**

Source Bureau of Meteorology



- Telemetry River Gauge
- Manual River Gauge
- ▲ Telemetry Rain Gauge
- ▲ Floodwarn Rain Gauge
- ▲ AWS / Synoptic Rain Gauge
- ▲ Manual Rain Gauge

■ **Table 2-1 Gauge Stations**

River	Gauge Station Number & Location	Period of Observation	Gauge Station Area (km ²)
Upper Goulburn River	405219, Dohertys	Aug. 1954 to date	694
Jamieson River	405218, Gerrans Bridge	Jul. 1954 to date	368
Goulburn River	405203, Eildon	Jan. 1916 to date	3,911
Goulburn River	405201, Trawool	Jan. 1908 to date	7,335

Details of major floods for the Upper Goulburn River and Jamieson River, from 1954 to June 2002 are listed in **Table 2-2**, along with flood frequencies, expressed as the “Average Recurrence Interval” (ARI).

Corresponding data for the Goulburn River at Eildon is also listed for comparison. It should be noted that inflows from other tributaries, and the operation of Eildon Weir itself, could affect the timing and magnitude of peak flows out of Lake Eildon.

The results from **Table 2-2** indicate that Lake Eildon can have a significant effect in mitigating floods.

■ **Table 2-2 Significant Floods**

Month, Year	Jamieson 405218			Upper Goulburn 405219			Goulburn @ Eildon 405203		
	Flow ML/d	Gauge Height (m)	ARI ¹	Flow ML/d	Gauge Height (m)	ARI ¹	Flow ML/d	Gauge Height (m)	ARI ²
August 1955	9,650	3.57	4.5	12,000	3.11	4	11,460	2.66	1.3
April 1956	8,400	3.35	4	8,600	2.35	2	3,150	1.47	<1
August 1956	10,400	3.71	7	15,600	3.89	8.5	34,500	4.66	4
August 1958	8,600	3.37	4	15,800	3.93	10	6,500	2.05	1
July 1964	11,200	3.85	8	14,500	3.65	6	6,150	2.01	1
October 1968	12,900	4.16	25	15,400	3.84	8.5	3,750	1.59	1
July 1974	11,100	3.92	8	14,200	3.58	6	15,350	3.06	1.3
May 1975	12,300	4.05	19	1,550	0.94	<1	4,650	1.76	1
July 1975	10,600	3.74	7	9,000	2.43	2	3,950	1.63	<1
July 1986	10,300	3.69	7	14,100	3.57	6	170	0.55	<1
September 1993	4,850 ³	2.66	1.4	15,500	3.86	8.5	36,800	4.82	5
October 1993	10,316	3.69	7	7,400	2.07	1.6	40,130	5.05	6
June 1995	12,000	4.00	18	13,000	3.33	5	485	0.74	<1
October 1996	12,350	4.06	20	14,800	3.71	8	17,225	3.24	2
September 1998	15,306 ⁴	4.47	80	19,300	4.66	40	2,300	1.29	<1

Notes	
1	Refer to Section 4 for flood frequency analyses
2	Approximate only, based on Thiess Environmental Services Pty Ltd : <i>Flood Warning Station Information Manual</i> , February 1999.
3	While the September 1993 flood was not as significant along the Jamieson River as the Upper Goulburn River, flooding still occurred at Jamieson.
4	Largest flood at Jamieson since at least 1955.

2.2 Existing Flood Data

A requirement of this project was to research potential sources of flood data. As indicated in **Table 2-3**, a number of flood levels obtained as a result of a flood reconnaissance by the Goulburn Broken Catchment Management Authority shortly after the September 1998 flood, provided the best source of flood information. These were surveyed in June 2001, during which a number of flood levels from earlier events were also picked up.

■ **Table 2-3 Flood Data**

Type	Comments
Flood Photography	A number of flood levels were obtained from a copy of a 1912 flood photo supplied by the Jamieson & District Historic Society.
Flood levels	Flood reconnaissance and survey in 1998 and 2001 identified a number of historic flood levels for the 1912, 1986, 1993 and 1998 floods.
Flood Maps	The flood map prepared as part of NRE's "Flood Data Transfer" Project pre-dates the September 1998 flood and was based on very limited information. An approximate 1998 flood extent was compiled in June 2002 (GBCMA File FPM/01/018).
Flood Structures	A review of bridge details from a database compiled by LICs for West Gippsland CMA revealed no documented flood information.
Flood Studies	None available.
Historic newspapers	An article on the September 1912 flood appeared in the September 1912 edition of the Jamieson Chronicle. No specific mention of flooding was found in a search of other editions of this paper or a similar search of the Mansfield Courier for details of floods at Jamieson.

Further details of information sources are given in **Appendix A**.

2.3 Newspaper Records of Floods

Anecdotal evidence points to a number of large floods at Jamieson prior to 1955, including 1912, 1934 and 1939. All three events preceded the construction of Lake Eildon in the 1950's.

Newspaper records indicate that the 1912 event was the largest flood since Jamieson was settled up to that date. No information was found for the August 1939 flood, although the *Mansfield Courier* (August 25 edition) observed that, while there was exceptionally heavy rain that month, floods in the region were not as severe as other areas. The 21 December 1934 edition of this newspaper mentioned that a "Jamieson Flood Fund" had been set up, but no details of the flood were provided.

Comparison with flow records at Eildon indicated large regional floods (in addition to the December 1934 and August 1939 events) occurred in August/September 1916, June to October 1917, May to July 1918, September 1921, October 1923, July 1942, July 1952, and October 1953.

The *Mansfield Courier* provided a few details of floods in the Mansfield/Lake Eildon area (July 1917, September 1921 and October 1923). However no specific details of floods at Jamieson could be found.

2.4 Review of Available Information

Having regard to the limited information and the results of further flood level reconnaissance and survey (described in **Section 3**) the following comments are made in respect of the accuracy and reliability of the information:

- A reasonable number of flood levels have been surveyed, including high reliability flood levels associated with the September 1998 flood. As this was a large event (40-year ARI) the 100-year flood levels can be estimated with a reasonable degree of confidence.
- There is a need for greater documentation of flood impacts for Jamieson, particularly the duration of flooding and the possible impacts of flowpaths. One flow path passes through the centre of the town, and while blocked at a number of roads, localised flooding and/or stormwater drainage may affect some houses.
- Detailed ground survey, and also possibly floor level survey, is desirable in the long term to fully determine flood impacts.
- The hydrology is not fully understood for the area, especially the inter-relationship between flows along the Upper Jamieson and Goulburn Rivers and at Lake Eildon. Further comments on hydrology are given in **Section 4**.

3. Flood Survey

As part of this scoping study, LICS Pty Ltd undertook a survey of Jamieson and its surrounds, in two stages.

3.1 Stage 1

This comprised of survey across the Jamieson River at four locations and a reconnaissance and survey of flood levels. Key residents were interviewed to establish the nature of flooding and to identify any flood marks from these landowner discussions.

Plan 540227 – Sheet 2 (**Appendix B**) shows the location of four cross sections, established in consultation with Mr Guy Tierney, Goulburn Broken CMA. The information was used to derive a margin between the September 1998 flood levels and the estimated 100-year ARI flood levels in **Section 5**.

Plan 540227 – Sheet 1 – incorporates 21 newly surveyed flood levels with 22 from an earlier survey.

All newly surveyed flood levels were documented with an interview sheet, site description, photograph, level reference number and reliability rating, and have been incorporated into GBCMA file FPM/01/018 containing information from a previous survey.

3.2 Stage 2

In **Section 5.4**, estimated 100-year ARI flood levels were determined and were used in conjunction with a trace survey to produce a flood inundation map showing:

- the 100-year ARI flood extent;
- a flood extent corresponding to an event producing flood levels 0.5 m below the 100-year ARI event;
- flood contours for the above events; and
- the approximate location of dwellings within the inundated areas.

A reduced copy of the map is included in **Appendix B**.

4. Hydrology

Flood frequency analyses were undertaken to estimate the magnitude of the 100-year ARI floods for the Jamieson and Upper Goulburn Rivers at Jamieson, based on results from their stream gauges at Gerrans Bridge and Dohertys.

4.1 Jamieson River

A daily instantaneous flow record was available on the Jamieson River at Gerrans Bridge (405218), approximately 5 km upstream of Jamieson. Data was available between February 1959 and May 2002, with only one day of missing data during this period.

This daily flow record was transposed downstream to coincide with the catchment at Jamieson, using a regionally-based formula derived from Grayson et al, (1996):

$$Q1/Q2 = (A1/A2)^{0.763} \text{ where}$$

Q1 and A1 are the flow rate and catchment area at Jamieson (385.9 km²); and
Q2 and A2 are the flow rate and catchment area at Gerrans Bridge (368 km²).

A Generalised Extreme Value (GEV) theoretical distribution was then fitted by the method of higher order L-moments (Wang, 1997) to the annual series of peak flows (the largest peak flow in each year of record). This method has the advantage that it gives greater weight to the larger peak flows and is thus less influenced by low (or zero) values in the annual series. The use of GEV / LH-moments is to be recommended in the revised flood frequency chapter of Australian Rainfall and Runoff. Confidence limits (90%) of the fit were also generated using a boot strapping technique.

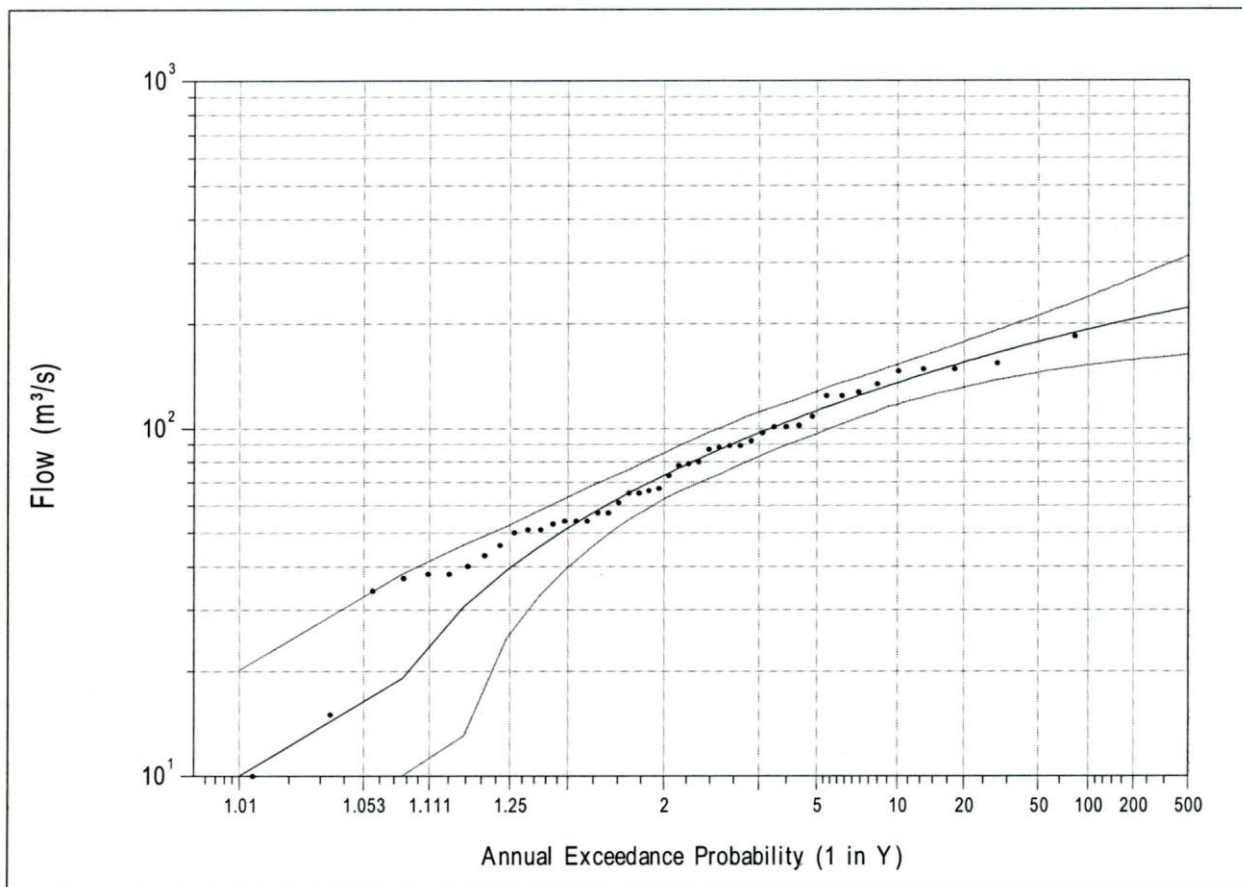
The results of the flood frequency analysis are illustrated in **Figure 4-1**.

