NARROMINE SHIRE COUNCIL

NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

VOLUME 1 - REPORT

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Prepared by:
Lyall & Associates
Consulting Water Engineers
Level 1, 26 Ridge Street
North Sydney NSW 2060

Tel: (02) 9929 4466
Fax: (02) 9929 4458
Email: lacewater@bigpond.com

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SUMMARY

S1 Study Objectives

Narromine Council commissioned the preparation of the Floodplain *Risk Management Study and Plan* for Narromine. The overall objectives of the *Floodplain Risk Management Study* were to assess the impacts of flooding, review existing Council policies as they relate to development of land in flood liable areas bordering the Macquarie River, consider options for management of flood affected land and to develop a draft *Plan (FRMP)* which:

i) Proposes modifications to existing Council policies to ensure that the development of flood affected land is undertaken so as to be compatible with the flood hazard and risk.

ii) Proposes Flood Planning Levels for the various Land Uses in the Floodplain.

iii) Sets out the recommended program of works and measures aimed at reducing over time, the social environmental and economic impacts of flooding.

iv) Provides a program for implementation of the proposed works and measures.

S2 Study Activities

The activities comprising this study included:

- Review of flooding patterns on the Macquarie River floodplain at Narromine (**Section 2**).
- Assessment of the economic impacts of flooding, including the numbers of affected properties and estimation of damages for flood events up to the Extreme Flood (**Section 2** and **Appendix A**).
- Review of potential floodplain management measures aimed at reducing flood damages, including an economic assessment of each measure (**Section 3**).
- Ranking of measures using a multi objective scoring system which took into account economic, financial, environmental and planning considerations (**Section 4**).
- Review of current flood related planning controls for the study area and preparation of an updated draft *Flood Policy* for Narromine (**Appendix C**).
- Preparation of a draft *FRMP* for Narromine (**Section 5**).

S3 Summary of Flood Impacts at Narromine

Narromine is a town of 3,500 people located on the southern bank of the Macquarie River about 40 km downstream of Dubbo. (**Figure 2.1**) The total catchment area upstream of Narromine is 26,000 km^2. The town has shown continuing growth in recent years, with residential sub-division development proceeding on the floodplain upstream (east) of Manildra Street, between Crossley Drive and the Mitchell Highway. (**Figure S1**)

Due to the large catchment and the mitigating effects of Burrendong dam on peak flows, floods would take several days to peak at Narromine and high flows would be prolonged for up to a week. The existing town levee runs for a distance of about 800 m along the southern bank of the river between Dandaloo Street and Manildra Street and was built to protect the town following the major 1950 flood. The levee would be overtopped at a low spot and there would be little freeboard remaining over the remainder of its length at the 1% AEP level of flooding.

Floods up to the 2% Annual Exceedance Probability (AEP) magnitude would be conveyed within the river channel, although there would be small backflows from the Macquarie River into the Crossley Drive area upstream of the existing town levee via drainage pipes located in the river bank. There would be no flows emanating from the river due to overtopping of the river bank at this frequency of flooding.

Significant overtopping of the southern bank of the river upstream of Manildra Street would commence for floods between the 2% and 1% AEP, with the floodplain progressively conveying a larger flow as flood magnitudes increase. Some of this flow would travel westwards into town via a drainage path denoted the "Manildra Floodway" in this study. The remainder would flow through the culverts in the Main Western Railway embankment to the southern part of town via a flood runner known as the "Town Cowal".

Depths of inundation in the town at the 1% AEP level of flooding would be in the range 0.47 m to 1.49 m on the southern side of the railway line, and 0.31 m to 1.74 m on the northern side. Depths of inundation for the 0.5% AEP flood would be 0.3 to 0.5 m greater than for the 1% AEP. Extreme Flood levels would generally be 0.3 to 0.5 m higher than 0.5% AEP levels. (The Extreme Flood defines the upper level of potential flooding and would result from a flood with discharges equal to three times those of the 1% AEP event.)

Table S.1 shows the impacts of flooding on the various categories of urban development in Narromine. About half of the residences and a considerable proportion of commercial properties would be flooded in the event of a 1% AEP flood. The 0.5% AEP flood would cause similar flood levels to those that occurred in the record flood of February 1955, which inundated almost the whole urban area of Narromine.

TABLE S.1
PREDICTED FLOOD DAMAGES IN NARROMINE URBAN AREA

Flood Event % AEP	No. of Properties with Floors Inundated			Total Damage ($ x 10^6)
	Residential	Commercial	Public	
2	0	0	0	0
1	747	58	20	44
0.5	1070	142	39	113
Extreme Flood	1174	144	40	162

S4 The Floodplain Risk Management Plan

The draft *Floodplain Risk Management Plan* showing recommended flood management measures for Narromine is presented on **Figure S1** and outlined in **Table S.2**. The measures comprise a mix of investigations, engineering works, planning measures and improvements to flood awareness and emergency management procedures. They involve:

- Further development of the design concept for the flood protection levee along the southern bank of the Macquarie River. This measure would involve refining the concept design and cost estimates developed in **Section 3** of this report. The work would also include further hydrologic analysis to assess requirements for the storage and disposal

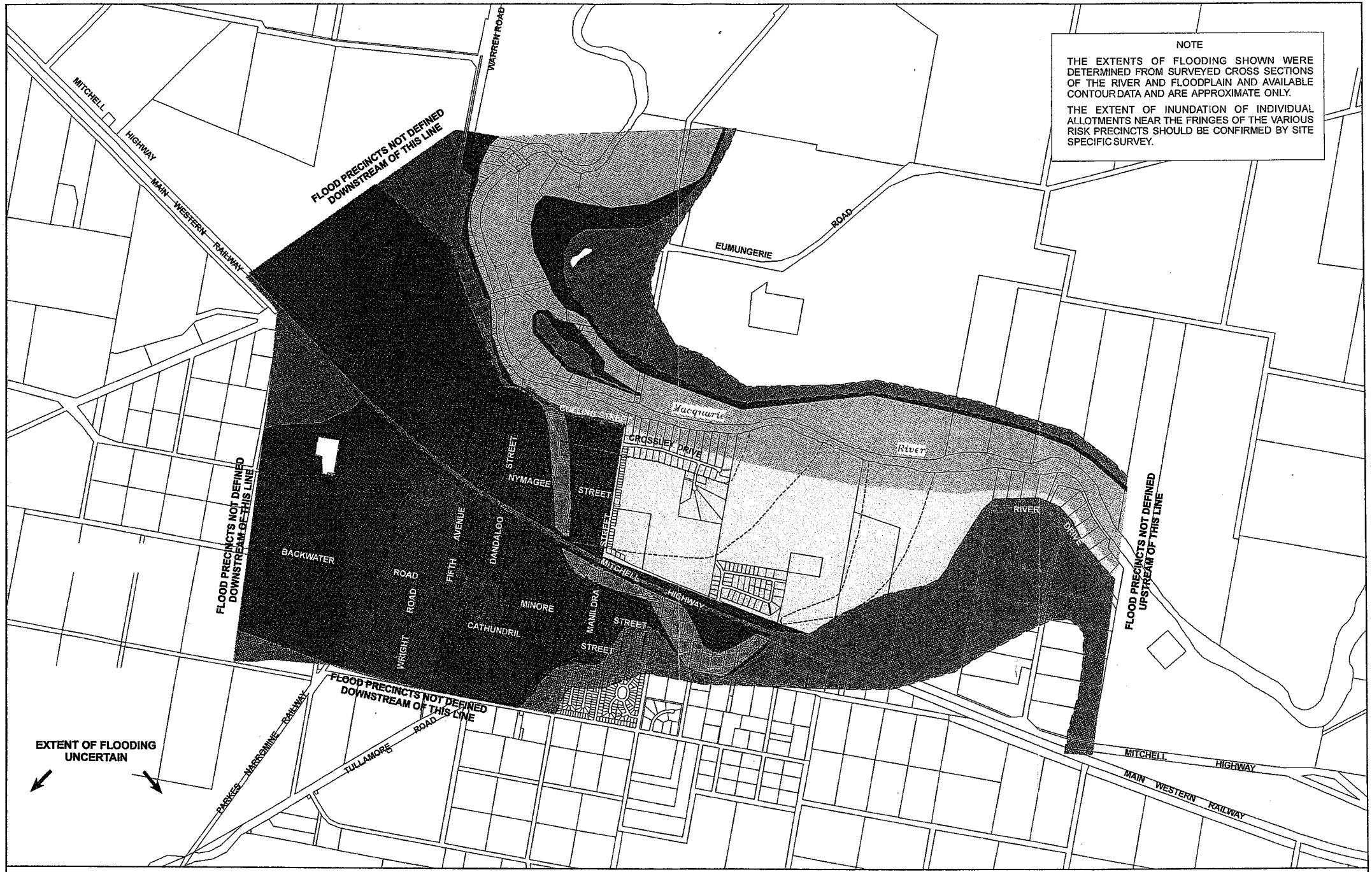
of runoff derived from the local stormwater catchments in Narromine. This investigation is required to confirm the engineering feasibility and economic merit of the levee and provide documentation to a standard to support an application for Government funding for the project.

- Further investigation of the feasibility of reducing flood levels in the ponding area east (upstream) of the Parkes Narromine Railway by enlarging the culverts in the embankment. The backwater influences of the pondage extend upstream into residences between Fifth Avenue and Manildra Street. On the basis of depth of inundation the area around Fifth Avenue is presently a "high hazard" area at the 1% AEP level of flooding. A concept scheme has been developed in this study to reduce flood levels. It comprises new culverts in the railway embankment to increase hydraulic capacity, in conjunction with the creation of an overland flow path to direct flows to the culverts. Existing survey of the area does not allow the feasibility of this scheme to be confirmed. The ponding area develops as a result of breakouts from the river being conveyed in the Town Cowal through the Main Western Railway culverts, as well as from runoff generated on the local stormwater catchments on the southern side of town. When the river levee scheme is constructed, the volume of flow contributing to the ponding will be considerably reduced. However, enlargement of the Parkes Narromine Railway culverts may still be required to cater for local runoff.
- Depending on the results of the above investigations and agreement on the provision of funding, preparation of detailed design and documentation of the chosen flood mitigation projects, followed by their construction as funding becomes available.
- The application of a graded set of planning controls that recognise both the type of development and the flood risk of the area, to be applied through an updated *Flood Policy* for Narromine. For the purposes of administering the *Policy*, the floodplain was divided into six areas of varying flood risk as shown on **Figure 5.2**.
- Improved emergency management plans for Narromine, including incorporation of flood information determined from the current floodplain management study in the SES's Narromine Local Flood Plan.
- As part of the improved emergency planning, SES should encourage the preparation by owners of individual Business Floodsafe Plans for commercial and industrial properties subject to flooding. A toolkit for the preparation of individual Business Floodsafe Plans has recently been developed by SES.

S5 Timing and Funding

The total estimated capital cost to implement the floodplain management plan is $2.53 Million, exclusive of Council and SES staff costs.

The timing of the proposed works will depend on Council's overall budgetary commitments and the availability of funds. Funding may be available through a number of sources, as identified in **Table S.2**.