The estimated magnitude of the 1 in 100-year flood of the Jamieson River at Jamieson is 192 m³/s (16,600 ML/d). The upper and lower limits of the 90% confidence interval are 157 m³/s (13,600 ML/d) and 235 m³/s (20,300 ML/d) respectively.

It should be noted that this low rate is substantially below that estimated from an empirical equation developed by N Nikolaou and Roel von't Steen, which compared the results of a large number of floods along the Great Dividing Range (DCNR, 1994):

$$Q = 4.67 \text{ Area}^{0.763},$$

where the catchment area is 385.9 km². This yields a flow rate of 439.3 m³/s (38,000 ML/d).



■ Figure 4-1 Flood Frequency Relationship for the Jamieson River

4.2 Upper Goulburn River

The analysis was repeated for the Goulburn River at Jamieson.

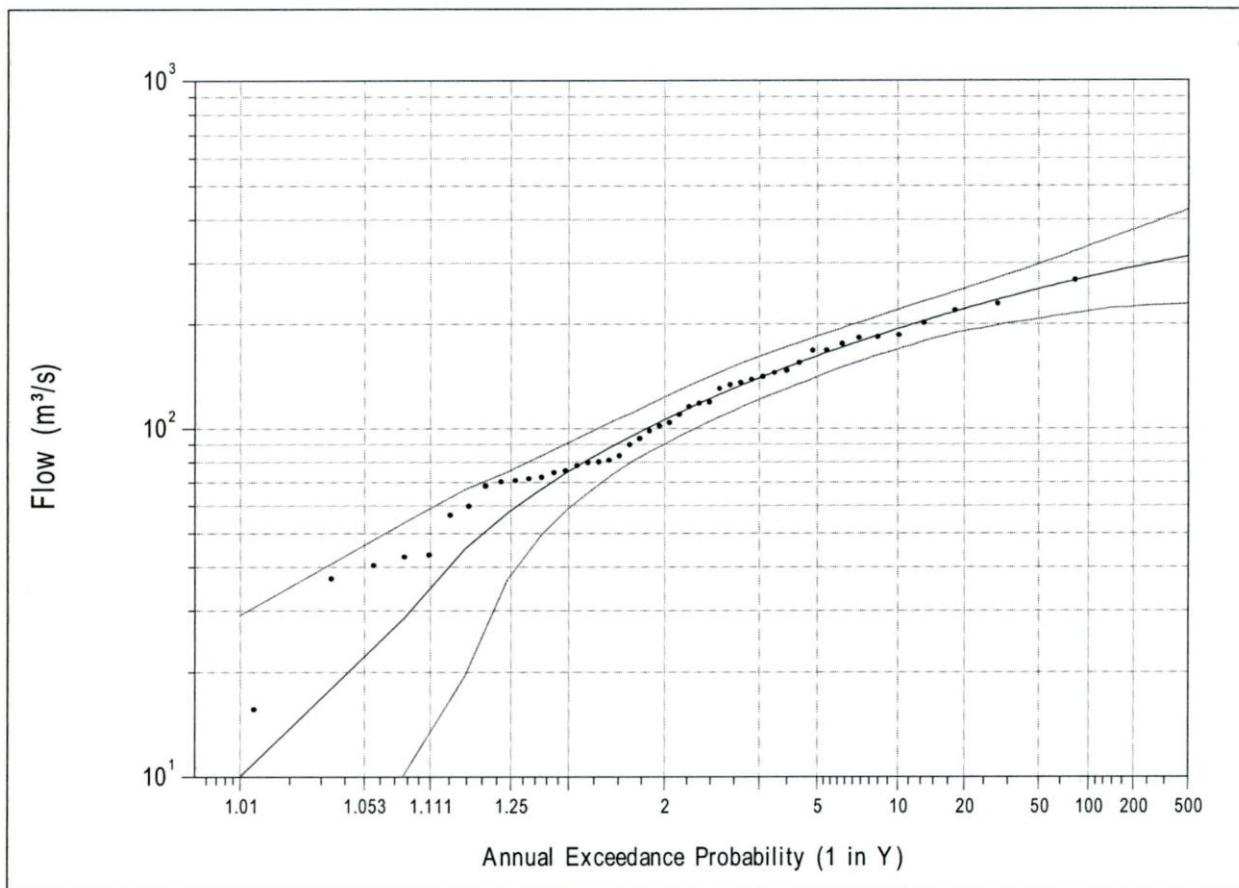
Recorded data was available at Dohertys (405219), 6 km upstream of Jamieson, between August 1954 and June 2002. This data was transposed to Jamieson using the same formula in Section 4.1 (the catchment areas being 718.8 km² and 694 km² respectively).

A flood frequency analysis was undertaken using the same methodology for the Jamieson River. Results are illustrated in Figure 4-2.

The magnitude of the 100-year ARI flood event for the Goulburn River at Jamieson is 273 m³/s (23,600 ML/d), with upper and lower 90% confidence limits of 220 m³/s (19,000 ML/d) and 329 m³/s (28,000 ML/d) respectively.

As with the Jamieson River at Jamieson, this flow rate is substantially below that estimated from an equation curve developed by N Nikolaou and Roel von't Steen (DCNR, 1994):

$Q = 4.67 \text{ Area}^{0.763}$, where the catchment area is 718.8 km². This yields a flow rate of 706.2 m³/s (61,000 ML/d).



■ Figure 4-2 Flood Frequency Relationship for the Goulburn River at Jamieson

4.3 Flow Correlations

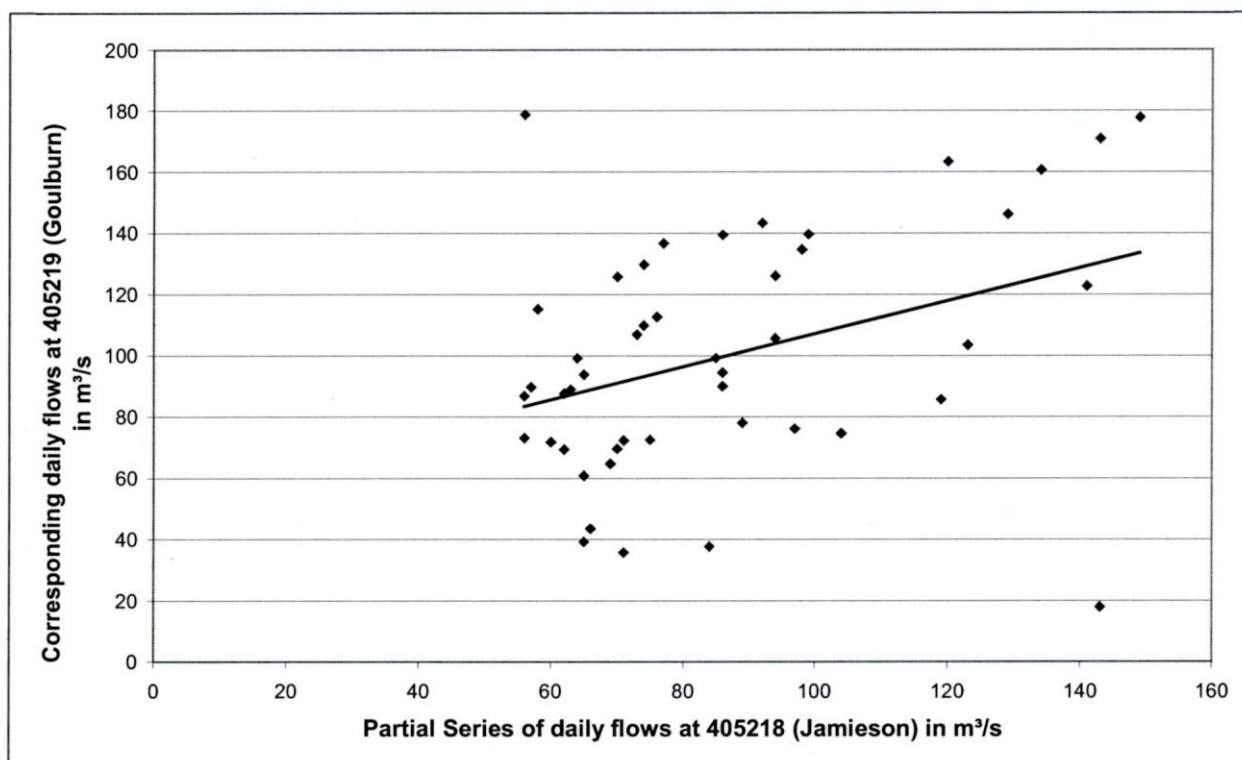
To see if there was a pattern between flows in the Upper Goulburn River and Jamieson River catchments, the 48 largest instantaneous flows for the Jamieson River at Gerrans Bridge was plotted against Upper Goulburn River flows, as a partial series².

The x-axis of this plot shows the magnitude of the 48 largest instantaneous flow events recorded for the Jamieson River. The y-axis is the corresponding flow on the Upper Goulburn River. For example, on the 4th of October 1993 a peak flow of 199 m³/s was recorded on the Jamieson River and a flow of 86 m³/s was recorded on the Goulburn River.

As illustrated in **Figure 4-3** the flows in the Goulburn River and Jamieson River are reasonably correlated, indicating that when flows along the Jamieson River are high, so too are flows along the Upper Goulburn.

² A "partial series" is one in which only flood peaks greater than a threshold flood (in this case the flow just below the 49th largest flood) are analysed. The flood frequency analyses undertaken in **Sections 4.1 and 4.2** were based on an "annual series" in which only the maximum flood peak for each year was considered.

If or when a detailed Flood Study is warranted for Jamieson, it is recommended that a more detailed joint probability analysis of the two rivers be undertaken in conjunction with investigations into the level of Lake Eildon. For this study a simplified approach has been adopted to estimate 100-year ARI flood levels at Jamieson, as described in Section 5.



■ Figure 4-3 Correlations of high flow events between the Jamieson River and the Goulburn River.

5. Determination of Flood Levels

The following approach was adopted to estimate 100-year ARI flood levels:

- 1) A flood profile for Jamieson River at Jamieson was prepared, based on September 1998 flood levels. This was the largest flood for which flow records are available and was approximately a 40-year ARI event (refer **Table 2-2**).
- 2) A steady state hydraulic model was developed using the 4 surveyed cross sections. The model was calibrated to the September 1998 peak flow rates. The measured peak 1998 flow at the Gerrans Bridge gauge station was 177.15 m³/s (15,306 ML/d), and this was transposed to Jamieson using the technique described in **Section 4.1**. The peak 1998 flow at Jamieson was calculated as 183.7 m³/s (15,900 ML/d).
- 3) The results were validated against recorded flood levels for the July 1986 and October 1993 floods. The measured flows at Gerrans Bridge for these two events were 119.54 m³/s (10,330 ML/d) and 119.40 m³/s (10,320 ML/d) respectively. Transposed to Jamieson the flows were 123.96 m³/s (10,710 ML/d) and 123.81 m³/s (10,700 ML/d) respectively.
- 4) The model was then run for 100-year ARI flood conditions at Jamieson.

It should be noted that a surveyed cross section across both the Jamieson and Upper Goulburn Rivers showed that the bed of the Jamieson River was approximately 0.57 m higher than the bed of the Upper Goulburn River. River levels differed by 1.38 m at the time of the survey, (the Jamieson River having the higher level) strongly indicating that the effect of the Upper Goulburn River on flood levels at Jamieson will be marginal, particularly since both river longitudinal gradients are large. Notwithstanding this, the level of Lake Eildon will have an effect on flood levels for the lower reaches of the township.

5.1 Flood Profile

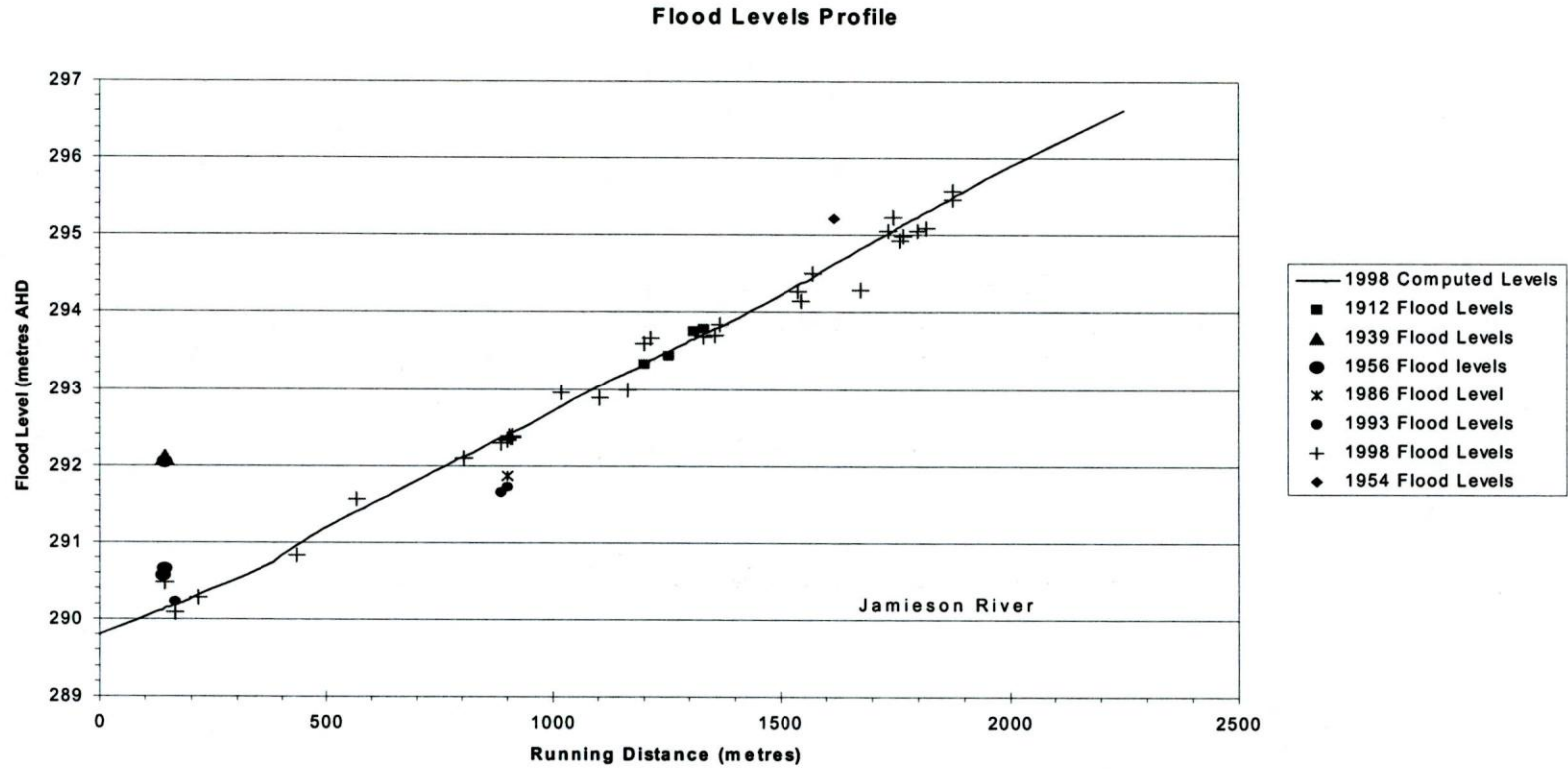
A plot of historic levels versus river distance is shown in **Figure 5-1**, along with results from the hydraulic model for the September 1998 flood. It is interesting to note that the 1912 flood (at the time the flood photo from which the flood levels were extracted) produces similar flood levels to the September 1998 event, which suggests this flood may have had similar average recurrence intervals. However the difference in timing between the flood peak and the time of the photography is not known.

A 1939 flood level and three 1956 flood levels at RD 145 m do not appear consistent with current trends. These flood levels came from the same source, and no reason could be found for the discrepancies.

Likewise a 1954 flood level at RD 1620 m was well above more recent flood levels, and is considered to be an anomaly.

These levels are likely to precede the filling of Lake Eildon.

■ Figure 5-1 Flood Profile



5.2 Model Calibration

As indicated previously, a hydraulic model was developed to simulate flood conditions at Jamieson. The four surveyed cross sections formed the basis for determining the geometric parameters of the model, with cross sections estimated at the upstream and downstream extents of the model and adjusted to mimic the expected characteristics of the bed and river slope.

The industry standard HECRAS software was used to produce the model. This had the capability of automatically generating interpolated cross sections. The model was calibrated to the 1998 peak flood flow of 183.7 m³/s (15,870 ML/d) and results are shown in **Table 5-1**.

■ **Table 5-1 Model Parameters**

River Chainage (m)	Minimum Bed Level (m AHD)	Computed Water Surface Elevation (m AHD)	Average Channel Velocity (m/s)	Flow Area (m ²)	Manning's "n"	
					Channel	Overbank
2250**	292.07	296.63	1.76	127.61	0.058	0.09
2092*	291.8	296.17	1.84	119.15	0.058	0.09
1933*	291.54	295.68	1.86	116.93	0.058	0.09
1775	291.07	295.16	1.91	112.45	0.058	0.09
1617*	290.76	294.63	1.94	114.49	0.055	0.09
1458*	290.44	294.09	1.93	119.27	0.055	0.09
1300	290.13	293.63	1.61	174.42	0.058	0.09
1117*	289.32	293.08	1.69	148.56	0.058	0.08
933*	288.51	292.50	1.80	136.86	0.058	0.08
750	287.71	291.95	1.96	125.08	0.050	0.08
620*	287.36	291.56	2.10	121.04	0.050	0.08-0.09
490*	287.01	291.17	2.16	115.62	0.050	0.07
360	286.67	290.68	2.41	102.16	0.050	0.07
180*	286.04	290.22	1.95	127.37	0.050	0.06
0**	285.67	289.80	1.93	123.11	0.050	0.05

Notes
 * Interpolated cross section
 ** Extrapolated cross section

Calculated 1998 flood levels from the model are plotted against recorded flood levels in **Figure 5-1**. Generally results are within +/- 0.15 m, which is considered reasonable having regard to natural fluctuations in the levels.

When the flood levels are averaged out by plotting out a best fit curve of flood level versus river distance, the margins between the levels calculated from the model and the "best fit" flood levels generally range from -0.02 m to 0.06 m, as can be seen from **Table 5-2**.

■ Table 5-2 Calibration Against Best Fit 1998 Flood levels

River Chainage (m)	Best Fit 1998 Flood level (m AHD)	Computed 1998 Flood Level (m AHD)	Difference (m)
1775	295.10	295.16	0.06
1617*	294.60	294.63	0.03
1458*	294.10	294.09	-0.01
1300	293.60	293.63	0.03
1117*	293.10	293.08	-0.02
933*	292.55	292.50	-0.05
750	291.95	291.95	0.00
620*	291.55	291.56	0.01
490*	291.10	291.17	0.07
360	290.70	290.68	-0.02
180*	290.10	290.22	0.12
0**	289.80	289.80	0.00

Notes

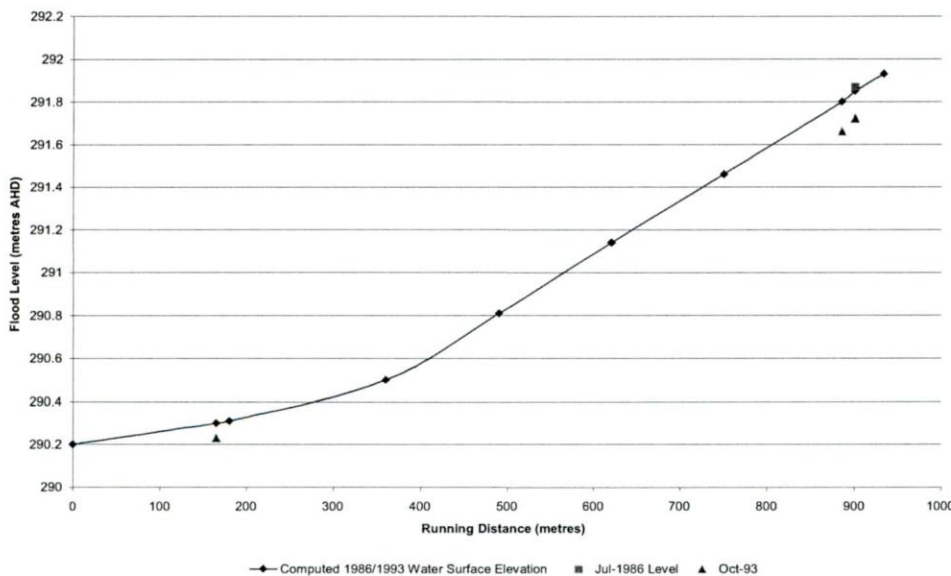
- * Interpolated cross section
- ** Extrapolated cross section

5.3 Validation Against July 1986 and October 1993 Floods

The peak flood flows at Jamieson for the July 1986 and October 1993 flood events were estimated to be 123.95 m³/s and 123.81 m³/s, based on recorded flows for Jamieson River at Gerrans Bridge, transposed according to the relevant formula in Section 4.1.

The HECRAS model was run for a design flow of 123.9 m³/s (10,700 ML/d), and the results are plotted against recorded flood levels for these two events in Figure 5-2. It should be noted that a high downstream flood level was retained to simulate conditions that occurred in October 1993, in which the level of Lake Eildon was well above the full supply level.

■ Figure 5-2 Validation Plot



The results show the model marginally overestimates the October 1993 flood levels by up to 0.15 m.

5.4 Modelling the 1% Flood

The calibrated and validated model was used to calculate flood levels for three possible 1 in 100-year flood scenarios:

- the mean 100-year ARI flow derived from the frequency analysis (192 m³/s or 16,600 ML/d);
- the upper 90% confidence limit of the 100-year ARI flow derived from the frequency analysis (235 m³/s or 20,300 ML/d); and
- 439.3 m³/s (38,000 ML/d), being an indicative estimate of the 1 in 100-year flood flow from an equation developed from a study of a large number of floods along and adjacent to the Great Dividing Range in Victoria (DCNR, 1994 – refer to **Section 4.1**).

Lake Levels

The largest level at Lake Eildon in recent times occurred in October 1993, when flood levels were allowed to encroach into the freeboard reserved for extreme floods, ie those approaching the probable maximum design flood event (Bill Viney, pers comm.). The normal operational procedures that generally prevented this occurring were not followed as inflows into the lake had already peaked and the forecast was for fine weather. This meant the probability of an extreme flood was virtually non-existent.