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 5.2

FLOOD RISK PRECINCTS

TABLE S.2
RECOMMENDED MEASURES FOR INCLUSION IN
NARROMINE DRAFT FLOODPLAIN RISK MANAGEMENT PLAN

Measure	Required Funding	Key Features of the Measure	Comments and Funding Source
Implement the recommended development controls based on *draft Flood Policy for Narromine.*	Council's staff costs	▪ Control development in floodplain as summarised in *draft Flood Policy* ***(Appendix C).*** ▪ Graded set of flood controls based on the type of development and their location within the floodplain, defined as land inundated by the Extreme Flood. ▪ Floodplain divided into six Flood Risk Precincts as shown on **Figure 5.2** ▪ Minimum floor levels for residential development to be 1% AEP flood plus 500 mm freeboard. ▪ Council may allow a lower floor level for commercial/industrial development, provided an area is available at 1% AEP flood plus 500 mm for the temporary storage of goods. ▪ Minimum floor levels for Essential Community Facilities and Critical Utilities Essential Services to be 0.5% AEP flood plus 500 mm freeboard and facility to be able to function in the event of the Extreme Flood. ▪ Minimum Floor levels for Flood Vulnerable Residential Development (e.g. aged persons, nursing homes) to be 0.5% AEP flood plus 500 mm freeboard. Council may allow a floor level equal to the residential FPL, provided an area is available at 0.5% AEP flood plus 500 mm for the storage of valuable equipment. ▪ Council's evaluation of development proposals to use data presented in *Narromine Flood Study, 2006 and site survey.*	This measure has a **high priority** in view of projected residential development in Narromine. It does not require Government funding.
Ensure flood data in this *Floodplain Risk Management Study and draft Plan* is available to SES for inclusion in flood emergency response procedures.	Council and SES costs	▪ SES's Narromine Local Flood Plan, 2007 is to incorporate information on locations of flood prone development presented in this *Floodplain Risk Management Study.* Flooded residences (inundated above floor level at 1% AEP) are shown on **Figure 2.7**.	This measure would improve emergency management procedures and has a **high priority**. It does not require Government funding.
Implement flood awareness and education program for residents and owners of commercial and industrial developments.	SES's and owner's costs	▪ SES to prepare Flood Information Brochure to advise residents of the flood risk, based on the information presented in the *Floodplain Risk Management Study.* ▪ Encourage preparation of a Business Floodsafe Plan for individual commercial and industrial developments based on the recently published SES Toolkit.	This measure would reduce flood losses and has a **high priority**. It does not require Government funding.
Feasibility Study of river bank levee.	$80,000	• Survey along proposed route of levee to define top of river bank. ▪ Prepare concept design; refine initial costing and economic analysis presented in this *Floodplain Risk Management Study.* ▪ Undertake Community Consultation. ▪ Prepare a submission for Council and Government funding.	This measure is the first step in providing the levee and has a **high priority** in view of the economic impacts resulting from the occurrence of a 1% AEP flood. It requires Council and Government funding.
Preparation of detailed design and construction of levee (dependent on the results of the above study)	$1.6 Million	▪ Prepare detailed design and documentation of levee. ▪ Works are to be implemented by Council when funding available.	This measure would depend on a favourable outcome from the Feasibility Study and the availability of Council and Government funding.
Feasibility Study of upgrading hydraulic capacity of culverts in Parkes Narromine Railway.	$50,000	• Survey natural surface levels in south-west sector of town upstream of the railway embankment. • Hydrologic and hydraulic analysis to assess requirements for control of both river flows and local stormwater runoff. ▪ Prepare concept design; refine the initial costing and economic analysis presented in this *Floodplain Risk Management Study.* ▪ Undertake Community Consultation. ▪ Prepare a submission for Council and Government funding.	This measure is the first step in providing the new culverts and reducing flood levels in the south-west sector of town. It has a **medium priority**. It requires Council and Government funding, or alternatively, contributions from developers of land on eastern side of railway embankment.
Prepare detailed design and construct culvert works (scheme is dependent on the results of the above study and whether river bank levee scheme is implemented. River bank levee would reduce ponding upstream of the Railway and possibly reduce the need for improved culverts.)	$0.8 Million	▪ Prepare detailed design and documentation of culverts. ▪ Works are to be implemented by Council when funding available.	This measure would depend on a favourable outcome from the Feasibility Study and the availability of funding.
Total Estimated Cost	**$2.53 Million**		

1. INTRODUCTION

1.1 Background

Narromine Shire Council, through its Floodplain Management Committee is undertaking a *Floodplain Risk Management Study and Plan* for the town in accordance with the New South Wales Government's flood prone lands policy and using procedures set out in the *Floodplain Development Manual, 2005*. The results of the *Study* and the draft *Plan* are presented in this report.

The *Floodplain Risk Management Study* used the data from the recent *Narromine Flood Study* (LACE, 2006) to undertake a review of the physical, social and economic aspects of flooding on the Macquarie River floodplain at Narromine in order to prepare the draft *Floodplain Risk Management Plan.*

The *Floodplain Risk Management Study* summarised present day flooding conditions as determined by the LACE, 2006 investigation and identified and assessed potential measures aimed at reducing the impact of flooding on both existing and future development. This process allowed the formulation of a draft *Floodplain Risk Management Plan* for Narromine having regard to both existing flooding problems and to potential future development.

1.2 Overview of Report

The *Floodplain Risk Management Study and draft Plan* are set out in this report. Contents of each section of the report are briefly described below:

- **Section 2**, Baseline Flooding Conditions. This section includes a general description of the Macquarie River catchment and a review of land use on the floodplain at Narromine. Social, economic, physical and ecological aspects of existing flood behaviour are described. The section reviews existing flood management measures, including flood warning and evacuation practices.
- **Section 3**, Potential Floodplain Management Measures. Possible floodplain management options for Narromine are outlined and assessed.
- **Section 4**, Selection of Floodplain Management Measures. Floodplain management strategies comprising combinations of options are assessed in detail and a preferred strategy is outlined.
- **Section 5**, Draft Floodplain Risk Management Plan. The contents of the *draft Floodplain Risk Management Plan* are summarised.

The report is supported by four **Appendices**, which provide further details of the investigations leading to the preparation of the draft Floodplain Management Plan.

Appendix A sets out the results of a detailed investigation of damages likely to be experienced to residential, commercial and industrial property in Narromine in the event of major flooding.

Appendix B reviews the operation of Burrendong Dam as a flood mitigation storage during flood periods and its impact on downstream flooding.

Appendix C sets out the *draft Flood Policy* for Narromine.

Appendix D contains several exhibits derived from the *Narromine Flood Study*, 2006 which have been included to assist the reader in understanding flooding patterns in Narromine.

1.3 Community Consultation

Following an inception meeting between the Consultants and Stakeholders who included Council, Community, SES and DECC representatives, a Community Newsletter was prepared by the Consultants and distributed to residents by letterbox drop.

The Newsletter contained a questionnaire seeking details from the community of flood experience and attitudes to potential floodplain management options. Community responses are summarised in **Section 3**.

1.4 Flood Frequency

In this report, the frequency of floods is generally referred to in terms of their Annual Exceedance Probability (AEP). The frequency of floods may also be referred to in terms of their Average Recurrence Interval (ARI). The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP)%	Average Recurrence Interval (ARI) – years
0.2	500
0.5	200
1	100
5	19.5
20	4.5
50	1.4

The AEP of a flood represents the percentage chance of its being equalled or exceeded in any one year. Thus a 5% AEP flood has a 5% chance of being equalled or exceeded in any one year; a 1% AEP flood has a 1% chance, and so on. While a 1% AEP flood is a major flood event, it does not define the upper limit of possible flooding. Over the course of a human lifetime of, say 70 years, there is a 50% chance that a flood at least as big as a 1% AEP will be experienced. There is a 30% chance that an 0.5% AEP flood will be experienced over this period.

Reference is also made in this report to the "Extreme Flood" on the Macquarie River, which is a flood with discharge of 3 times the 1% AEP event. This flood approximates the upper limit of flooding. It would be an extremely rare flood and has been used in the study to define the upper limit of flooding at Narromine. Such floods are analysed to determine the consequences of an event much greater than the 1% AEP event (plus freeboard), which is usually used to define the **Flood Planning Level** for residential development. A larger flood event may be used to define the FPL for essential services, retirement homes and other vulnerable developments. Definition of the Extreme Flood also allows for the consideration of emergency response measures to be included in the *draft Floodplain Risk Management Plan*.

1.5 Flood Levels/Survey Reliability

The indicative extents of inundation and division of the floodplain into Flood Risk Precincts have been shown in plans included in the report. They were defined using existing sources of survey data. Topographic mapping data for the Narromine Study area are limited to ortho-photomaps at 1:4000 scale with 2 m contour spacing, as well as relatively coarsely spaced cross sections of the river channel and floodplain which were used to define their hydraulic conveyance characteristics in the *Narromine Flood Study*, 2006.

The flood related information shown on the plans is "indicative" only and should be read in conjunction with the cautionary note attached, which provides important information regarding procedures for determining flood affectation of a particular property. The use of the information contained on the plans should only be undertaken with a full appreciation of the basis on which they were prepared.

2. BASELINE FLOODING CONDITIONS

2.1 Physical Setting

The town of Narromine is located on the Macquarie River in the north-west of NSW, about 450 km from Sydney and 40 km downstream of the regional centre of Dubbo. The town has a population of about 3,500 and 1,500 residential properties and has shown steady growth in recent years. Most of the urban development including the main business and commercial area is located in flood prone land on the southern bank of the river.

The Macquarie River at Narromine has a catchment area of 26,000 km^2. **Figure 2.1** is a plan showing the drainage pattern of the Macquarie River catchment upstream of the town. There are two major water storages upstream of Narromine. Burrendong Dam completed in 1965, is located at the confluence of the Macquarie and Cudgegong Rivers and is approximately 120 km upstream of Narromine. Windamere Dam is situated on the Cudgegong River about 100 km upstream of Burrendong Dam.

Windamere Dam has a total storage capacity of 368 GL and controls a catchment area of 1,070 km^2. The reservoir has no reserved storage capacity or operating rules designed to reduce flood flows. The small proportion of the catchment controlled by the dam, together with the absence of flood mitigation storage, results in the dam having no significant effect on flood flows on the Macquarie River.

Burrendong Dam has a total catchment area of 13,900 km^2, approximately 50% of the catchment at Narromine. The dam has a total storage volume of 1,680 GL of which 480 GL is allocated to flood mitigation. The flood mitigation volume represents approximately half the volume of runoff which passed the dam site in the February 1955 flood. That flood resulted in the highest recorded flood level on the Macquarie River and inundated most of the urban area of Narromine.

Due to the large percentage of the catchment controlled by the dam, the large flood mitigation capacity and the planned operation of the spillway gates during floods, Burrendong Dam has a significant effect on the majority of flood events at Narromine. If the dam had been in existence, the February 1955 flood would have been substantially reduced at Narromine.

2.2 Floodplain Definition and Flooding Patterns

2.2.1 Floodplain Definition

Narromine is bounded on the northern side by the Macquarie River and on the south side by the Backwater Cowal, which is a tributary of the Boggy Cowal. The Backwater Cowal is fed by a local catchment extending to the south-west of Narromine and can also be fed from a breakout of the river upstream of Narromine. A ridge of high ground separates the Backwater Cowal from the town. Consequently, floodwaters from the Backwater Cowal are unlikely to enter the town area.

A number of breakouts occur from the Macquarie River in the vicinity of the town, which allow floodwaters to enter town. The main breakout is near the end of Dandaloo Street. This breakout is blocked by the existing Culling Street levee. The town of Narromine would be largely unaffected by Macquarie River flooding for events up to the 2% AEP event and flood levels would be below the crest of the Culling Street levee. At the 1% AEP level of flooding the Culling Street levee would be overtopped at a low point and the "freeboard" (that is, the factor of safety between

the flood peak and the levee crest) would generally be less than 500 mm. There would also be breakouts from the river occurring at several low spots in the river bank between the upstream end of the levee at Manildra Street and River Drive, about 4 km upstream. An overland flow path denoted the "Manildra Floodway" in this study would convey overbank flows westwards across the developing area between Crossley Drive and the Mitchell Highway and over Manildra Street into town. Overflows would also be conveyed along the Town Cowal flow path to the railway culvert near the industrial area and thence to the southern part of town.