Accordingly 1993 levels at the Eildon Weir rose to a maximum of 0.58 metres above the full supply level of 288.90 m AHD.

A check of the peak lake levels for the September 1993 flood at Lake Eildon Head Gauge (RD 445 km) and Goughs Bay (RD 464km) revealed the lake level peaked on 16 September. The level was at the same level at both locations ie. 289.48 m AHD. Therefore no flood gradient was detected at the two locations.

A relatively high September 1993 flood level close to the confluence of the Jamieson and Goulburn Rivers suggested a flood levels at Lake Eildon of the order of 290.1 m AHD. This is 0.62 m higher than the level at Goughs Bay and Eildon Head gauge.

The level of the Jamieson River at its junction with the Goulburn River is affected by complex factors such as wind effects, the likelihood of the lake being above full supply level and any local effects of floodwaters entering Goulburn Inlet. It should be noted that the width of the Goulburn Inlet (into Lake Eildon) is of the order of 50 to 100 metres, and one would expect local flood surge effects.

In the absence of a detailed investigation a downstream level of 290.1 m AHD has been assumed for modelling purposes, based on the observed flood behaviour that occurred in September 1993.

Model Runs

Results for the three scenarios discussed earlier are shown in **Table 5-3**.

■ **Table 5-3 Possible 1 in 100-Year Flood Levels**

River Chainage (m)	Computed 100-Year ARI Levels for Flows of:			Computed 1998 Level (m AHD)	Difference		
	Scenario 1 192 (m ³ /s)	Scenario 2 235 (m ³ /s)	Scenario 3 439 (m ³ /s)		Scenario 1 (m)	Scenario 2 (m)	Scenario 3 (m)
2250	296.70	297.01	298.0	296.63	0.07	0.38	1.37
2091.66	296.23	296.54	297.52	296.17	0.06	0.37	1.35
1933.33	295.74	296.04	297.00	295.68	0.06	0.36	1.32
1775	295.22	295.50	296.41	295.16	0.06	0.34	1.25
1617	294.69	294.93	295.79	294.63	0.06	0.30	1.16
1458	294.14	294.35	295.14	294.09	0.05	0.26	1.05
1300	293.68	293.91	294.81	293.63	0.05	0.28	1.18
1117	293.13	293.38	294.39	293.08	0.05	0.30	1.31
933	292.56	292.83	293.93	292.50	0.06	0.33	1.43
750	292.01	292.28	293.32	291.95	0.06	0.33	1.37
620	291.62	291.88	292.85	291.56	0.06	0.32	1.29
490	291.24	291.50	292.46	291.17	0.07	0.33	1.29
360	290.78	290.99	291.88	290.68	0.10	0.31	1.20
180	290.40	290.53	291.32	290.22	0.18	0.31	1.10
0	290.10	290.10	290.10	289.80	0.30	0	0.30

Rows highlighted in yellow correspond to the surveyed cross sections

Discounting the lowermost sections where the flood depths are influenced by the starting flood level, **Scenario 1** provides a margin of only 0.05 to 0.06 m above 1998 flood levels. This is considered too low, especially considering the observed fluctuations in the 1998 recorded flood levels.

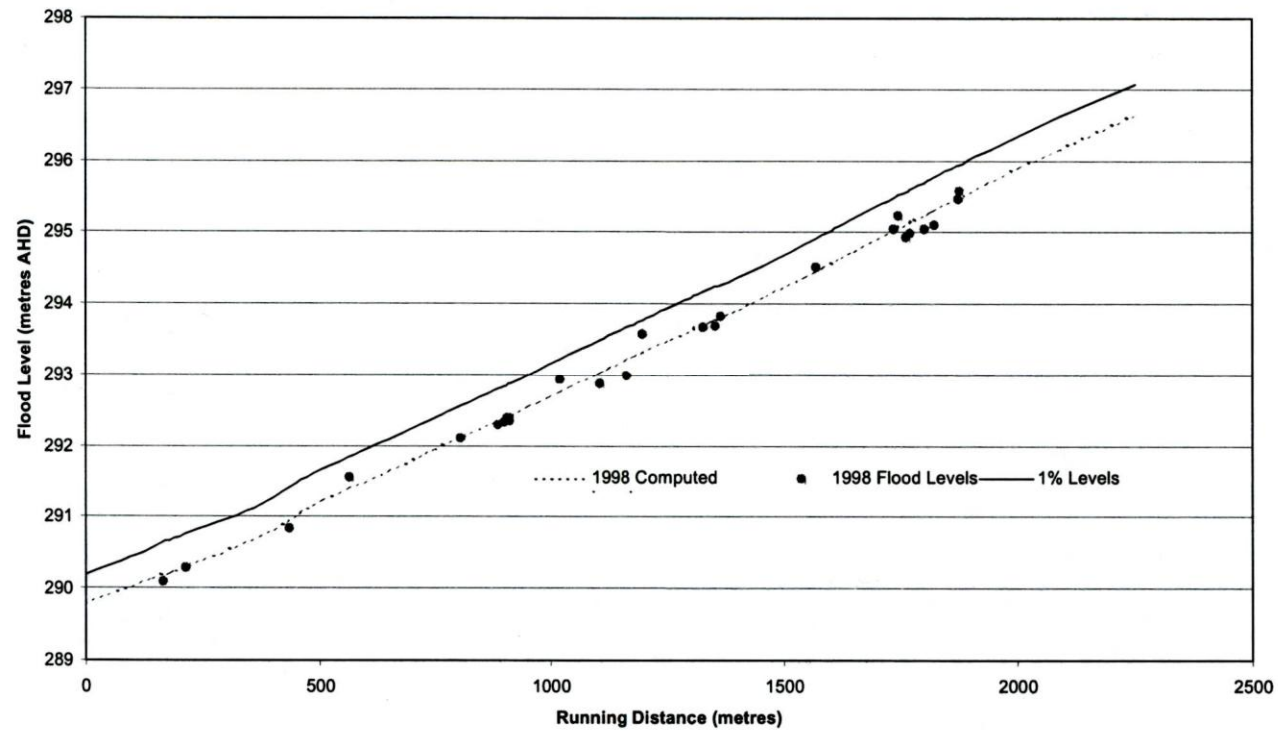
Scenario 3 is not considered realistic as it produces flood levels considerably higher than any that have previously observed. From **Figure 4-1** a flood flow of 439 m³/s corresponds to that which will occur on average every 1,000 years or more.

Scenario 2 is based on the upper 90% confidence limit flow derived from the frequency analysis and it seems appropriate to adopt this as a reasonably realistic approximation of the 100-year ARI flood, given that the period of record is only 42 years.

Based on a margin of 0.35m (from **Table 5-3**) plus an additional allowance of 0.1 m to accommodate the fluctuations in flood levels (as per **Table 5-2**) it would seem appropriate to adopt a margin of 0.45 m above 1998 flood levels for the 100-year ARI flood.

Adopted 100-year ARI flood levels are shown in **Figure 5-3**. At the downstream end, levels have been adjusted to accommodate a level of 290.2 m AHD at the confluence of the Jamieson and Upper Goulburn Rivers.

■ Figure 5-3 100-Year ARI Flood Levels for Jamieson



5.5 Flood Levels for a Range of Events

In order to estimate how flood levels vary for a range of floods, the hydraulic model was run for a series of statistical floods. Results are shown in **Table 5-4**, for the 4 surveyed cross sections.

■ **Table 5-4 Flood Levels for a Range of Floods**

	Cross Section Running Distance (metres)			
	1775	1300	750	360
Flood Levels (m AHD)				
July 1986 (123.95 m ³ /s) 7 year ARI	294.65	293.15	291.46	290.45
October 1993 (123.81 m ³ /s) 7 year ARI	294.65	293.15	291.46	290.45
Sep 1998 (183.7 m ³ /s) 20 year ARI*	295.16	293.63	291.95	290.68
2 year ARI (73 m ³ /s)	293.97	292.52	290.67	289.57
5 year ARI (115 m ³ /s)	294.55	293.06	291.33	290.13
10 year ARI (140 m ³ /s)	294.81	293.30	291.59	290.35
20 year ARI (180 m ³ /s)	295.13	293.61	291.92	290.65
50 year ARI* (210 m ³ /s)	295.34	293.78	292.12	290.85
100-year ARI* (235 m ³ /s)	295.50	293.91	292.28	290.99
200 year ARI* (275 m ³ /s)	295.71	294.11	292.51	291.21
500 year ARI * (315 m ³ /s)	295.91	294.29	292.72	291.41
* Used the upper 90 percentile curve in Figure 4-1 for the larger flows.				
Increase (Decrease) in Flood Level above 1998 level (metres)				
July 1986 (123.95 m ³ /s) 7.5 year ARI	(0.51)	(0.48)	(0.49)	(0.23)
October 1993 (123.81 m ³ /s) 7.5 year ARI	(0.51)	(0.48)	(0.49)	(0.23)
Sep 1998 (183.7 m ³ /s) 20 year ARI	0	0	0	0
2 year ARI (73 m ³ /s)	(1.19)	(1.11)	(1.28)	(1.11)
5 year ARI (115 m ³ /s)	(0.61)	(0.57)	(0.62)	(0.55)
10 year ARI (140 m ³ /s)	(0.35)	(0.33)	(0.36)	(0.33)
20 year ARI (180 m ³ /s)	(0.03)	(0.02)	(0.03)	(0.03)
50 year ARI (210 m ³ /s)	0.18	0.15	0.17	0.17
100-year ARI (235 m ³ /s)	0.34	0.28	0.33	0.31
200 year ARI (275 m ³ /s)	0.55	0.48	0.56	0.53
500 year ARI (315 m ³ /s)	0.75	0.66	0.77	0.73

~ 0.3 or 0.03
=

6. Economic, Social and Environmental Impacts

In order to justify the need for further studies or activities, a means of assessing economic, social and environmental impacts is desirable.

In May 2000, Read Sturgess and Associates, Consulting Economists, completed a “Rapid Appraisal Method (RAM) to assist the rapid evaluation of floodplain management projects in economic, social and environmental terms (NRE, 2000). The RAM has been designed to provide a set of simple and rapid evaluation tools, useful for estimating flood damages and determining the benefits and costs of certain types of works and measures.

6.1 Economic Assessment

The RAM methodology was used to determine the flood damages within Jamieson for areas delineated as land subject to inundation in a 100-year ARI flood, and land that would be inundated from a 20-year ARI event approximately. The latter event corresponded to a flood that produced flood levels 500 mm below the 100-year ARI flood levels.

From the flood inundation map included in **Appendix B** the number of dwellings affected and the cumulative length of sealed and unsealed roads were determined. Information was obtained for the Caravan Park to enable the number of caravans, cabins and ablutions blocks affected to be estimated.

This raw data was then multiplied by appropriate CPI adjusted unit rates and factors (listed in **Table 6-1**). These were derived from the RAM or were estimated having regard for a study of flood impacts for a caravan park at Chinaman’s Bridge near Nagambie (SKM, 2000).

■ **Table 6-1 Flood Damage Rates**

Item	Rate
Dwellings	\$22,550 per property
Agricultural damages	Not applicable
Sealed roads per km	\$20,350 per km
Other roads - per km	\$9,185 per km
Caravans and annexes	\$7,500 each
Cabins in the caravan park	\$8,500 each
Caravan park ablutions block	\$6,000 each
Notes	
The rates for dwellings and roads have been CPI adjusted from NRE, 2000.	
The rates for caravans, cabins and ablutions blocks have been estimated from information obtained from SKM, 2000	
The rates for dwellings, caravans, cabins and ablutions blocks are potential damages. An adjustment has been made to estimate direct damages, assuming the community has little experience of flooding and the flood warning time is 2 hours. Direct damages have been assumed to be 90% of the potential damages, in accordance with the RAM.	

In this way the direct flood damages were calculated for the areas inundated in a 100-year ARI and 20-year ARI flood event. Indirect damages were assumed to be 30% of the direct damages, as suggested in the RAM.

Flood damages were assumed to be zero for floods less than or equal to the flood at which floodwaters commence to affect low lying areas. By considering the cross section information in **Appendix B** and the flood frequency analysis this was estimated to be a 2-year ARI event.

The “average annual damage” (AAD) for Jamieson was estimated by plotting the frequency of the three threshold events (2-year ARI, 20 year ARI and 100-year ARI events) against the estimated damages for each event, and calculating the area under the graph. A similar exercise was undertaken to assess the “average annual population affected” (see **Section 6.2** below). Results are summarised in **Table 6-2**.

■ **Table 6-2 Estimated Flood Damages**

Item	Items Inundated	Direct Damages \$	Indirect Damages \$	Total Damages \$	Estimated Population Affected
Land Inundated in a 20 Year ARI Flood					
Buildings	19 properties	385,605			48
Roads (Incl. Caravan park)	0.33 km sealed 0.64 km unsealed	12,594			
Caravan Park	70 caravans 8 cabins 1 ablutions block	539,100			100
Total		937,299	281,190	1,218,489	148
Land Inundated in a 100-Year ARI Flood					
Buildings	27 properties	547,965			68
Roads	0.42 km sealed 0.75 km unsealed	15,436			
Caravan Park	70 caravans 8 cabins 1 ablutions block	539,100			100
Total		1,102,501	330,750	1,433,251	168
Average Annual Damages		\$341,800 per annum			
Average Annual Population Affected		41 people per annum			

6.2 Social Assessment

The RAM provides a means of assessing social impacts by considering the “average annual population affected” (AAPA) which is the average number of people exposed to the effects of flooding each year. This is an indicator of the effects of flooding on the health and safety of the community and is determined in a similar manner to the AAD, by preparing a graph of population affected by flooding against probability of the flood occurring and integrating the area below the curve.

For buildings, the population affected by the 100-year ARI and 20-year ARI flood events was estimated by multiplying the number of dwellings affected by 2.5. To this was added an estimate of the number of residents from the Caravan Park affected.

The AAPA has been included in **Table 6-2**.

6.3 Environmental Assessment

While the RAM provides a method for assessing environmental effects of proposed works, the method is not particularly useful for flood studies, unless they are likely to lead to structural works.

A measure of environmental benefits can be obtained by considering specific works and measures that could result from a study or implementation of a floodplain management plan.

The preparation of flood inundation maps and their incorporation into municipal planning schemes will have some environmental benefit, as they provide a mechanism for ensuring proposed works are consistent with the flood risk. In doing so, there is a greater likelihood of preserving the natural functions of floodplains to convey and store floodwater, together with their inherent environmental benefits.

On the other hand, works such as levees and raised earthworks, that isolate sections of the floodplain in order to provide flood protection are likely to have an adverse affect on environmental values.

The environmental impacts of proposed works and measures for mitigating flood damages should be investigated as part of any future floodplain management plan.

7. Assessment of the Need for Further Studies

It is considered that the estimated 100-year flood extent and levels provide a sound basis for ensuring that future development on the floodplain at Jamieson is compatible with the flood risk.

Structural works such as levees and retardation basins are not considered appropriate for Jamieson because of their expense and ongoing maintenance costs, the fact that comparatively few people would benefit, and the potentially adverse environmental affects. While structural works could be perhaps justified economically for some areas (eg the Caravan Park), there is likely to be strong community opposition, because of the visual impacts and the likely hydraulic adverse impacts on adjoining areas.

Provided future planning controls are put in place, and new floor levels are based on an appropriate margin above the estimated 100-year ARI flood levels, it is considered that at the present time, the preparation of a detailed floodplain management plan for Jamieson is not warranted.

If circumstances change, and a detailed floodplain management study becomes justified, the following investigations could be included:

- ground level and floor level survey;
- a joint probability analysis of the two rivers be undertaken in conjunction with investigations into the level of Lake Eildon;
- hydraulic modelling to improve 100-year flood estimates; and
- a review of flood control overlays (Floodway and Land Subject to Inundation) assuming better data becomes available.

8. Recommendations

It is recommended that:

- the 100-year ARI flood levels and flood extent map be adopted for planning purposes;
- the information presented is used to prepare floodway and land subject to inundation zone and overlays for incorporation into the municipal planning scheme; and
- improvements to emergency response arrangements for the Caravan Park are undertaken because of the flood risk.

The results of this study should be reviewed when better survey information becomes available, or when a major flood provides additional information.

A flowpath passes through the centre of the town, and has the potential to pass into the town drainage system at Cobham Street. It is recommended that the Shire monitors the performance of floods in this area, to ensure that this potential flow path does not become active.

9. References

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A., & Mein, R.G. 1996, *Hydrological Recipes: Estimation Techniques in Australian Hydrology*, Cooperative Research Centre for Catchment Hydrology, Clayton, Australia.

Wang, Q.J., (1997) LH moments for statistical analysis of extreme events. *Water Resources Research*. 33(12) pp2841-2848.

DCNR (1994): *Regression of Flood Flows Versus Catchment Areas in Victoria for Urban and Rural Catchments along and adjacent to the Great Dividing Range*. Developed by Nick Nikolaou and Roel von't Steen, Floodplain Management Unit, Department of Conservation and Natural Resources.

Sinclair Knight Merz (2000): *Chinaman's Bridge Caravan Park Feasibility Study*.

Appendix A Flood Information

A review of flood information was undertaken as part of this project. The following sections provide a brief overview of the consultation and review process undertaken.

A.1 Goulburn Broken CMA

Goulburn Broken CMA was the main source of flood data for this project. Mr Guy Tierney, the Authority's Floodplain Manager, supplied a background file containing information used for a flood reconnaissance and survey project initiated after the September 1998 floods. This included a photograph taken in 1912, which showed flooding along parts of Cobham Street, Perkins Road and surrounding areas. A number of flood levels were extracted from the photograph as part of this earlier flood level survey.

Drawing (No. 540216) was also supplied, dated 13/06/2001. The showed the 1998 flood extent and surveyed flood levels, and also contained a longitudinal profile of the 1998 flood levels.

A.2 Delatite Shire Council

Delatite Shire provided information comprising:

- Correspondence from the Rural Water Commission of Victoria date 24 October 1991, providing flood advice for a dwelling to be erected at No. 16 Bridge Street Jamieson.
- An approximate 1934 flood extent, shown on a Parish map. This was similar to the 1998 flood extent.
- A copy of a flood map for Jamieson, part of NRE's "Flood Data Transfer" Project. This was based on information that predated the 1998 flood extent.

A.3 VicRoads

There are two road bridges at Jamieson (Structures 8703 and 5404). VicRoads were contacted for details but were unable to advise whether useful flood information or cross section information was available without a substantial searching fee. Therefore an alternative option was pursued.

In a project for the West Gippsland CMA, LICS Pty Ltd collated information on bridges for Victoria and compiled a database. They were therefore able to provide information on the design level for each bridge, the bed level, the date of construction, and design information. No flood information was detected.

LICS surveyed the underside of the two bridges and confirmed that they were both well above the 100-year ARI flood levels.

A.4 Goulburn-Murray Water

Goulburn-Murray Water were contacted and advised that they had no information of use to the project.

A.5 Jamieson and District Historical Society

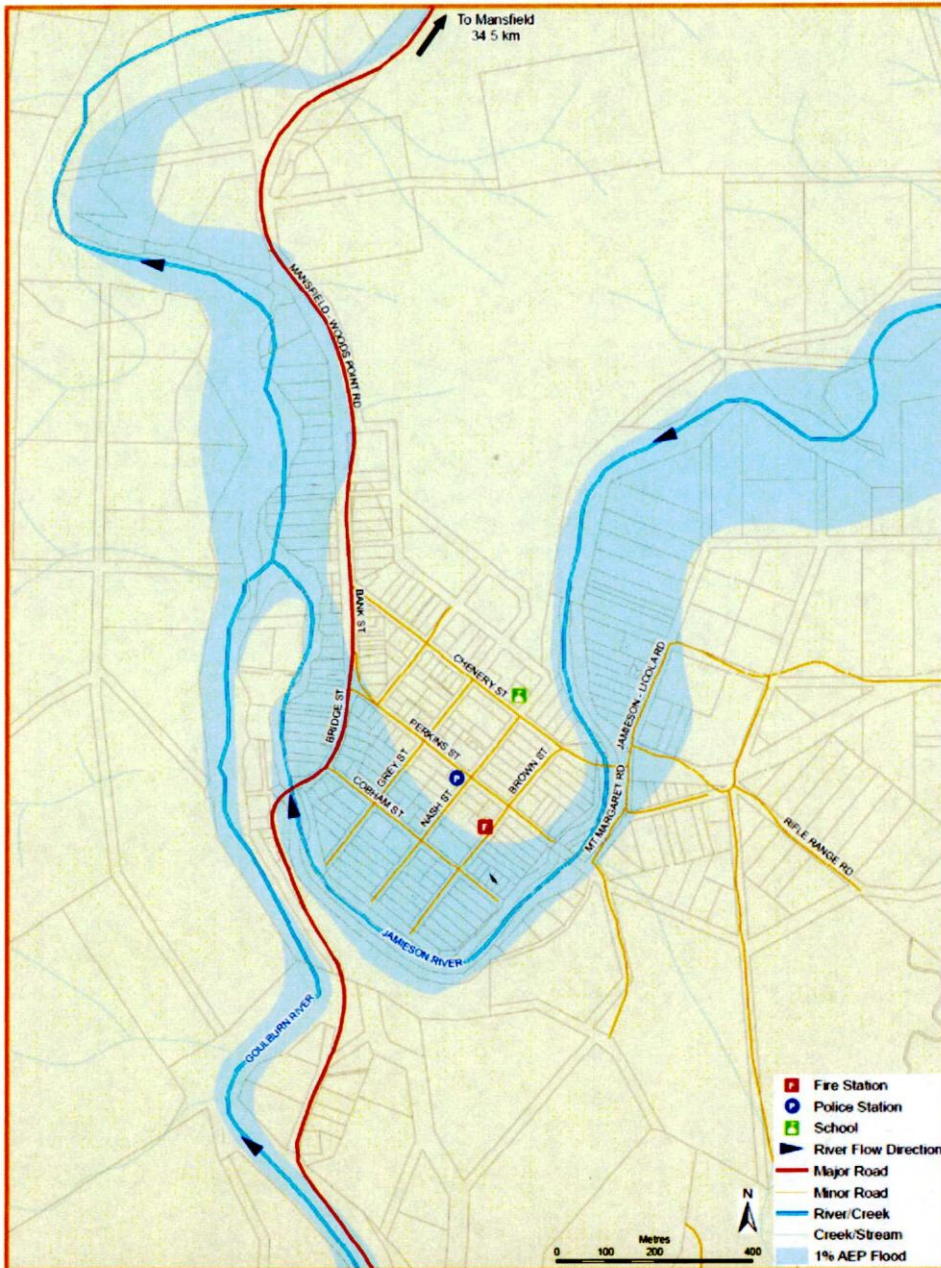
The Secretary of the Jamieson and District Historical Society was contacted for flood information but advised that no information was available on its files.

A museum located at Jamieson was inspected and was found to contain historic photographs of previous flood events. These were not followed up, as sufficient flood marks were available from other sources.