Due to the prolongation of flows from the breakouts over several days, floodplain storage areas within the town would fill and there would be above-floor inundation of residences and commercial properties. The 1% AEP flood would inundate most of the town. Flood levels along the length of the Macquarie River fronting the town would be at bank full level. A further small increase in water surface levels would result in a large volume of floodwaters entering the town over a wide frontage, including the overtopping of most of the town levee.

The indicative extents of flooding for the 1%, 0.5% AEP design floods and the Extreme Flood have been plotted on the aerial photography supplied by Council and are shown in **Figure 2.2.** The extents of flooding were determined from the surveyed cross sections of the Macquarie River and floodplain and available 2 m contour data. They are therefore approximate only and should not be used to identify the degree of flood affectation, or otherwise, of individual allotments located within the floodplain.

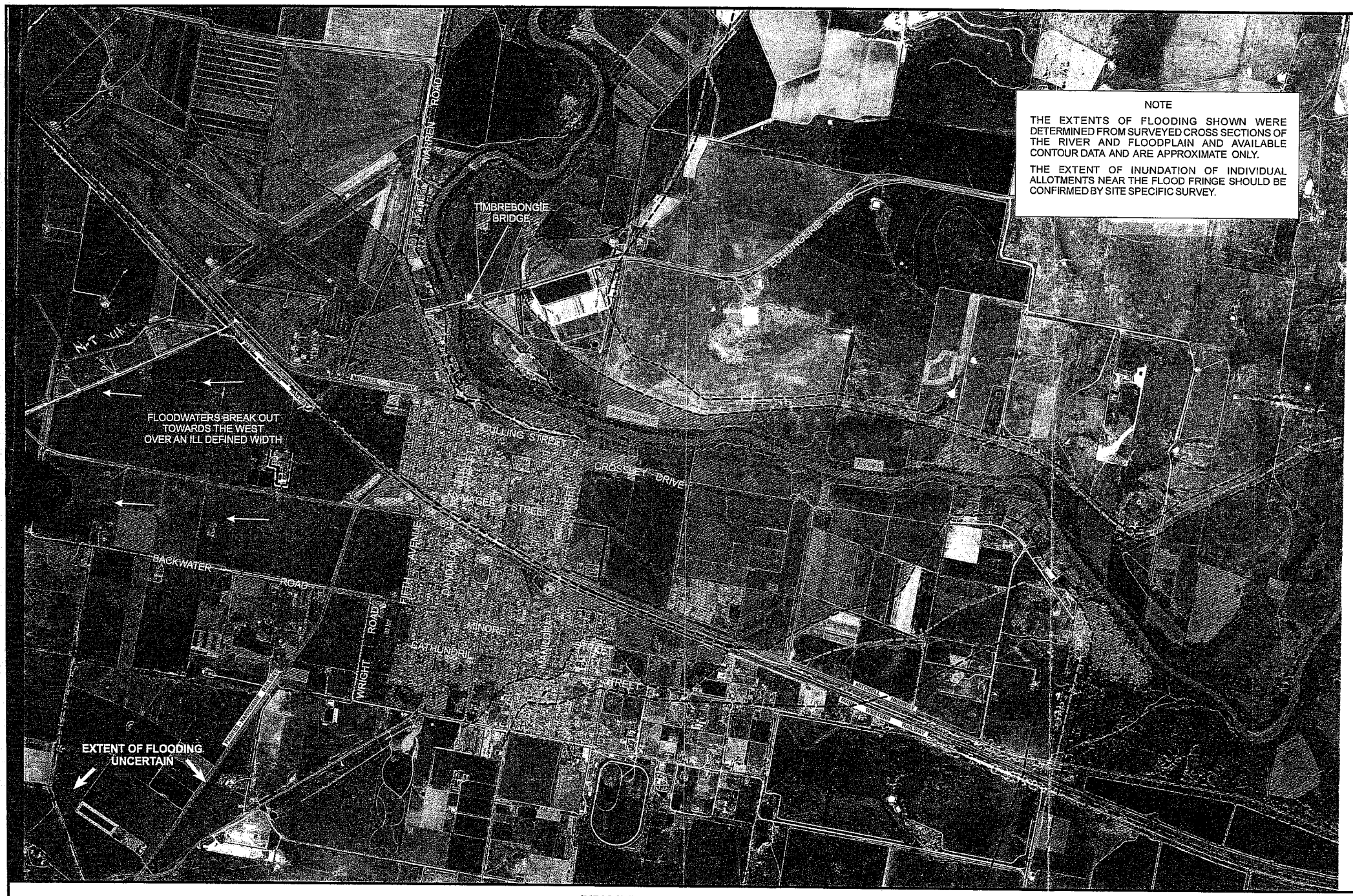
Some of the areas shown to be lying within the extent of flooding may in fact be situated on locally elevated sites, either natural or filled, and therefore would not be inundated. The extent and depth of inundation within individual allotments would need to be confirmed by a site specific survey, and interpolation of the peak flood levels estimated at the various nodal points of the hydraulic model used to define flooding.

2.2.2 Flooding Patterns and Depths of Inundation

Figure 3.2 of the *Narromine Flood Study, 2006* along with **Figure 3.7** from that study, have been included in **Appendix D** of this report to illustrate flooding patterns in Narromine. **Figure 3.2** of **Appendix D** shows depths of inundation at typical locations in Narromine. The Manildra Floodway, shown on this diagram, is a significant conveyor of flows breaking out from the river between Manildra Street and River Drive. At the 1% AEP, the peak discharge heading westwards over Manildra Street would be in excess of 70 m^3/s. Depths of inundation in the floodplain between Crossley Drive and the Mitchell Highway, which is undergoing residential development, would average about 0.5 to 0.6 m, with a depth of flow of about 0.4 to 0.5 m occurring over Manildra Street.

A flow of 26 m^3/s would be conveyed on the Town Cowal through the culverts in the Main Western Railway embankment to the southern side of town. On the southern side of town the main flow path runs along Minore Street which would convey about 25 m^3/s westwards to the ponding area on the upstream side of the Parkes Narromine Railway. Drainage from this area is through the twin 600 mm diameter pipes in the railway embankment. The backwater influences of the Parkes Narromine Railway embankment extend as far upstream as Manildra Street.

On the southern side of the culverts in the Main Western Railway embankment, the Town Cowal continues westwards along the embankment and then crosses the railway back to the northern side of town, where it is met by flows conveyed by the Manildra Floodway. Below its junction with



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.2

INDICATIVE EXTENTS OF INUNDATION
1%, 0.5% AEP AND EXTREME FLOOD EVENT

the Manildra Floodway, flow in the Town Cowal for the 1% AEP flood would approximate 63 m^3/s, which would continue to the Warren Road. Minor flows would also be conveyed westwards through the streets. Flows of 13 m^3/s and 16 m^3/s would be conveyed westwards towards the Aerodrome along Warren Road and Mitchell Highway respectively and the balance would flow over the Highway to be joined by discharge from the Parkes Narromine Railway culverts.

The entry of floodwaters into town via the low points in the river bank would result in inundation over most of the developed part of town at the 1% AEP. Depths of inundation would be in the range 0.47 m to 1.49 m on the southern side of the Main Western Railway line, and 0.31 m to 1.74 m on the northern side (ref. **Figure 3.2** of the *Narromine Flood Study, 2006* in **Appendix D**).

2.3 Characteristics of Flooding

2.3.1 Critical Gauge Heights

Three gauges have over the years been used as the official gauge at Narromine. They are:

- the weir gauge
- the town gauge
- the Timbrebongie Bridge Gauge (shown on **Figure 2.2**)

The Timbrebongie Bridge gauge (GS 421006) is currently used for flood warning purposes. It has a gauge zero of RL 224.01 m AHD.

Stream flow records are currently collected at the Baroona Gauge (GS 421127). This station is located on the Macquarie River about 22 km upstream of Narromine and has an automatic recorder. Records commenced in 1986.

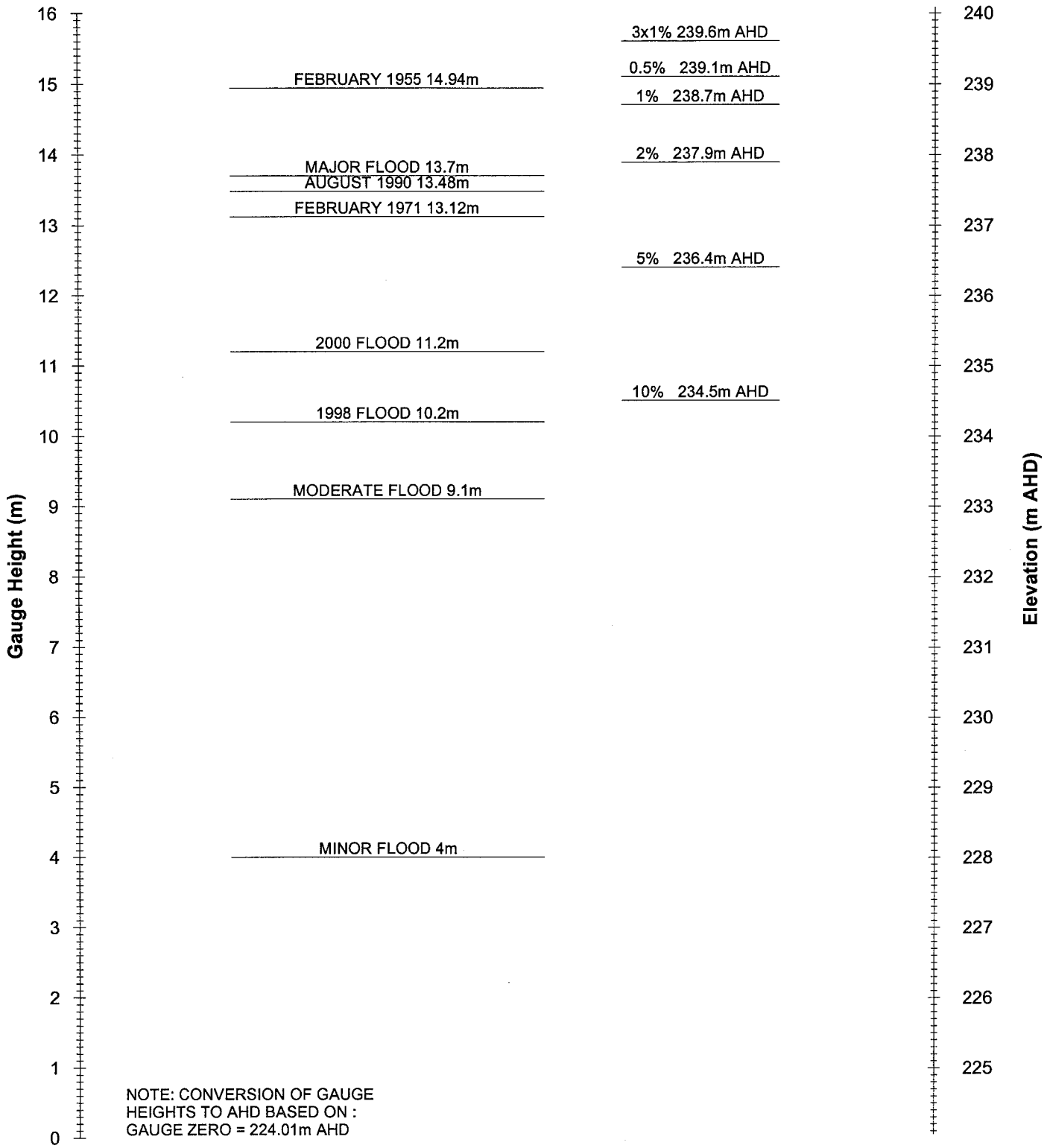
Figure 2.3 shows comparative peak flood levels at the Timbrebongie Bridge gauge, including the SES flood classifications for minor, moderate and major floods. The gauge height corresponding with a major flood event is 13.7 m, which is just below the design 2% AEP flood.

Only two floods have exceeded the 5% AEP flood level since construction of Burrendong Dam: in February 1971 and August 1990. The August 1990 flood was the third significant flood event experienced in the period April – August 1990 and was the biggest post-Burrendong flood, reaching a peak of 13.48 m on the bridge gauge. The August 1990 flood was about 0.4 m below the 2% AEP design flood and did not result in damaging flooding in the town.

2.3.2 February 1955 Flood

The 1955 flood is the largest flood to have occurred in Narromine since European settlement and had a frequency of 1% AEP at the time of its occurrence. However, the construction of Burrendong Dam in 1965 with its large flood mitigation storage component has meant that to generate flows in the Macquarie River of an equivalent magnitude would require a much rarer flood, with a frequency of around 0.5% AEP.

At Narromine, the 0.5% AEP design flood is about 0.2 m higher than the peak flood level recorded at the gauge in the 1955 flood. However, due to changes which have occurred on the floodplain over the past 50 years which have tended to raise flood levels, a repetition of the 1955 flood flows would produce similar depths of inundation to the 0.5% AEP design flood within town.



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.3

COMPARATIVE FLOOD LEVELS
TIMBREBONGIE BRIDGE
MACQUARIE RIVER

2.3.3 Rate of Rise and Duration

The construction of Burrendong Dam has resulted in a reduction in peak levels and an attenuation of the flood wave in downstream areas. The shape of the hydrograph at Narromine can also be influenced by the magnitude and relative timing of flood flows in the Talbragar River, which joins the Macquarie at Dubbo. However, in general, the stage hydrograph at Narromine is characterised by a slow time of rise lasting from 2 to 4 days, followed by maintenance of flows near the peak for several days and a recession time lasting up to several weeks.

Flood peaks take between 2 to 4 days to traverse the reach of river from Burrendong to Narromine. Flood waves sometimes exhibit a double peak, for example in February 1971, due to the early arrival of flows from the Talbragar River. Contributions to flow from the Talbragar River can augment downstream flooding in the Macquarie River, but flows from this catchment in isolation are not sufficient to result in significant flood events at Narromine.

Section 3 of the report summarises the impact of Burrendong Dam on the frequency of flooding at Narromine, with further details presented in **Appendix B**.

2.4 Floodplain Zoning

Land use planning within the Narromine Council area is regulated by way of the *Narromine Local Environmental Plan 1997.* Land use zones within the floodplain are shown on **Figure 2.4.** The following discussion provides an overview of the land use types within the floodplain affected by the 1% AEP flood.

1(c) Rural Small Holdings– This zone within the floodplain is predominantly located in the following areas:

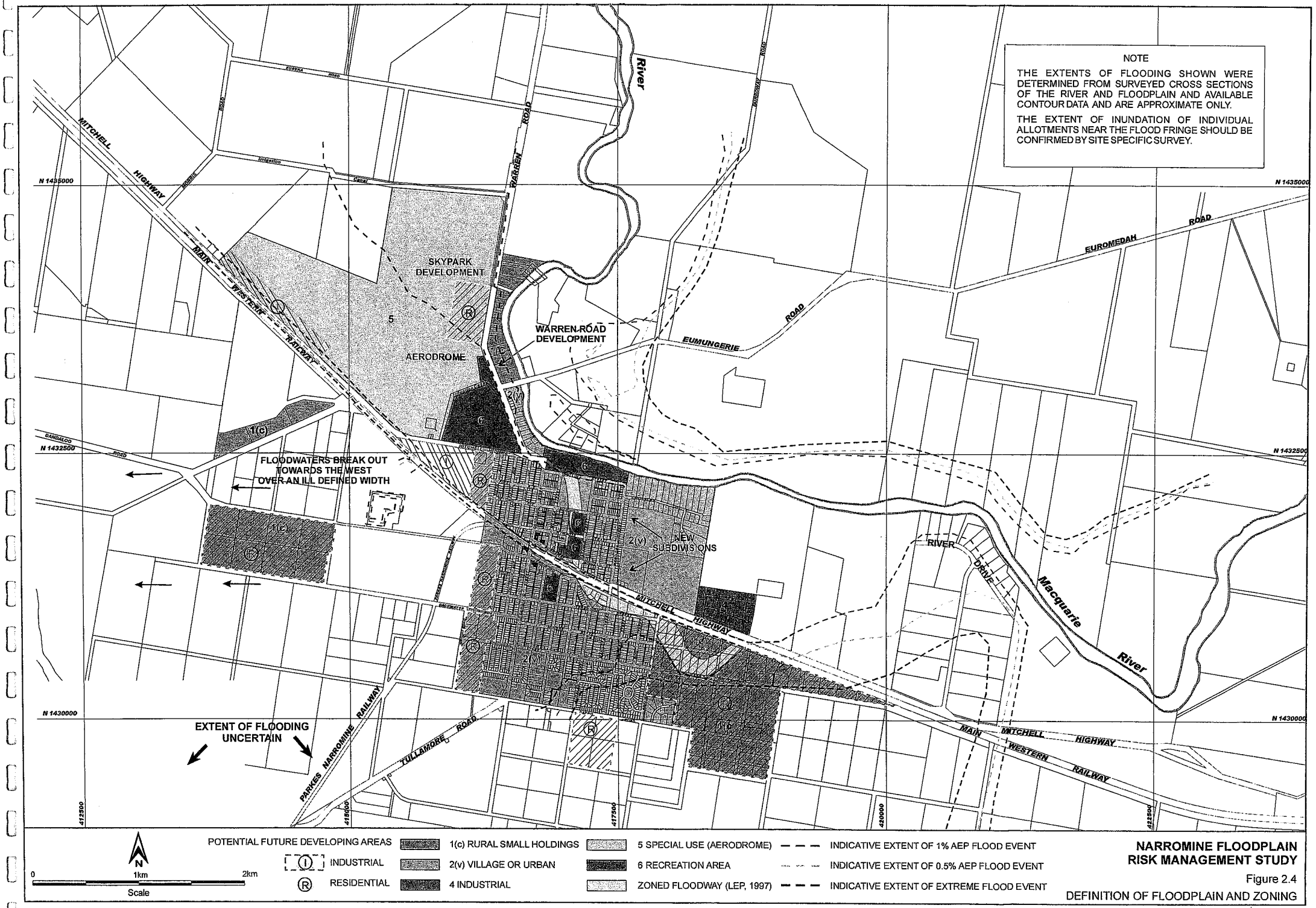
- To the north of the town in the area between the river and Warren Road. This area is known locally as the Warren Road Development.
- On the eastern part of the town, south of the Main Western Railway.
- Areas to the west of the Parkes Narromine Railway.

2(v) Village or Urban– This zoning applies to most of the town and includes the residential and commercial areas. There are also two parcels to the east of the Parkes Narromine Railway which have been identified by Council as Potential Future Growth Areas. The developing residential area situated on the southern floodplain between Crossley Drive and the Mitchell Highway, to the east of Manildra Street, is also subject to this zoning.

(4) Industrial– The only land zoned industrial is situated on the northern side of the Main Western Railway embankment to the east of the town. It is understood that this zoning has recently been extended to encompass an adjoining area of vacant land.

(5) Special Use (Aerodrome) – The aerodrome is located on the floodplain in the north-west sector of Narromine between Warren Road and the Mitchell Highway.

(6) Recreational Area– There are several areas zoned Recreational Area, including the area between the existing levee and the Macquarie River and other areas located on the Town Cowal.



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.4

DEFINITION OF FLOODPLAIN AND ZONING

(7) Floodway – The Town Cowal has been zoned as a "Floodway", extending from the point where it crosses the main Western Railway to the southern part of town, continuing westwards to where it re-crosses the railway and extending northwards to Culling Street. It is understood that the "Floodway" was defined for zoning purposes on the basis of the results of the previous Narromine Flood Study prepared in 1998.

Recent surveys of several parcels of rural land east of A'Beckett Street have indicated that the area zoned "Floodway", at least near its upstream limit on the southern side of the railway, may extend into land that is actually outside the extent of the 1% AEP flood (i.e. extend into areas that remain dry for that flood). Floodways are defined in the *Floodplain Management Manual, 2005* and in the *draft Flood Policy* for Narromine presented in **Appendix C**, as "Those areas of the floodplain where a significant discharge of water occurs during floods" and which "even if partially blocked would cause a significant redistribution of flood flow, or a significant increase in flood levels." Limitations on survey currently available do not allow all of the potential inconsistencies to be resolved between the area actually zoned "Floodway" and the area to which the true definition of a floodway (in a hydraulic sense) should apply. Based on available data, the extent of the floodway was defined in a hydraulic sense in **Figure 2.9** - see **Section 2.7** for further discussion.

Pending the updating of the Narromine LEP, the "Floodway" zoning as shown in **Figure 2.4** may take precedence in consideration by Council of approvals of proposed developments in flood prone lands. However, the data included in **Figure 2.9** could be incorporated in any future updating of the LEP, 1997. Council should also give consideration to the recommendation that flood mapping should not be included in the updated LEP. This would allow Council to incorporate in its administration of flood prone land any improved definition of flooding as more detailed survey information becomes available, without the need for continually amending the LEP.

2.5 Economic Impacts of Flooding

A detailed assessment of potential flood damages for floods from the 2% AEP event to the extreme event was carried out for this study and is reported in **Appendix A.** For this analysis peak flood levels were obtained from data presented in the *Narromine Flood Study, 2006*. Details of building structures and their states of repair were obtained from a drive-by survey, and floor levels were estimated from natural surface levels shown on the Narromine Sewerage Plans. No floor levels were actually surveyed. However, the approach adopted gave reasonable estimates of the numbers of properties inundated, as well as the depths of inundation above floor level of sufficient accuracy for this strategy study.

Damages to residential, industrial, commercial and public buildings were estimated. There are no data available on historic flood damages to the residential and commercial/industrial sectors in Narromine. Accordingly, it was necessary to adopt the procedure set out in DECC's *Floodplain Guidelines Number 4* which transposes data on damages experienced to residential development as a result of recent flooding in other urban centres. Damages to commercial and industrial property were estimated using data transposed from recent Floodplain Management Studies.

Table 2.1 makes the distinction between "Flood Affected" and "Above-Floor Inundated" properties. Flood Affected properties are all properties which would be affected by flooding in Narromine and includes properties where the water can be expected to be on land around the house, as well as properties which would be inundated above floor level. Above-Floor Inundated

NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.9

FLOODWAY DIAGRAM 1% AEP

properties are those Flood Affected properties where the flood waters would be above the floor of the building.

Figure 2.5 shows the relationship between flood damages and flood frequency.