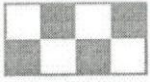
Appendix B Survey Details

B.1 Cross Section Locations

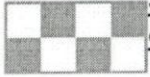
Jamieson



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SES



SEE Subsequent pages 3 & 4 to modify & merge to accommodate our EM Style guide linking EM Plans with subplans - Kevin

NB no objection to the merge including eg logo of SES, CMA etc etc\

Insert 3 linked local flood photos – see p 3



Mansfield Shire

Flood Emergency Plan

A Sub-Plan of the Municipal Emergency Management Plan

For Mansfield Shire Council
And

VICSES Unit(s) Mansfield AND North East Regional HQ

Draft Template Version 2.2, October 2011



Insert Council Logo



APPENDIX F – MAPS

Map 1 – Upper Goulburn Catchment

Map 2 – Mansfield 1% AEP flood

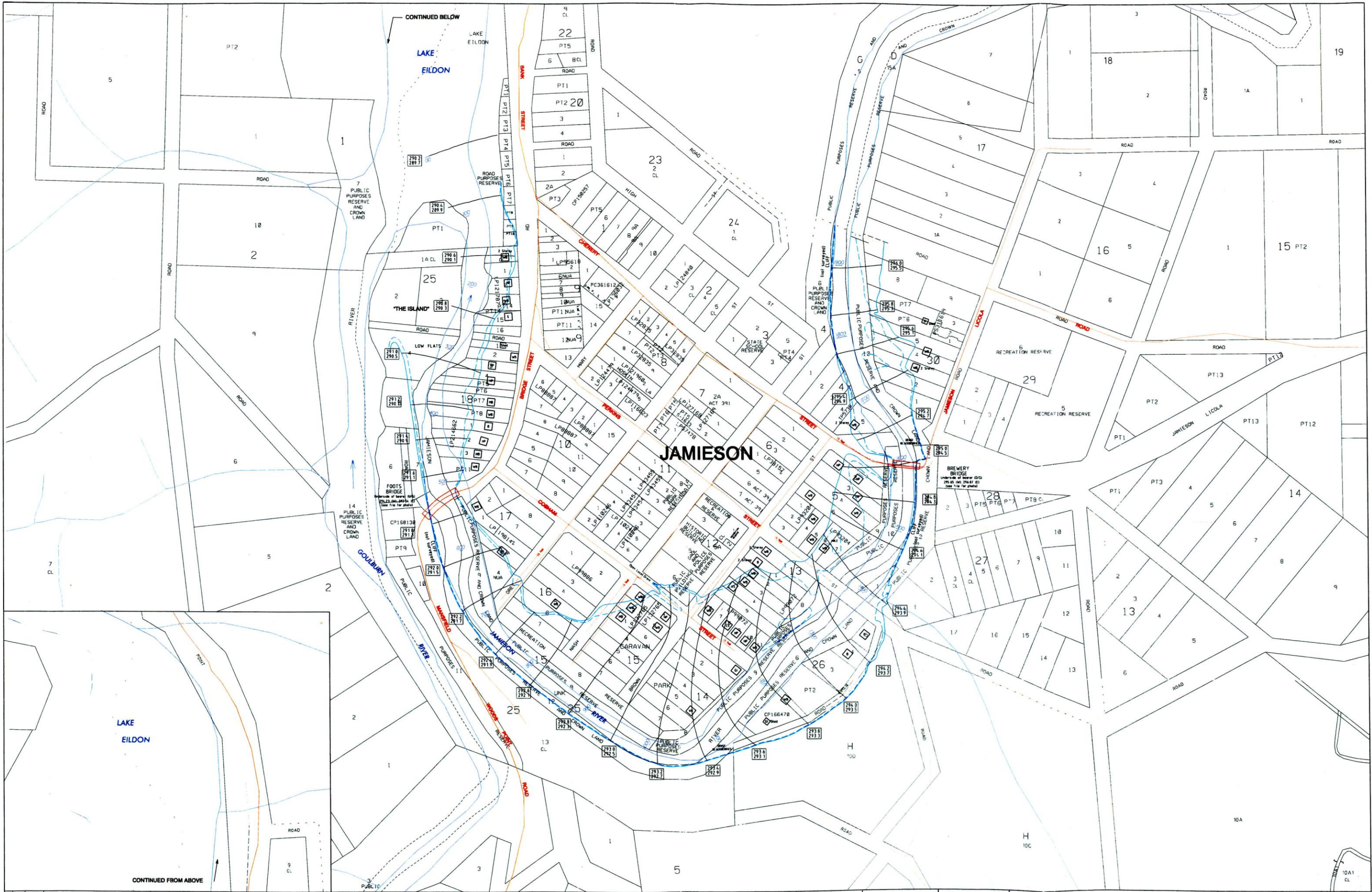
Map 3 - Jamieson 1% AEP flood

Map 4 - Jamieson Local Flood Guide Map

The following studies available on
<http://www.ga.gov.au/flood-study>

Contain further mapping and images

- Jamieson Flood Scoping Study Final report 2003 (AFSID 1916)
- Mansfield Flood Study 2005 (AFSID 2685)
- Mansfield Flood Study Extension April 2006. (AFSID 2686)
- Mansfield Flood Mapping Study Draft (GBCMA, 2013)



CONTINUED FROM ABOVE

REV	DATE	DESCRIPTION

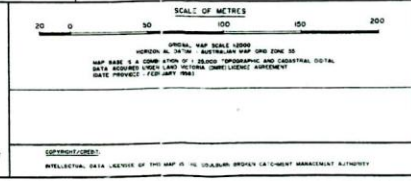
REV	DATE	DESCRIPTION

SURVEY - By LICS Pty Ltd May 2001 (refer SPEC 100112-10-1)
SURVEY - By LICS Pty Ltd July and December 2002
ELEVATIONS - In Australian Height Datum

1. Jamieson River distances have been measured on the topographic base bridge 100 for distances to of the confluence with the Goulburn River in Lake Eildon.
 2. Some additional minor 'islands' of up ground probably exist within the 1% minus 0.5m flood boundary and are not shown.
 3. Locations of buildings shown are approximate only and are not an indicator of flooding above floor level.
 4. In the caravan area, if there are any 'semi-permanent' caravans/structures (for plan refer File 199081010) these cabins and vans may be below flood levels.

LEGEND

- 1% FLOOD EXTENT
- 1% minus 0.5m FLOOD EXTENT
- 300 RIVER DISTANCE (see note 1)
- 293.2 1% FLOOD CONTOUR WITH 1% AND 1% minus 0.5m VALUES SHOWN
- 292.7
- BUILDING AND BUILDING MATERIAL
- MF - WEATHERBOARD S - STONE
- HP - HARDIP-ANK HS - HUD BRICK
- CS - CEMENT SHEET AS - ALUMINIUM SHEET
- B - BRICK



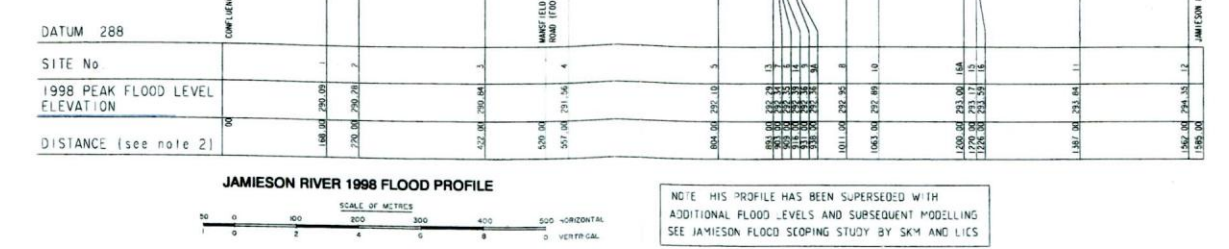
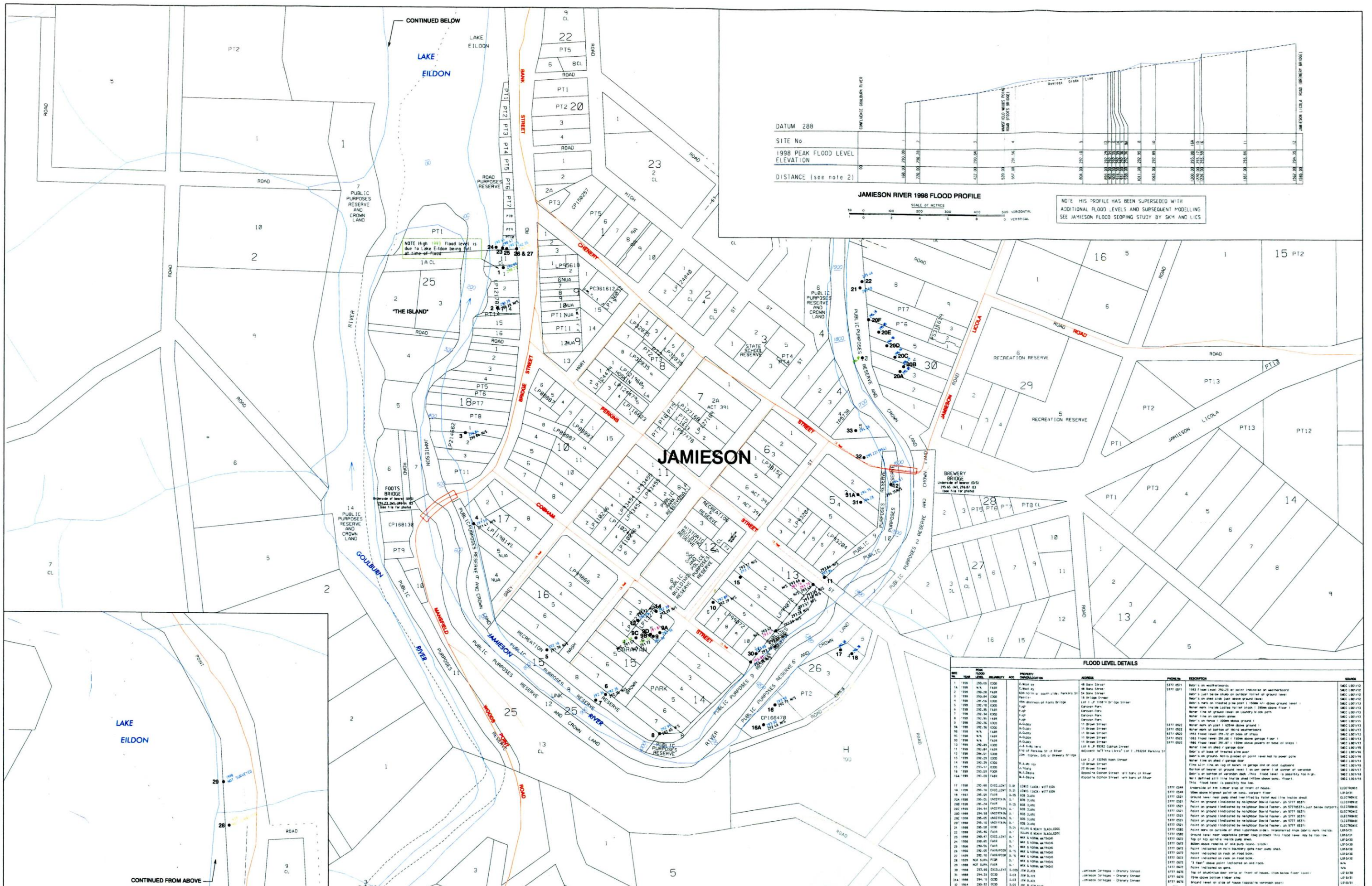
cs
 CONSULTING SERVICES
 11 MELBURY
 PREPARED BY: M. EDWARDS
 CHECKED BY: M. EDWARDS

SINCLAIR KNIGHT MERZ
 1 NAZARET AV
 M. EDWARDS
 PREPARED BY: M. EDWARDS

GOLBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
JAMIESON RIVER - JAMIESON
 1% and 1% minus 0.5m FLOOD EXTENTS AND FLOOD CONTOURS