TABLE 2.1
TOTAL NUMBER OF PROPERTIES INUNDATED - NARROMINE

Flood Event % AEP	Number of Properties Flooded					
	Residential		Commercial/Industrial		Public Buildings	
	A	B	A	B	A	B
2	0	0	0	0	0	0
1	1065	747	126	58	35	20
0.5	1181	1070	147	142	40	39
Extreme Flood	1228	1174	146	144	40	40

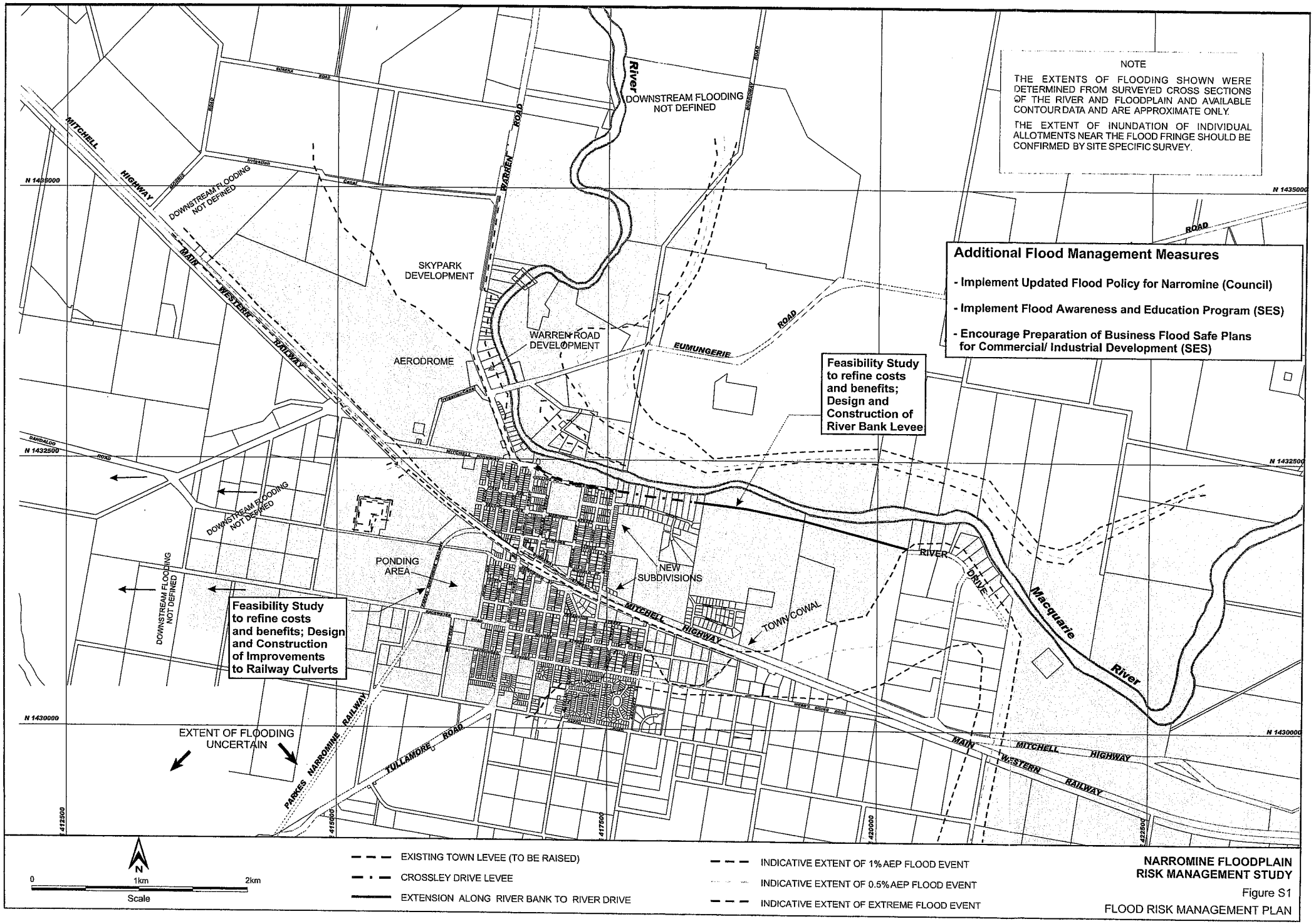
Note: A – Flood affected property (Flooding in allotments + flooding above floor level)
B – Above-Floor inundated property (Flood level above floor level)

Table 2.2 and **Figure 2.6** shows the *cumulative average annual damages* related to flood frequency. The *average annual damages* represent the damages that would be expected each year on a long term basis for all flood events and amount to $1.3 Million at Narromine. The *cumulative average annual damages* represent the long term damages for all floods up to the frequencies shown on the x axis of this figure. For example, the *cumulative average annual damages* for floods up to the 1% AEP level of flooding amounts to $0.2 Million. (A detailed explanation of the terms used in the damages assessment is given in **Appendix A** and their use in economic analysis of potential flood management works and measures is described in **Chapter 3** of the report.) **Figure 2.7** shows the locations of flooded properties assessed using the flood and property level data.

The data in **Table 2.2** indicates that flood damages increase progressively with the magnitude of the flood up to about $113 million for the 0.5% AEP flood. For an Extreme Flood, the damages could be up to $162 million.

TABLE 2.2
URBAN FLOOD DAMAGES NARROMINE ($ x 10^6)

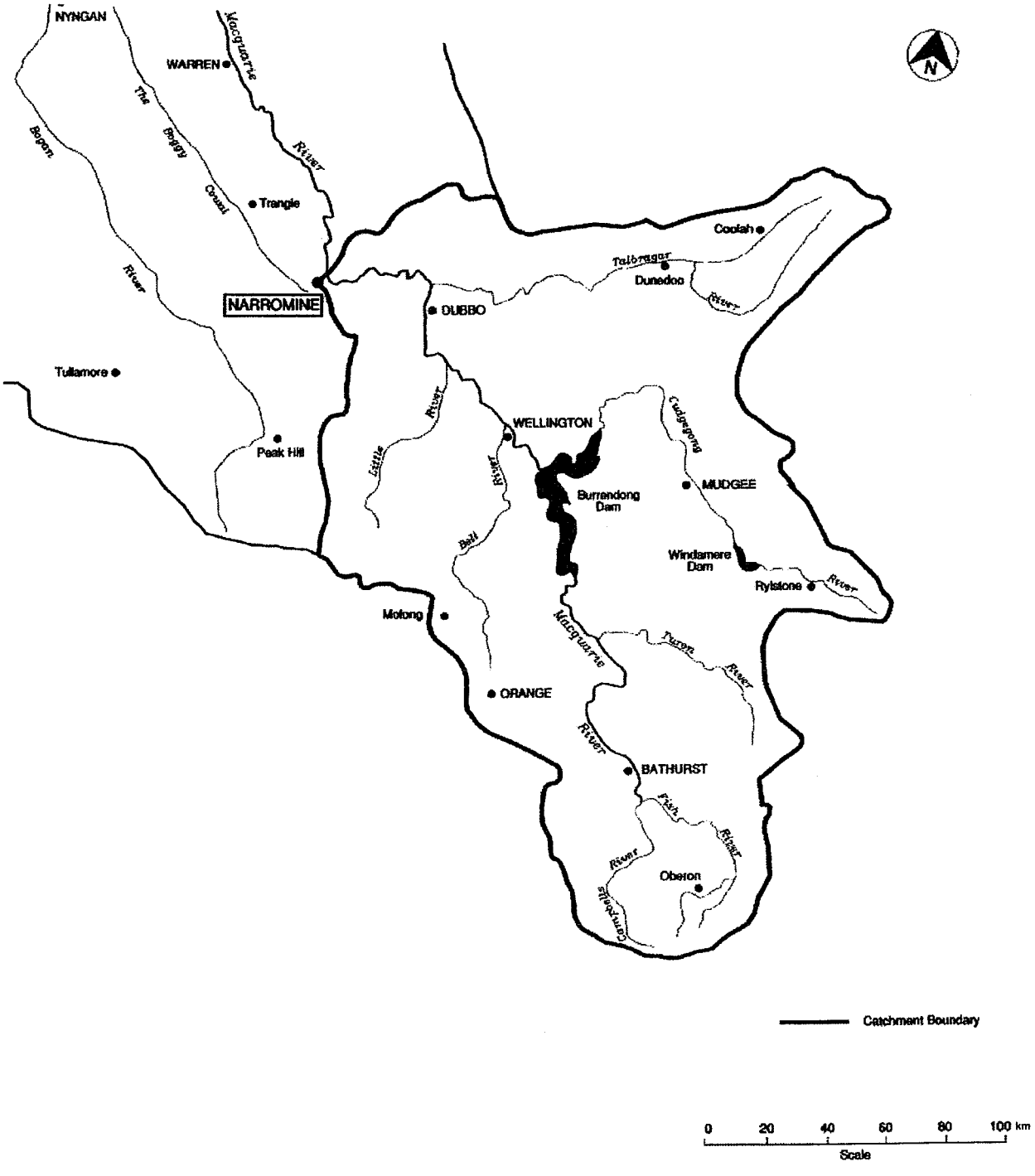
Flood Event % AEP	Residential	Commercial / Industrial	Public Buildings	Total Damage	Cumulative Average Annual Damage
2	0	0	0	0	0
1	34	4.4	5.3	44	0.2
0.5	49	53	11	113	0.6
Extreme Flood	57	89	16	162	1.3



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure S1

FLOOD RISK MANAGEMENT PLAN

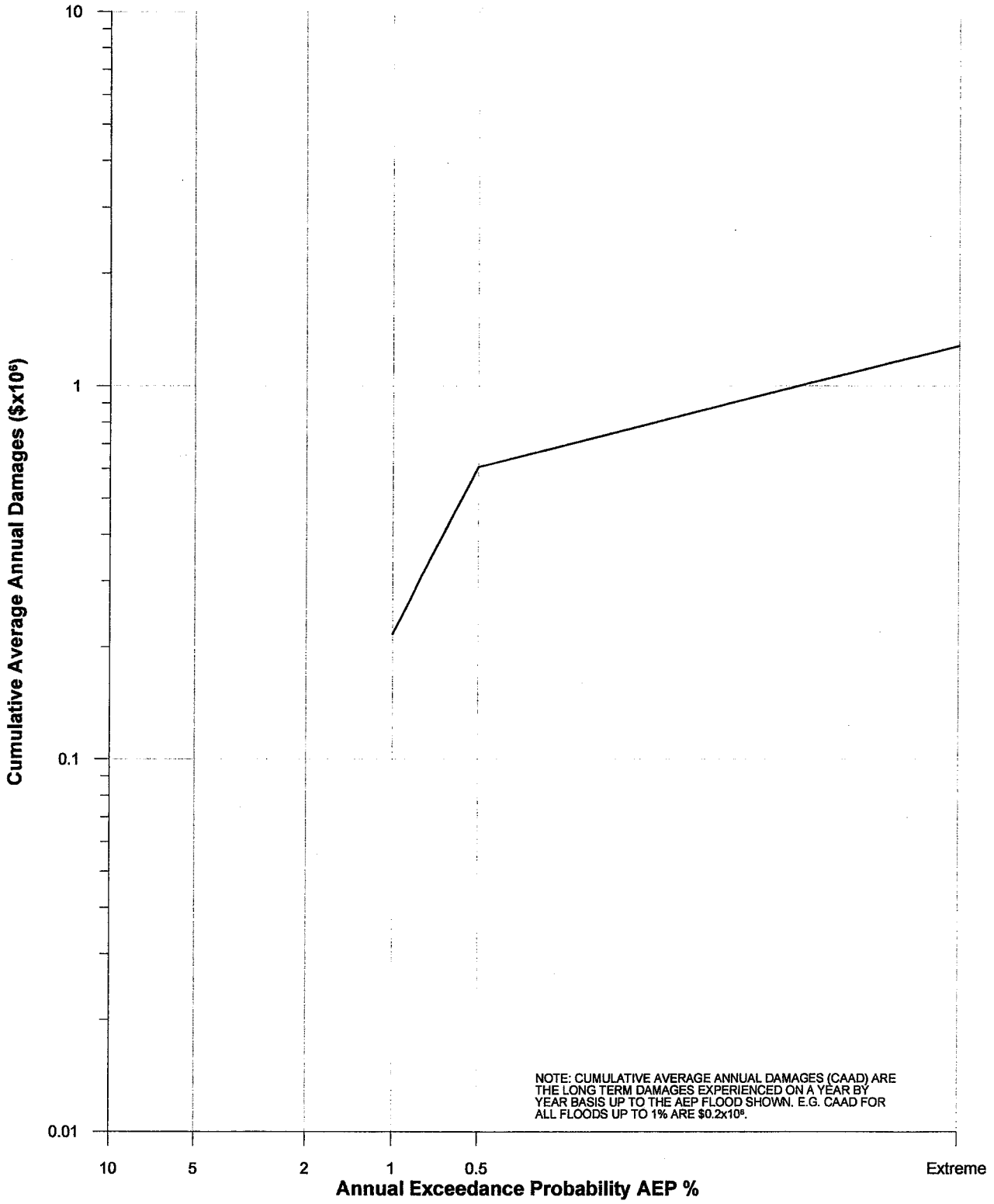


Taken from
Bewsher Consulting, 1998

NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.1

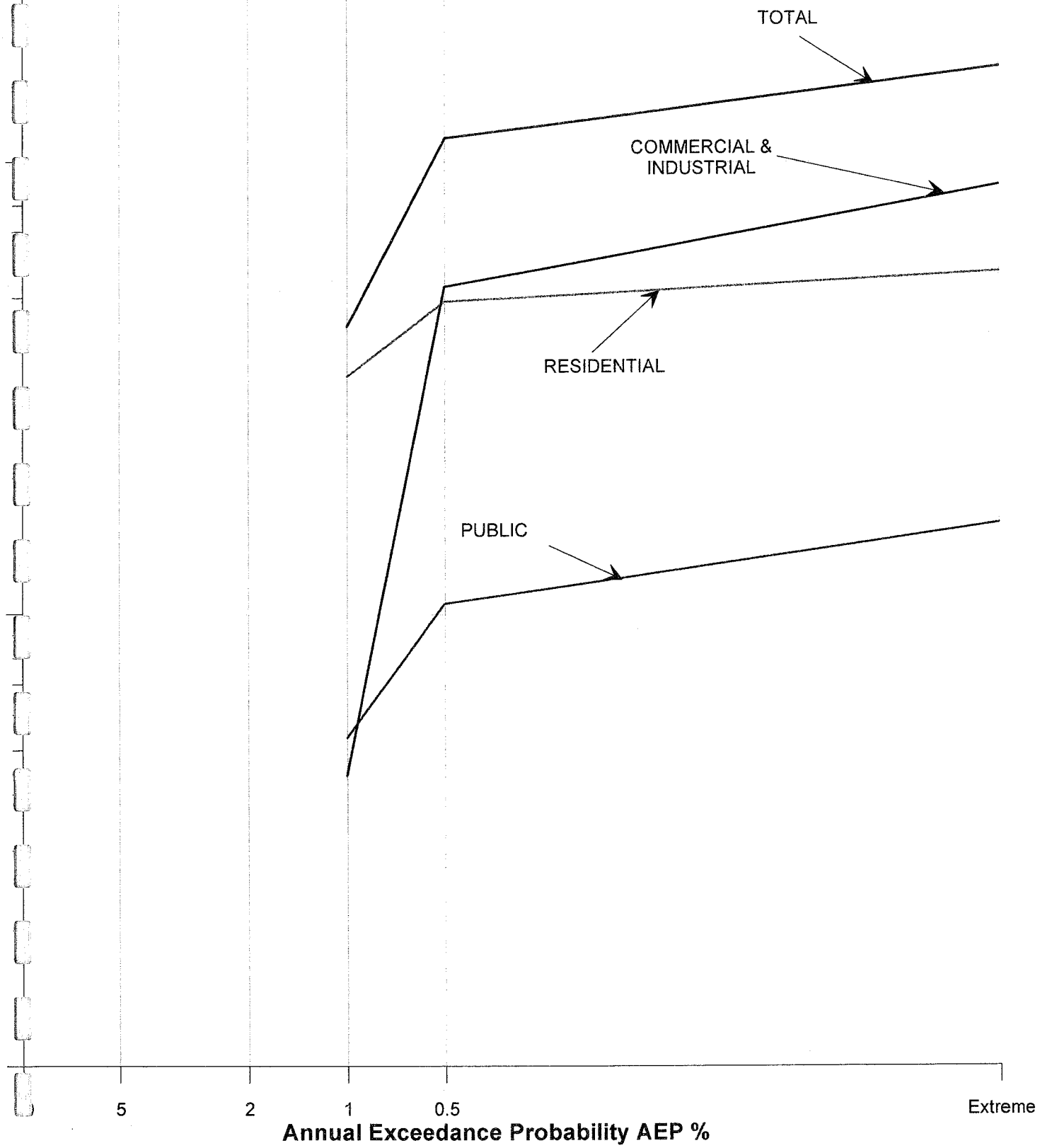
LOCALITY PLAN



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.6

CUMULATIVE AVERAGE ANNUAL DAMAGES


TOTAL
COMMERCIAL &
INDUSTRIAL
RESIDENTIAL
PUBLIC
5
2
1
0.5
Extreme
Annual Exceedance Probability AEP %


MITCHELL HIGHWAY
TRANGIE ROAD
MACQUARIE RIVER
CULLING STREET
SIXTH AVENUE
FIRST AVENUE
SECOND AVENUE
ELLENGERAH ST
CROSSLEY DRIVE
MERINGO STREET
NEW SUB-DIVISION
NYMAGEE STREET
BURRAWAY STREET
Town Cowal
DERRIBONG STREET
NEW SUB-DIVISION
FIFTH AVENUE
THIRD AVENUE
FOURTH AVENUE
MAIN WESTERN RAILWAY
DERRIBONG STREET
DANDALOO
MERILBA
TEMOIN
MERYULA
ALGALAH ST
TERANGION
BACKWATER ROAD
MINORE
ALGALAH
MANILDRA STREET
MURGAH
BOOTH
ABECKETT
CATHUNDRIL STREET
DUFFY ST
TANCRED ST
NELLIE VALE ROAD
DAPPO ROAD
DAVIS DRIVE
Town Cowal
MACQUARIE DR
SUNGIFT AVENUE
INDUSTRY AVENUE
MITCHELL HIGHWAY
LEGEND
Residential Properties with Floors Inundated
Commercial Properties with Floors Inundated
Public Properties with Floors Inundated
Extent of 1% AEP Flood
N
0
250
500 m
Scale
NOTE: FLOOR LEVELS OF FLOODED PROPERTIES WERE ESTIMATED FROM NATURAL SURFACE LEVELS SHOWN ON NARROMINE SEWER PLANS AND SITE INSPECTION
NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY
Figure 2.7
FLOODED PROPERTIES
1% AEP

The impact of flooding on infrastructure such as roads, bridges and electricity varies depending on the size of flood. **Table 2.3** provides a summary of indicative impacts of flooding on infrastructure in Narromine for various design flood events.

TABLE 2.3
QUALITATIVE EFFECTS OF FLOODING ON INFRASTRUCTURE AND COMMUNITY ASSETS AT NARROMINE

Damage Sector	Flood Event (%AEP)			
	2	1	0.5	Extreme Flood
Electricity	0	8	8	1
Telephone	0	2	2	1, 2
Roads	0	3, 4, 5	3, 4, 5, 6	1, 3, 4, 5, 6
Bridges	0	9	9	9
Sewerage	0, 10	0, 10	0, 10	0, 10
Water Supply	0	0	0	1
Parks and Gardens	0	11	11	11

Notes:
0 = No significant damages likely to be incurred
1= Due to significant increase in discharge and depth for extreme flood event, damages likely to be incurred
2 = Narromine telephone exchange flooded
3 = CBD (Dandaloo St) flooded
4 = Mitchell Hwy flooded u/s town
5 = Streets in Town Cowal area flood affected
6 = Warren Road flooded
7= Bores above flood level
8= Electricity sub-station flood affected
9= Timbrebongie Bridge above flood level but approaches flood affected
10= Sewage Treatment Plant relocated to flood free land
11= Recreational facilities flooded (Rotary Park)

Most of the town area, including the locations of all of the essential services, is located on land that would be inundated by the 1% AEP flood. They include:

SES Facilities
Council Chambers
Police Station
Ambulance Station
Telephone Exchange
Hospital

2.6 Flood Hazard

Flood hazard categories may be assigned to flood affected areas in accordance with the procedures outlined in the *Floodplain Development Manual, 2005*.

Flood prone areas may be provisionally categorised into *Low Hazard* and *High Hazard* areas depending on the depth of inundation and flow velocity. Flood depths up to about 1 m, in the absence of any significant flow velocity, represent the boundary between Low and High Hazard conditions. Similarly, flow velocities up to 2.0 m/s but with minimal flood depth also represent Low Hazard conditions.

Flood hazards categorised on the basis of depth and velocity only are *provisional*. They do not reflect the effects of other factors that influence hazard. These other factors include:

- Size of flood – major floods though rare can cause massive damage and disruption
- Effective warning time – flood hazard and flood damage can be reduced by evacuation if adequate warning time is available
- Flood awareness – flood awareness greatly influences the time taken by flood affected residents to respond effectively to flood warnings. The formulation and implementation of response plans for the evacuation of people and possessions promote flood awareness.
- Rate of rise of floodwaters – situations where floodwaters rise rapidly are potentially more dangerous and cause more damage than situations in which flood levels increase slowly.
- Duration of flooding – the duration of flooding (or length of time a community is cut off can have a significant impact on costs associated with flooding. The duration is shorter in smaller, steeper catchments.
- Evacuation problems and access routes – the availability of effective access routes from flood prone areas directly influences flood hazard and potential damage reduction measures.

Hazard categories may be reduced or increased after consideration of the above factors.

Narromine has a potential warning time of flooding from the Macquarie River of several days, as estimated by the time of travel of the flood wave from Burrendong Dam. (The effective warning time is, however, considerably longer due to the monitoring of the incoming flood peak by the gate operators).

The duration of peak flooding would last for several days for a major event, as high flows may be prolonged on the Macquarie River due to releases from Burrendong Dam. These factors would suggest maintenance of, but not an increase in, the provisional hazard rating. Other factors, such as reasonable flood awareness in the town resulting from the flood experiences of February 1955 and August 1990, absence of major evacuation problems or access problems due to the depth of flooding would suggest that an increase in the hazard rating was not warranted. On balance, therefore, the provisional hazard rating should not be increased.

Because of the low flow velocities over the floodplain the definition of flood hazard at Narromine is mainly dependent on the depth of inundation. In most of the Low Hazard areas the velocity of

flow would be expected to be low, less than 0.2 m/s. The boundary between high and low hazard zones has been estimated using the surveyed cross sections of the floodplain and limited natural surface spot levels shown on the Sewerage Plans supplied by Council. Assessment of the flood hazard in individual allotments or for future sub-division development would require a site survey so that the depth of inundation could be accurately determined.

Figure 2.8 shows the flood hazard for the 1% AEP flood defined according to the above principles. At the 1% AEP, in addition to the river channel, the Town Cowal from the downstream side of its initial crossing of the Main Western Railway to the southern side of town would be located in a high hazard zone, as would be the backwater area on the upstream (eastern) side of the Parkes Narromine Railway.

2.7 Hydraulic Categorisation (Floodway Areas)

This section deals with the identification of floodway areas on the floodplain at Narromine. Floodways (in a hydraulic sense) are those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with obvious naturally defined channels and are the areas that, even if only partially blocked, could cause a significant re-distribution of flow, or a significant increase in flood level which may in turn adversely affect other areas. They are of relevance to the present study in proposing controls over future development (ref. **Section 3.8.2** and **Appendix C** for the *draft Flood Policy*). In addition to the Macquarie River channel there are two floodways on the southern floodplain: the Town Cowal and the Manildra Floodway.