DELATTE SHIRE

PROJECT NUMBER	G TERNY
CONSEQUENCE NUMBER	FPM/01/018
SHEET NUMBER	1 of 1
FRANKING NUMBER	540228



NO	TIME	PEAK FLOOD LEVEL	RELIABILITY	NO	PROPERTY ORIGINATOR	ADDRESS	PHONE NO	DESCRIPTION	SOURCE
1	1998	230.00	GOOD	1	John Doe	10 Main Street	5555 1234	Water mark on wall of house	MEASUREMENT
2	1998	230.00	FAIR	2	Jane Smith	20 Park Street	5555 5678	Water mark on window sill	MEASUREMENT
3	1998	230.00	GOOD	3	Bob Jones	30 Lake Street	5555 9012	Water mark on door frame	MEASUREMENT
4	1998	230.00	GOOD	4	Charlie Brown	40 Hill Street	5555 3456	Water mark on ceiling	MEASUREMENT
5	1998	230.00	FAIR	5	Diana Prince	50 Valley Street	5555 7890	Water mark on floor	MEASUREMENT
6	1998	230.00	GOOD	6	Frank Miller	60 Glen Street	5555 2345	Water mark on wall	MEASUREMENT
7	1998	230.00	GOOD	7	Grace Kelly	70 York Street	5555 6789	Water mark on door	MEASUREMENT
8	1998	230.00	FAIR	8	Henry Ford	80 West Street	5555 0123	Water mark on window	MEASUREMENT
9	1998	230.00	GOOD	9	Ivy Green	90 East Street	5555 4567	Water mark on floor	MEASUREMENT
10	1998	230.00	GOOD	10	Jack Black	100 North Street	5555 8901	Water mark on wall	MEASUREMENT
11	1998	230.00	FAIR	11	Karen White	110 South Street	5555 2345	Water mark on door	MEASUREMENT
12	1998	230.00	GOOD	12	Liam Neeson	120 West Street	5555 6789	Water mark on window	MEASUREMENT
13	1998	230.00	GOOD	13	Mia Farrow	130 East Street	5555 0123	Water mark on floor	MEASUREMENT
14	1998	230.00	FAIR	14	Noah Wyle	140 North Street	5555 4567	Water mark on wall	MEASUREMENT
15	1998	230.00	GOOD	15	Olivia Wilde	150 South Street	5555 8901	Water mark on door	MEASUREMENT
16	1998	230.00	GOOD	16	Peter Dinklage	160 West Street	5555 2345	Water mark on window	MEASUREMENT
17	1998	230.00	FAIR	17	Quinn Tarantino	170 East Street	5555 6789	Water mark on floor	MEASUREMENT
18	1998	230.00	GOOD	18	Ryan Murphy	180 North Street	5555 0123	Water mark on wall	MEASUREMENT
19	1998	230.00	GOOD	19	Sarah Stone	190 South Street	5555 4567	Water mark on door	MEASUREMENT
20	1998	230.00	FAIR	20	Tom Cruise	200 West Street	5555 8901	Water mark on window	MEASUREMENT
21	1998	230.00	GOOD	21	Uma Thurman	210 East Street	5555 2345	Water mark on floor	MEASUREMENT
22	1998	230.00	GOOD	22	Will Smith	220 North Street	5555 6789	Water mark on wall	MEASUREMENT
23	1998	230.00	FAIR	23	Xosha Roxx	230 South Street	5555 0123	Water mark on door	MEASUREMENT
24	1998	230.00	GOOD	24	Yves Montand	240 West Street	5555 4567	Water mark on window	MEASUREMENT
25	1998	230.00	GOOD	25	Zoe Lister-Jones	250 East Street	5555 8901	Water mark on floor	MEASUREMENT
26	1998	230.00	FAIR	26	Adam Sandler	260 North Street	5555 2345	Water mark on wall	MEASUREMENT
27	1998	230.00	GOOD	27	Billy Crystal	270 South Street	5555 6789	Water mark on door	MEASUREMENT
28	1998	230.00	GOOD	28	Cameron Diaz	280 West Street	5555 0123	Water mark on window	MEASUREMENT
29	1998	230.00	FAIR	29	Dustin Diamond	290 East Street	5555 4567	Water mark on floor	MEASUREMENT
30	1998	230.00	GOOD	30	Ewan McGregor	300 North Street	5555 8901	Water mark on wall	MEASUREMENT
31	1998	230.00	GOOD	31	Faye Dunaway	310 South Street	5555 2345	Water mark on door	MEASUREMENT
32	1998	230.00	FAIR	32	George Clooney	320 West Street	5555 6789	Water mark on window	MEASUREMENT
33	1998	230.00	GOOD	33	Halle Berry	330 East Street	5555 0123	Water mark on floor	MEASUREMENT
34	1998	230.00	GOOD	34	Idris Elba	340 North Street	5555 4567	Water mark on wall	MEASUREMENT
35	1998	230.00	FAIR	35	Jessie J	350 South Street	5555 8901	Water mark on door	MEASUREMENT
36	1998	230.00	GOOD	36	Keanu Reeves	360 West Street	5555 2345	Water mark on window	MEASUREMENT
37	1998	230.00	GOOD	37	Liam Neeson	370 East Street	5555 6789	Water mark on floor	MEASUREMENT
38	1998	230.00	FAIR	38	Milla Jovovich	380 North Street	5555 0123	Water mark on wall	MEASUREMENT
39	1998	230.00	GOOD	39	Nicole Kidman	390 South Street	5555 4567	Water mark on door	MEASUREMENT
40	1998	230.00	GOOD	40	Orlando Bloom	400 West Street	5555 8901	Water mark on window	MEASUREMENT
41	1998	230.00	FAIR	41	Penelope Cruz	410 East Street	5555 2345	Water mark on floor	MEASUREMENT
42	1998	230.00	GOOD	42	Quentin Tarantino	420 North Street	5555 6789	Water mark on wall	MEASUREMENT
43	1998	230.00	GOOD	43	Ryan Murphy	430 South Street	5555 0123	Water mark on door	MEASUREMENT
44	1998	230.00	FAIR	44	Sarah Stone	440 West Street	5555 4567	Water mark on window	MEASUREMENT
45	1998	230.00	GOOD	45	Tom Cruise	450 East Street	5555 8901	Water mark on floor	MEASUREMENT
46	1998	230.00	GOOD	46	Uma Thurman	460 North Street	5555 2345	Water mark on wall	MEASUREMENT
47	1998	230.00	FAIR	47	Will Smith	470 South Street	5555 6789	Water mark on door	MEASUREMENT
48	1998	230.00	GOOD	48	Xosha Roxx	480 West Street	5555 0123	Water mark on window	MEASUREMENT
49	1998	230.00	GOOD	49	Yves Montand	490 East Street	5555 4567	Water mark on floor	MEASUREMENT
50	1998	230.00	FAIR	50	Zoe Lister-Jones	500 North Street	5555 8901	Water mark on wall	MEASUREMENT

REV. NO. 1

REV. NO.	DATE	DESCRIPTION
1	10/10/02	FLOOD LEVEL DETAILS ADDED
2	03/07/02	FLOOD LEVEL DETAILS ADDED

LEGEND

- 5 ● 1998 FLOOD LEVEL AND SITE NUMBER
- 9C ● 1993 FLOOD LEVEL AND SITE NUMBER
- 9D ● 1996 FLOOD LEVEL AND SITE NUMBER
- 26 ● 1996 FLOOD LEVEL AND SITE NUMBER
- 27 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 28 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 29 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 30 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 31 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 32 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 33 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 34 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 35 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 36 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 37 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 38 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 39 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 40 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 41 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 42 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 43 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 44 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 45 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 46 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 47 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 48 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 49 ● 1993 FLOOD LEVEL AND SITE NUMBER
- 50 ● 1993 FLOOD LEVEL AND SITE NUMBER

SCALE OF METRES: 0 100 200

JAMIESON RIVER - JAMIESON

HISTORIC FLOOD LEVEL DETAILS AND 1998 FLOOD PROFILE

GOLBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

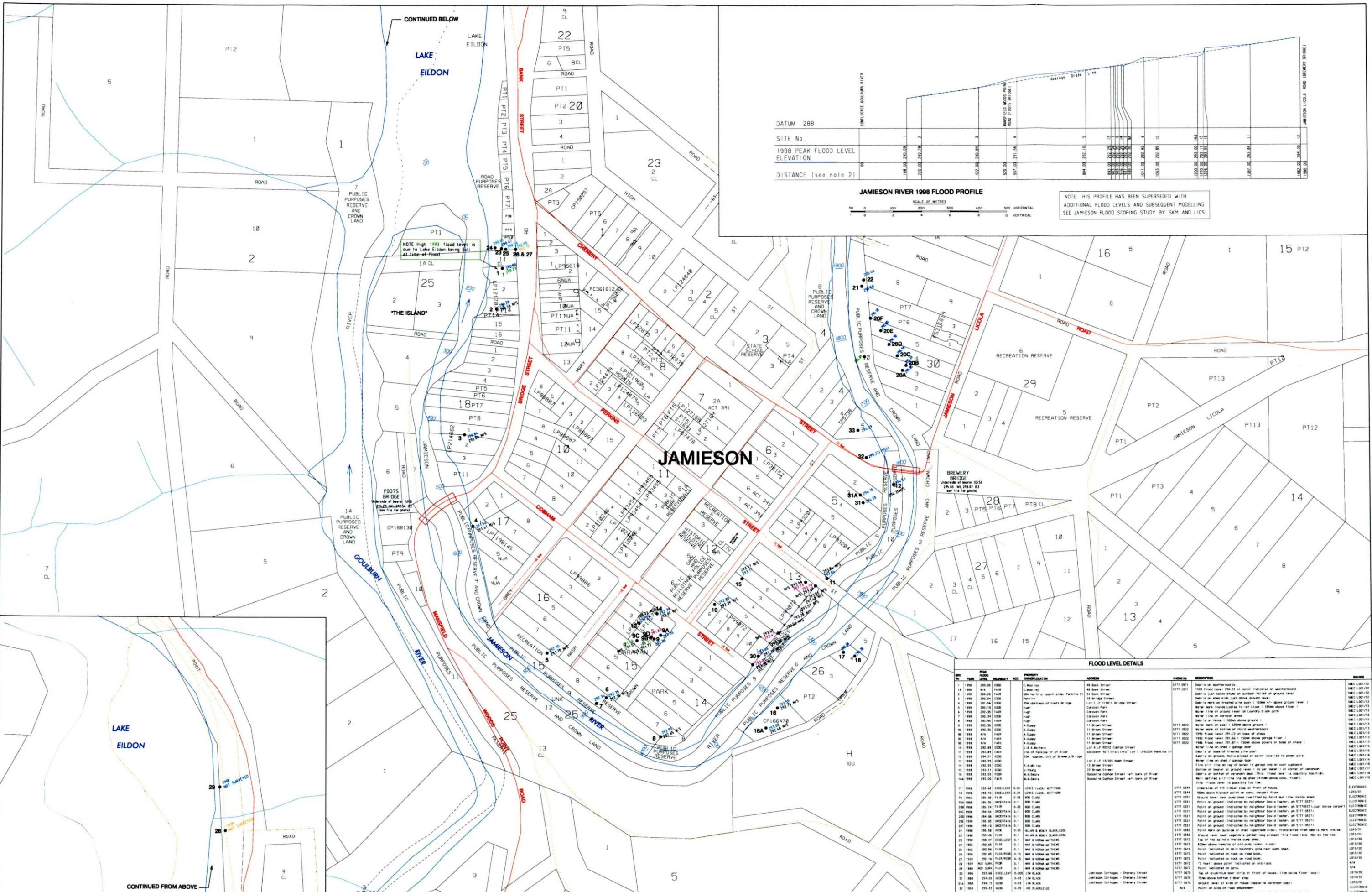
PROJECT NUMBER: G TIERNEY

FORM/01/018

1 OF 1

540216 B

B.2 Flood Level Locations



DATUM	288
SITE No.	
1998 PEAK FLOOD LEVEL ELEVATION	
DISTANCE (see note 2)	