Floodplain Risk Management Guideline No 2 Floodway Definition, offers guidance in relation to two alternative procedures for identifying floodways. They are:

- **Approach A.** Using a *qualitative approach* which is based on the judgement of an experienced hydraulic engineer. In assessing whether or not the area under consideration was a floodway, the qualitative approach would need to consider; whether obstruction would divert water to other existing flow paths; or would have a significant impact on upstream flood levels during major flood events; or would adversely re-direct flows towards existing development.

- **Approach B.** Using the hydraulic model, in this case the MIKE 11 model used in the *Narromine Flood Study, 2006*, to define the floodway based on *quantitative experiments* where flows are restricted or the conveyance capacity of the flow path reduced, until there was a significant effect on upstream flood levels and/or a diversion of flows to existing or new flow paths.

Both **Approaches** were used in the present study. The extents of the 1% AEP floodways are shown as dashed lines on **Figure 2.9**.

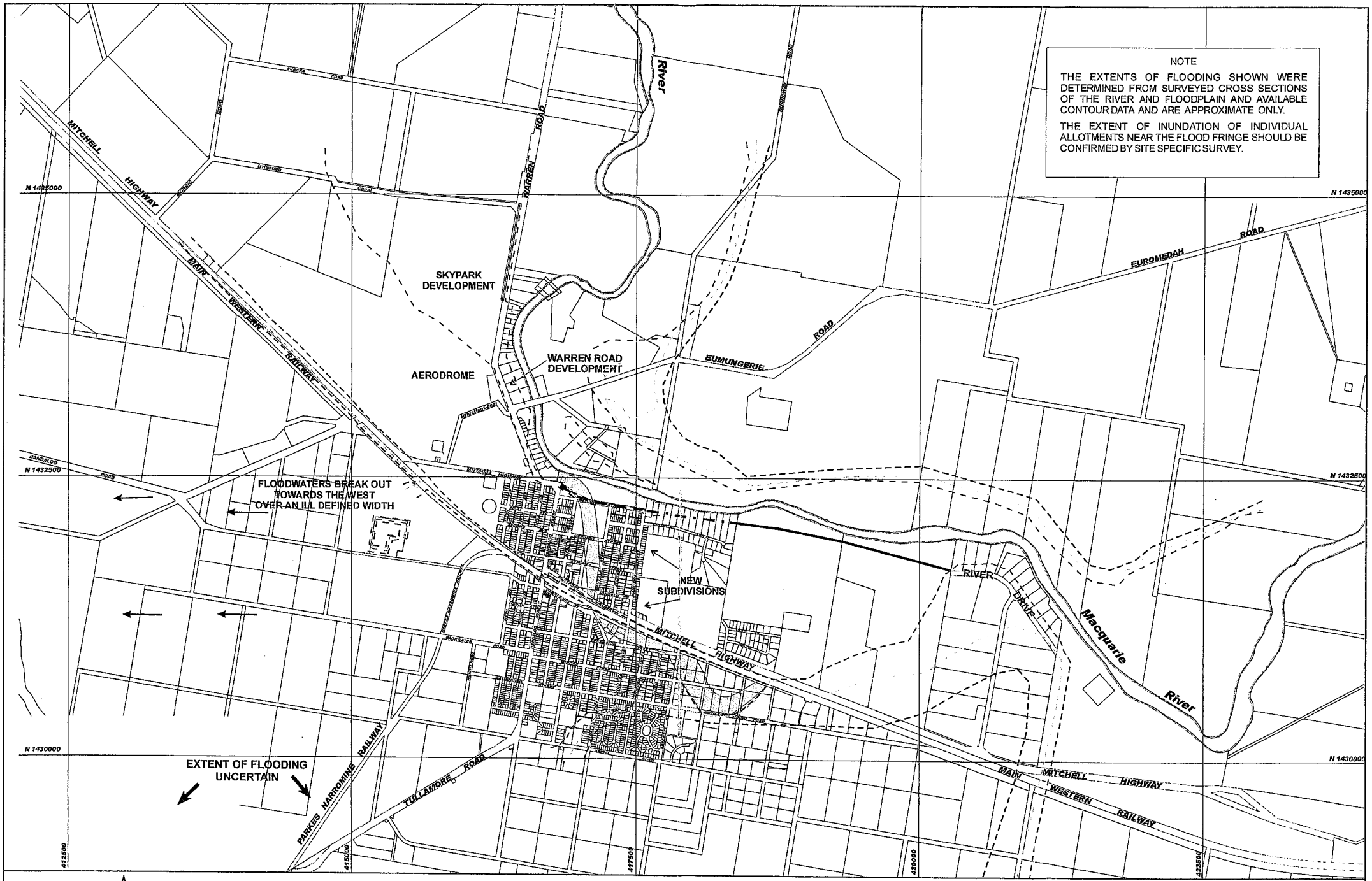
Manildra Floodway.

The breakouts from the river occur upstream of Crossley Drive and traverse the floodplain, flowing over Manildra Street and joining the Town Cowal on the northern side of the railway. To assess flow depths and velocities, two cross sections were included in the hydraulic model. They extended across the two new sub-divisions upstream of Manildra Street between Crossley Drive and the Mitchell Highway. The available surveys of these areas represented the natural surface levels which existed prior to development of these two sites. The Kingsway sub-division (the

NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.8

FLOOD HAZARD DIAGRAM
1% AEP



NARROMINE FLOODPLAIN RISK MANAGEMENT STUDY

Figure 3.1

PROPOSED LEVEE LOCATION

development more remote from the Highway), was undertaken without large scale filling of the area. Consequently the survey was representative of current natural surface levels in this property. The Polofields site (closer to the Highway) was not developed at the time of preparation of this study and no information was available showing the proposed allotment layout and levels.

The hydraulic modelling showed that under 1% AEP flooding conditions, the maximum depth and velocity of flow in the Manildra Floodway would average about 590 mm and 0.15 m/s respectively across the 800 m wide waterway. The maximum velocity multiplied by the depth would be 0.09. A value of 0.4 is often used to define the boundary between low and high hazard. Consequently these values are characteristic of low hazard conditions occurring within the sub-division area under major flood conditions.

The 1% AEP depth of inundation in the two sub-divisions did not vary greatly across the waterway section, ranging between values of 0.4 m and 0.8 m. Because of the uniformity of depth, all of the waterway section functioned on an equal basis as far as the conveyance of flow is concerned. The flow per unit width averaged 0.09 $m^3/s/m$ over the extent of the section, with a maximum value of 0.14 $m^3/s/m$ in the deepest flooded areas and a minimum of 0.05 $m^3/s/m$ in the shallowest areas. These are quite mild unit rates of discharge, characteristic of shallow, slow moving overland flow.

It was considered that there would be no justification for placing more severe development controls in allotments located in the deeper flooded areas than in the shallower flooded areas. The flood related controls over development in this area proposed in the draft *Narromine Flood Policy* of **Appendix C** were confined to setting minimum floor levels (1% AEP flood level plus 500 mm) and setting controls over filling in allotments in order to minimise obstructions to the passage of flow.

The hydraulic analysis also showed that the cross sectional area of the waterway between Crossley Drive and the Highway (normal to the direction of flow) could be reduced by up to 50 per cent without an increase in flood level being experienced in the Manildra Floodway, or flows being re-directed towards the Town Cowal Floodway and thence to the southern side of the railway embankment.

To ensure that flow would not be unduly restricted by development in the sub-divisions, the draft *Flood Policy* considers that a width equal to at least 50 per cent of the gross width of each allotment normal to the direction of flow should be kept clear of obstruction to allow for the conveyance of flow. Applying these restrictions to all allotments will maintain the existing distribution of flow passing over Manildra Street. It is important to ensure that there is no concentration of flow due to the intended upstream development.

Downstream of Manildra Street, flows would travel through existing residential areas, with most of the flow being conveyed along the east-west running street system to the Town Cowal. The proposed conditions over upstream development would ensure that the existing pattern of slow moving flow is maintained and therefore no controls would be required in those areas other than the imposition of minimum floor levels.

Town Cowal Floodway.

In **Figure 2.9**, the Town Cowal Floodway (Hydraulic Categorisation as shown by dashed lines) was superimposed on the Town Cowal Floodway as defined in Council's LEP, 1997. On the southern side of the railway embankment the hydraulic floodway generally lies within the extent of the zoned floodway, indicating that development in theory could intrude somewhat without adversely affecting adjacent flow patterns. On the northern side of the railway the hydraulic floodway deviates slightly from the zoned floodway at its downstream end near Culling Street. Flow velocities in this area are comparatively mild, around 0.3 to 0.4 m/s. However, before allowing development to proceed additional survey would be required to refine the estimate of the location of the floodway and its width at this point.

The estimated location of the floodway was continued both upstream and downstream of town. However there are less survey data available in those areas than within the town and consequently it is not possible to define its extent with certainty.

On the upstream portion of the floodplain north of the railway embankment, between the point at which the Town Cowal breaks out of the Macquarie River and the culverts in the railway embankment, flow velocities would be very low, around 0.1 m/s. It is considered that low intensity development could proceed in this area (subject to more detailed consideration with the benefit of site survey).

Downstream of the town the floodway has been defined as far as the Main Western Railway. Flow velocities in this area would be up to 1 m/s. Additional survey to refine the definition of the floodway would be required before development could proceed in the potential industrial area between the Mitchell Highway and the railway (see **Figure 2.4**).

2.8 Social Effects of Flooding

The *Floodplain Development Manual, 2005* categorises flood damages as either tangible or intangible, with tangible damages further subdivided into direct and indirect. Essentially, tangible damages relate to the impact of flooding on the economic operation of Narromine while intangible damages or losses relate to the social impact of that flooding. Social impacts which could arise from flooding in Narromine include:

- inconvenience
- isolation
- disruption
- psychological disturbances as a result of anxiety and trauma, and
- physical ill-health

Flooding raises the following social implications for life in Narromine:

- Significant tracts of rural land within the study area are used for agricultural pursuits. These areas are contained within the fertile floodplain of the Macquarie River. Flooding of these areas has the potential for a significant impact on the economic viability of such activities and commensurate social impact both on the land owners and businesses which depend upon the viability of those activities.

- The Mitchell Highway to the east of Narromine is severed by floodwaters from the Town Cowal in a major flood.

- Dandaloo Street Mitchell Highway is the "main" street of Narromine. This section of Narromine contains the majority of the business/commercial and retailing activity of Narromine. This area could be flooded for several days during a 1% AEP flood event causing major social disruption to the town and the surrounding rural areas.

- During the 1% AEP event, the majority of shops, a number of schools, churches, the post office, motor registry, ambulance station, telephone exchange and police station would be inundated, which would contribute to the major social impact of such an event.

The above list is not exhaustive but does give an indication of the extent of the potential social impact of flooding in Narromine.

2.8 Environmental Considerations

The majority of the floodplain within the town of Narromine has been developed for agriculture or urban purposes. The only remaining "natural" areas lie within the river banks, particularly along the Macquarie River.

The Macquarie River has a stable V shaped channel along much of its length through Narromine. The channel is generally 15 m deep and most of the floodwater is contained within its banks. The main river channel contains remnant vegetation including some large eucalypts but has also been subject to invasion by exotic species such as willows and weed species from domestic gardens. The invasion of exotic species along the river bank has the potential to increase the hydraulic roughness and raise flood levels. There does not appear to be any evidence that this has occurred yet, but monitoring of the vegetation along the Macquarie would be warranted to ensure that exotic species did not produce a significant increase in hydraulic roughness.

Council should consider a pro-active approach to the management of the vegetation along the riverine corridor of the Macquarie and prepare a vegetation management plan to maintain the original native vegetation and maintain a corridor for the movement of native birds and animals along the river.