JAMIESON RIVER 1998 FLOOD PROFILE



NOTE: HIS PROFILE HAS BEEN SUPERSEDED WITH ADDITIONAL FLOOD LEVELS AND SUBSEQUENT MODELLING SEE JAMIESON FLOOD SCOPING STUDY BY SKM AND LICs

REF	YEAR	PEAK FLOOD LEVEL	RELIABILITY	ACC	PROPERTY IDENTIFICATION	ADDRESS	PHONE No.	DESCRIPTION	SOURCE
1	1998	290.09	0.00		1. Water level	48 Bank Street	5777 0811	Water level at weir	SMC 1001/10
2	1998	290.29	FAIR		2. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
3	1998	290.34	0.00		3. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
4	1998	291.14	0.00		4. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
5	1998	290.35	FAIR		5. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
6	1998	290.34	0.00		6. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
7	1998	290.35	0.00		7. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
8	1998	290.35	0.00		8. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
9	1998	290.36	0.00		9. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
10	1998	290.35	0.00		10. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
11	1998	290.35	0.00		11. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
12	1998	290.35	0.00		12. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
13	1998	290.35	0.00		13. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
14	1998	290.35	0.00		14. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
15	1998	290.35	0.00		15. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
16	1998	290.35	0.00		16. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
17	1998	290.35	0.00		17. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
18	1998	290.35	0.00		18. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
19	1998	290.35	0.00		19. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
20	1998	290.35	0.00		20. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
21	1998	290.35	0.00		21. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
22	1998	290.35	0.00		22. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
23	1998	290.35	0.00		23. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
24	1998	290.35	0.00		24. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
25	1998	290.35	0.00		25. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
26	1998	290.35	0.00		26. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
27	1998	290.35	0.00		27. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
28	1998	290.35	0.00		28. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
29	1998	290.35	0.00		29. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
30	1998	290.35	0.00		30. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
31	1998	290.35	0.00		31. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
32	1998	290.35	0.00		32. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
33	1998	290.35	0.00		33. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
34	1998	290.35	0.00		34. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
35	1998	290.35	0.00		35. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
36	1998	290.35	0.00		36. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
37	1998	290.35	0.00		37. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
38	1998	290.35	0.00		38. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
39	1998	290.35	0.00		39. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10
40	1998	290.35	0.00		40. Water level	18 Bank Street	5777 0811	Water level at weir	SMC 1001/10

REVISED

REV. NO.	DATE	DESCRIPTION
A	14/07/02	FLOOD LEVEL DETAILS ADDED
B	28/07/02	FLOOD LEVEL DETAILS ADDED
C	28/07/02	FLOOD LEVEL DETAILS ADDED
D	28/07/02	FLOOD LEVEL DETAILS ADDED

LEGEND

- 1998 FLOOD LEVEL AND SITE NUMBER
- 1912 FLOOD LEVEL
- 1993 FLOOD LEVEL AND SITE NUMBER
- 1996 FLOOD LEVEL AND SITE NUMBER
- 1939 FLOOD LEVEL AND SITE NUMBER
- NATURAL SURFACE
- RIVER DISTANCE (INDICATED BY 10)

SCALE OF METRES

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

JAMIESON RIVER - JAMIESON

HISTORIC FLOOD LEVEL DETAILS AND 1998 FLOOD PROFILE

LICs PTY LTD

1000 Goulburn Street, Goulburn NSW 2580

Ph: 602 232 2200

Fax: 602 232 2201

www.lics.com.au

DELATITE SHIRE

PROJECT NUMBER: G TIERNEY

CONTRACT NUMBER: FRM/O/O/B

SHEET NUMBER: 1 OF 1

DRAWING NUMBER: 540216

REVISION: B

DATE: 28/07/02

BY: M BOYCE

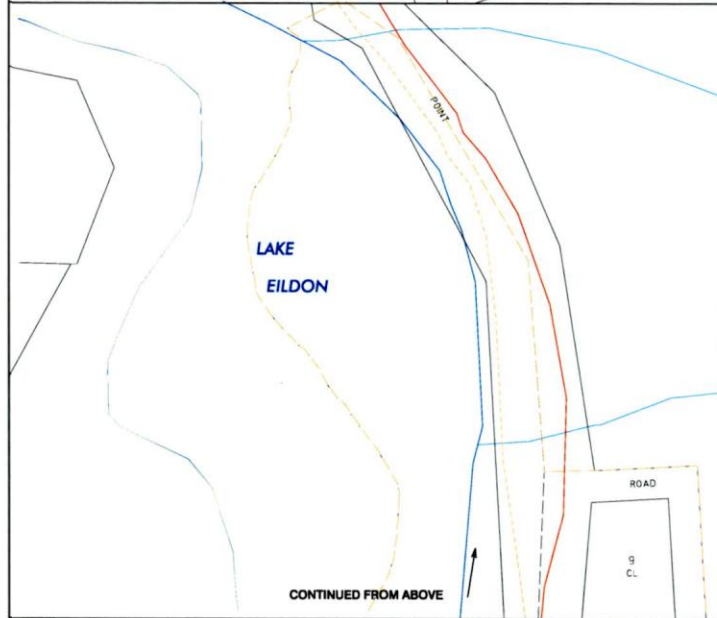
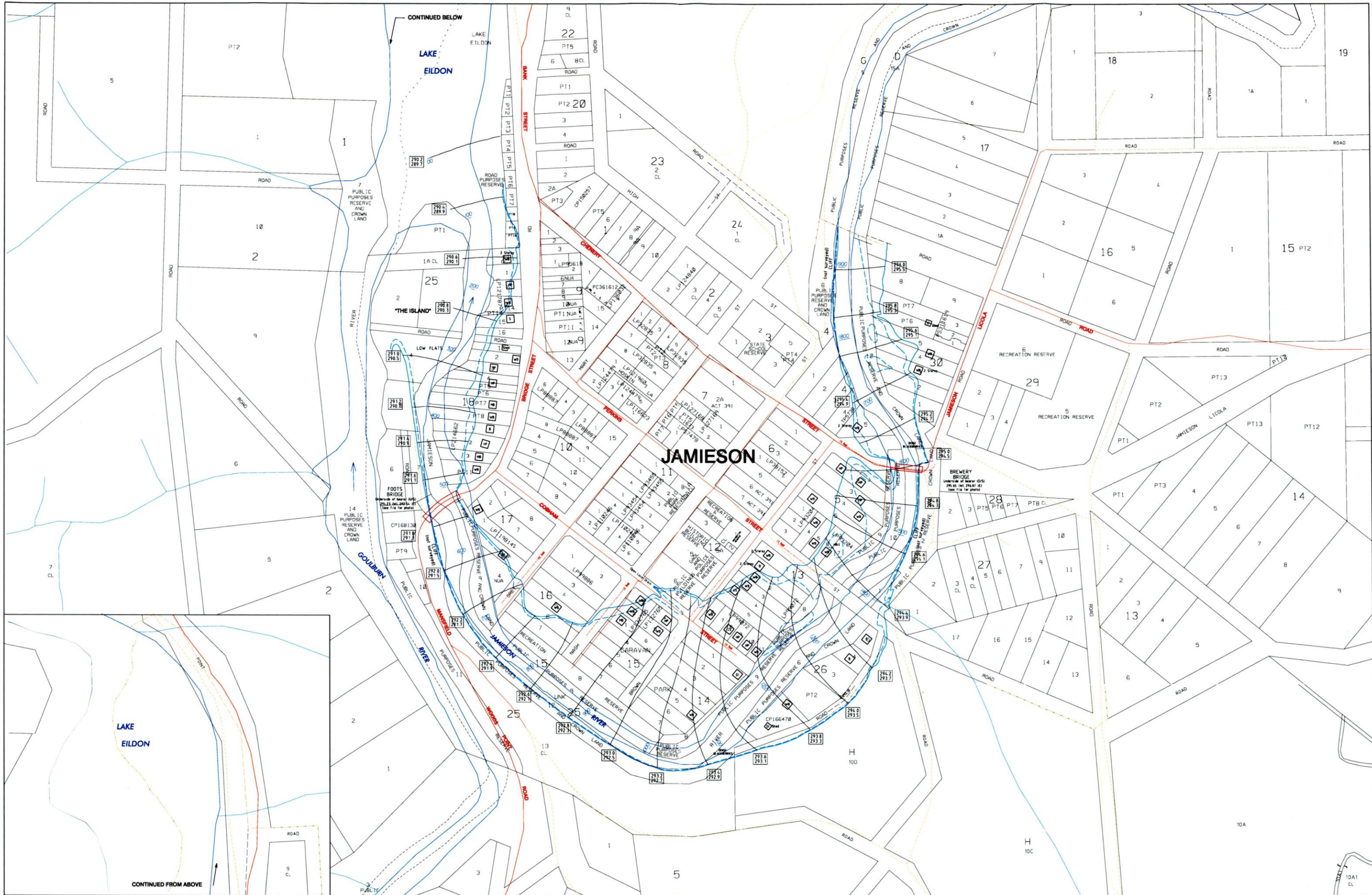
CHECKED: M BOYCE

DATE: 28/07/02

BY: S NAZARETIAN

CHECKED: S NAZARETIAN

B.3 Flood Extents



CONTINUED FROM ABOVE

REV	DATE	DESCRIPTION	PLAN NO.
1	25/02/03	ORIGINAL CREATED	

CONTINUED BELOW

REV	DATE	DESCRIPTION	PLAN NO.
1	25/02/03	ORIGINAL CREATED	

SURVEY - By LICs Pty Ltd May 2001 (refer SHEET 100112-10)
SURVEY - By LICs Pty Ltd July and December 2002
 (refer Field Book 14218)
ELEVATIONS - To Australian Height Datum

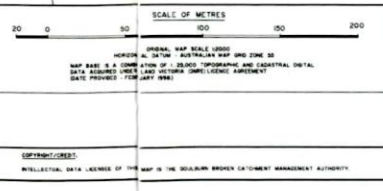
1. Jamieson River distances have been measured on the topographic base Origin 100 for distances to the confluence with the Goulburn River at Lake Eildon.
 2. Some additional minor 'ISLANDS' of high ground probably exist within the 1% minus 0.5m (and possibly the 1%) flood extents.
 3. Locations of buildings shown are approximate only and are not an indicator of flooding above floor level.
 4. In the corner bars, 'S' indicates an 'S' and 'M' indicates 'M' (as per standard cartographic convention for plan refer File 00010101). These cabins and vans may be below flood levels.

LEGEND

- 1% FLOOD EXTENT
- 1% minus 0.5m FLOOD EXTENT
- 800 RIVER DISTANCE (see note 1)
- 1% FLOOD EXTENT WITH 1% AND 1% minus 0.5m VALUES SHOWN

BUILDING AND BUILDING MATERIAL:

- WB - WEATHERBOARD
- W - WOOD
- CS - CEMENT SHEET
- B - BRICK
- S - STONE
- MB - MUD BRICK
- AS - ALUMINIUM SHEET



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DELATTE SHIRE

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

JAMIESON RIVER - JAMIESON

1% and 1% minus 0.5m FLOOD EXTENTS AND FLOOD CONTOURS

PROJECT NUMBER: G TIERNEY
 CORRESPONDENCE NAME: FPM/G/O/B
 SHEET NUMBER: 1 OF 1
 DRAWING NUMBER: 540228