2.9 Administrative/Political Considerations

The entire floodplain within the study area lies within the town of Narromine, the NSW State seat of Dubbo and the Federal electorate of Calare. Administrative interfaces on issues relating to the *Floodplain Risk Management Study* occur with respect to the following:

- Flood Warning — Bureau of Meteorology, Department of Environment and Climate Change, Narromine Council and the State Emergency Service (SES).

- Planning Controls — Department of Planning NSW. The regional planning powers of the Department and its overview of zoning matters are important in any rezoning.

• Funding	Commonwealth Government, Department of Environment and Climate Change, Narromine Council. Any request for funds to implement the recommendations of this report will be submitted through DECC with assistance sought from the Commonwealth.
• Floodplain Crossings	Both the Roads and Traffic Authority, and the Rail Infrastructure Corporation own bridge and approach embankment works on the floodplain and would be vitally interested in any recommendation concerning these works.
• Welfare Management	Department of Community Services, a range of Service Groups, Council, SES and Police. The complex arrangements under the State Emergency Management Organisation structure create numerous interfaces in the delivery of welfare services.
• Catchment Management	Central West Catchment Management Authority, (Macquarie Street Dubbo).

2.10 Flood Warning and Evacuation Practice

2.10.1 Narromine Local Flood Plan

The State Emergency Service is nominated as the principal combat and response agency for flood emergencies in NSW. The SES is responsible for the issuing of relevant warnings (in collaboration with the Bureau of Meteorology), as well as ensuring that the community is aware of the flood threat and how to mitigate its impact.

The *Narromine Local Flood Plan, 2007*, published by SES covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures for all levels of flooding within the Narromine Shire area. The *Local Flood Plan* is administered by the Narromine SES Local Controller who controls flood operations within the Narromine Shire Council area, which is located within the Macquarie SES Division. The *Plan* includes updated flood information as presented in the *Narromine Flood Study* (LACE, 2006).

The *Narromine Local Flood Plan* is set out under the following headings:

- **Responsibilities** of SES and supporting services including Narromine Shire Council, DECC, Dubbo, Orana Local Area Command of NSW Police Service, RTA, Railcorp, Bureau of Meteorology, NSW Fire Brigades, Country Energy, Telstra and other Government and local service organisations.
- **Preparedness** of the Plan for flood emergencies including: participation in Floodplain Management activities organised by Council (i.e. this present Study and participation in the Floodplain Management Committee), development of Flood Intelligence describing flood behaviour, extent of inundation and effects on the community, development of Flood Warning Systems for flood affected areas, public education and dissemination of flood brochures and displays in Public Areas.
- **Response** to flooding including coordination of other agencies and organisation for flood management tasks.
- **Recovery** including debriefing arrangements after the flood emergency has abated.

2.10.2 Operational Management of Local Flood Plan

Narromine has been divided into seven sub-sectors for operational management as follows:

- Narromine CBD
- Rosebank Area
- Airport Area
- Central Narromine
- Railway south
- Narromine North
- Narromine West

2.10.3 Activation of Flood Plan

The plan will be activated by the Narromine SES Local Controller:

a. On receipt of a Bureau of Meteorology Preliminary Flood Warning, Flood Warning Flood Watch, Severe Weather Alert and/or Severe Thunderstorm Warning.

b. On receipt of a dam failure alert.

c. When other evidence leads to an expectation of flooding within the Council area.

2.10.4 Flood Intelligence During Flood Emergencies

Sources of flood intelligence during times of flooding are:

a. **Bureau of Meteorology**. The Bureau provides:

- *Flood Watches*, which give an early appreciation of developing meteorological situations that could lead to flooding. These are normally provided on a whole-of-catchment basis for the Macquarie-Bogan River System.
- *Flood Warnings*, which include river height readings and height-time predictions. The gauges for which predictions are provided are listed in **Table 2.4** below.
- *Severe Weather* and Severe thunderstorm Warnings.

b. **Macquarie SES Division Headquarters**. The Division Headquarters provides information on flooding and its consequences, including those in nearby Council area.

c. **Narromine Shire Council.** Information on road closures within Council areas.

d. **Burrendong Dam**. The dam failure Warning System provides information on Burrendong Dam.

e. **Department of Environment and Climate Change.** Provides flow rates and river levels during flood events.

TABLE 2.4
FLOOD GAUGES MONITORED
BY NARROMINE SES LOCAL HEADQUARTERS

Gauge Name	Type	AWRC No.	Stream	Flood Classification			Reading Arrangements
				Minor	Moderate	Major	
Wellington Bridge *⊕	Manual	421003	Macquarie River	4.0	9.10	12.20	DECC
Dubbo *⊕	Telemeter	421001	Macquarie River	5.5	7.9	11.0	DECC
Barooona ⊕	Telemeter	421127	Macquarie River	4.0	10.0	12.0	DECC
Narromine *⊕	Manual	421006	Macquarie River	4.0	9.1	13.7	DECC
Weemabah	Manual	10414	Macquarie River	na	na	na	Council
Gin Gin	Telemeter	421031	Macquarie River	na	na	na	DECC
Rawsonville	Manual	421055	Coolbaggie Creek	na	na	na	DECC
Peak Hill *⊕	Telemeter	421076	Bogan River	2.5	4.6	6.0	DECC
Dandaloo *⊕	Telemeter	421083	Bogan River	4.1	5.2	6.0	DECC

Notes:
1. The Bureau of Meteorology provides flood warnings for the gauges marked with (*)
2. The SES holds a Flood Intelligence Card for the gauges marked (⊕)

2.10.5 Flood Warnings and Their Dissemination

The Narromine SES Local Headquarters:

- Provides advice to the Macquarie SES Region Headquarters on current and expected impacts of flooding.
- Co-ordinates the delivery of warnings to the community by door-knocking, telephone, mobile public address systems, local radio stations and two-way radio.

The Macquarie SES Region Headquarters issues warning information in the form of SES Region Flood Bulletins to media organisations and agencies.

Warnings are provided as follows:

a. **SES Livestock and Equipment Warnings.** Following heavy rain or when there are indications of significant creek or river rises (even to levels below Minor Flood height), the Narromine SES Local Controller advises the Macquarie SES Region headquarters which issues SES Livestock and Equipment Warnings to radio stations.

b. **Bureau of Meteorology Flood Watches.** If there are signs of impending floods, Flood Watches may be incorporated in SES Flood Bulletins released to radio stations by the Macquarie SES Region Headquarters.

c. **Bureau of Meteorology Flood Warnings.** Flood Warnings are issued for the locations detailed in **Table 2.4**. On receipt of such warnings, the Narromine SES Local controller will:

- Advise the Narromine Shire Council and the Narromine Shire Council Local Emergency Operations Controller.
- Provide the Macquarie SES Region Headquarters with information for inclusion in SES Flood Bulletins on the estimated impacts of flooding at the predicted heights.

d. **Evacuation Warnings.** Evacuation warning messages are disseminated according to Annex E of the Plan.

e. **Dam Failure Warnings.** Special arrangements apply in the case of severe flooding that may have the potential to cause the failure of Burrendong Dam. Details of these arrangements are described in the Dam Safety Emergency Plan for Burrendong.

f. **Standard Emergency Warning Signal (SEWS).** This signal may be played over radio and television stations to alert communities to Evacuation Warnings, Special Warnings or Dam Failure Warnings. Approval to use the signal will be obtained by the Narromine SES Local Headquarters from the Macquarie SES Region Headquarters.

2.10.6 Flood Intelligence Information of Benefit to SES Contained in the Study

One of the objectives of the present Study was the provision of the latest Flood Intelligence to SES. The SES has already upgraded its *Local Flood Plan, 2007* to incorporate flood information contained in the recent *Narromine Flood Study, 2006.* The results of the present Study provide the following information:

(1) Relates river gauge heights to design floods of various frequencies and historic flood levels (ref **Figure 2.3**).

(2) Presents indicative extents of inundation, peak flood levels and depths of inundation for various flood frequencies (ref **Figure 2.2** and exhibits in **Appendix D**).

(3) Numbers of flood affected properties for various frequencies (ref **Tables 2.2** and **2.3**), dealing with the economic impacts of flooding.

(4) Provides indicative information on the locations of properties flooded above floor level in **Figure 2.7**.

(5) Provides indicative depths of inundation of residential properties for a range of flood events (data supplied to Council).

2.11 Existing Flood Controls

2.11.1 Current Flood Policy

Narromine Council adopted a policy in August 2005, which sets minimum floor levels for new dwellings in the 2(v) Village Zone based on a previous flood study investigation (Bewsher Consulting, 1998). Subsequently, since finalisation of the *Narromine Flood Study, 2006*, the revised flood levels presented in that document have been used.

Council specifies a minimum finished floor level of 500 mm above the 1% AEP flood. If this floor level will require the applicant to fill the site in excess of 1200 mm and other buildings in the vicinity are built flat on ground, further assessment by Council may be undertaken to ensure an adequate floor height above the flood height, while assimilating the new building into the existing built environment.

The policy recognises that certain types of development may require floor levels to be raised due to the limited mobility and/or large number of inhabitants (such as an aged care facility), or buildings which house emergency equipment (such as an ambulance station) and other buildings important to the town's economy. Because of their importance they are to have a higher floor level.

The floor level for new special use developments (which include hospitals, aged care facilities, nursing homes, medical centres, schools, higher education facilities and the like) is to be at least the same level as the 0.5% AEP flood for that section of town. For additions to existing premises of the kind referred to in this clause of the policy, any extension is also to be built to the 0.5% AEP flood level unless the addition involves non-habitable rooms, storage of non-important items and is not intrinsic to the proper functioning of the town.

Comment on Current Flood Policy: The more recent hydraulic investigations reported in the *Narromine Flood Study, 2006* have shown that on the southern side of town, 0.5% AEP flood levels are only 150 mm above the 1% AEP levels. Consequently, the adoption of the 0.5% AEP level (without freeboard) could result in minimum floor levels of special uses development being at a lower level than adjacent residential developments, which are based on the 1% AEP flood plus 500 mm. To maintain the relative levels of protection for the various categories of development, the Flood Planning Levels proposed in the draft Flood Policy of **Appendix C** incorporate a uniform freeboard (500 mm).

2.11.2 Impacts of Revised Flood levels

According to the 1998 Flood Study, Narromine was largely unaffected by the 1% AEP flood, as that study did not recognise the flow entering the town via the low points in the river bank upstream of Manildra Street. More recent flood levels derived in the *Narromine Flood Study, 2006* are considerably higher than the 1998 study for the 1% AEP event, with the increase ranging between 0.46 m in the area upstream of Manildra Street denoted the "Manildra Floodway", to 0.95 m on the Town Cowal near Nymagee Street and 1.14 m further downstream near Meringo Street. A large area on the southern side of town would be inundated due to the escape of flows from the Town Cowal westwards along Minore and Cathundril Streets to the culverts in the Parkes Narromine Railway embankment. The area east of the railway embankment would be subject to backwater flooding due to floodwaters ponding behind the embankment.

The developing residential area on the eastern side of Manildra Street (**Figure 2.7**) will be affected, as minimum floor levels previously advised to developers will need to be raised. Further upstream, flood levels in land recently re-zoned for large lot residential purposes have increased according to the 2006 data. A similar situation exists for a proposed extension of the existing industrial area bordering the Mitchell Highway.

Revision of the flood levels also has an impact on existing residential development in Crossley Drive. Allotments previously considered flood free at the 1% AEP level of flooding are now flood affected according to the new data, with several residences being subject to shallow above - floor inundation. The increase in assessed flood affectation in this area will need to be incorporated in Council's and SES's flood emergency planning.