ANNEX A TO
THE KEMPSEY SHIRE
LOCAL FLOOD PLAN

THE NATURE OF FLOODING IN THE KEMPSEY SHIRE

CATCHMENT FEATURES

Except for a small area in the south-east which is drained by the Maria River, the entire Kempsey Shire falls within the catchment area of the Macleay River (see Maps 3 and 4). The river rises well to the west of the shire in the Guyra, Dumaresq, Armidale, Uralla and Walcha areas of the Great Dividing Range, its tributaries extending for a distance of about 160 kilometres from the coast. The whole catchment covers 11,500 square kilometres.

The Macleay River valley consists of three distinct zones:

1. **The New England Tablelands section**, where the principal tributaries (the Chandler, Muddy and Apsley rivers) rise. This section is entirely outside Kempsey Shire.

2. **The Gorge section**, where the rivers leave the tablelands in a series of waterfalls and join to form the Macleay River in the well-defined gorge zone. Here the valleys are steep sided, stream gradients are steep and flood flow velocities are high. On this section there are several minor tributaries (the Parrabel, Hickeys, Georges and Nulla Nulla creeks and Dykes River) but no major ones. Below the Hickeys Creek confluence the topography becomes less severe as the river emerges from the gorges.

3. **The lower valley section** which begins at the upper limit of tidal influence about 16 kilometres upstream of Kempsey. Here there are extensive alluvial flats, occupying some 43,000 hectares, and well-defined natural levees along the river and its tributaries (the Belmore River and Christmas, Kinchela and Clybucca creeks). Some of the levees have been raised as part of the flood mitigation effort. The ground slopes away from the levees to low-lying swamplands (the Doughboy, Cooroobongatti and Belmore Swamps and Swan Pool) which act as storage areas for floods. These swampy areas are mostly less than a metre above sea level. The river reaches the sea via the main entrance and during floods may do so through Korogoro Creek, Rowes Cut, Ryans Cut, Killicks Creek and South West Rocks Creek. Other breakouts through the sand dunes may also occur.

FLOOD CHARACTERISTICS

Areas Affected

Flooding upstream of Kempsey is confined to areas close to the river and its tributaries though in the more severe events quite large areas can be inundated in the Temagog, Mooneba, Sherwood, Turners Flat, Dondingalong and Euroka areas.

Much larger areas downstream of Kempsey are liable to flooding. During flood episodes, backwater flows up the tributary creeks and drains begin to fill the swamps. In larger events, flows also occur over the river banks which in some areas have been augmented by levee building.

On some occasions, flooding in the lower valley can be exacerbated by very high tides or by storm surge conditions. Below Jerseyville the extent of flooding may be more closely correlated with sea conditions than with upstream flood magnitude. In 1963, flood levels were higher in this area than in 1949 when the flooding was much more severe at Kempsey.

The lower valley includes Connection Creek, which may take water from Belmore Swamp to the Maria River or vice versa.

Flood Travel Times

River flow times during floods vary considerably from event to event but the following are indicative patterns.

Georges Creek to Bellbrook: 6 hours on average. Peaks can be experienced at Bellbrook before Georges Creek or well after depending on local inflows from creeks and/or heavier rain towards the coast than in the gorge section.

Georges Creek to Kempsey: 15-23 hours. Shorter times usually occur in floods which are mainly produced by rainfall over the catchment downstream of Georges Creek.

Bellbrook to Kempsey: 9-15 hours, with the shorter times again normally applying in events resulting from rain over the lower catchment.

Kempsey to Frederickton: 30 minutes.

Frederickton to Smithtown: 30 minutes.

Warning Times

The CBM endeavours to provide the following warning lead times for the town of Kempsey:

1. 12 hours notice of a height of 5.0 metres.
2. 24 hours notice of peak heights greater than 5.2 metres.

These indicative targets may not be met in the case of floods produced by very heavy coastal rain. Basing predictions on forecast rainfall rather than on river levels should alleviate the situation somewhat in these circumstances although such predictions are generally less accurate.

The rate of river rise is an important influence on effective warning time. The rate of rise of the Macleay River at Kempsey in 1949 indicates what is possible in a severe event. In that flood, the river rose from the 'normal' non-flood level (about a metre at the Kempsey Traffic Bridge gauge) to its eventual peak of 7.92 metres in about 28 hours. The present 'minor flood' level of 4.0 metres was reached in 13 hours, water entering the town within a further two hours. The peak occurred an additional 13 hours later.

WEATHER SYSTEMS AND FLOODING

The heavy rain which produces floods in the Kempsey Shire may come from the following kinds of weather system:

1. **East Coast low pressure systems** which travel along the coast, usually in a southerly direction and during the cooler months, and direct moist on-shore winds over the Macleay River basin. Orographic uplift of these airmasses brings heavy rain over the lower valley and the Gorge zone. The August 1949, June 1950 and May 1963 floods, the most severe in living memory, were of this origin. In 1949 the heaviest rainfall was over the lower valley, whereas in 1950 and 1963 it was over the Gorge section but with substantial falls also occurring over the lower valley. The 1949 system was unusual in that it originated over land in southern Queensland, moving south-eastwards very slowly over the Macleay River catchment.

2. **Rain depressions originating as tropical cyclones** in the Gulf of Carpentaria or Coral Sea and moving southwards. The flood of January 1974 was of this type, the 'tail' of ex-tropical cyclone Wanda causing heavy falls over south-eastern Queensland and north-eastern NSW. Two months later, flooding occurred from a rain depression which had originated as Tropical Cyclone Zoe.

1. **Monsoonal low-pressure systems** moving across the Great Dividing Range from northern Australia, usually during the late summer and autumn months. These systems are indicated on weather maps as elongated low-pressure troughs stretching from the Northern Territory to the north coast of NSW. These may produce heavy rains over the

Gorge zone. Flooding from this mechanism is rare in the Macleay River valley, however.

4. **Sequences of fronts** crossing the valley from west to east, usually in the winter months. The individual fronts are not usually associated with very heavy falls but the cumulative effect of a series of them over a period of some weeks may produce flooding. The flood-producing mechanism is uncommon.

5. **High-intensity, short-duration, convective thunderstorms** occur frequently over the shire, especially during the summer months. The rain from such storms may cause town drainage systems or minor creeks to surcharge, creating local flooding of low-lying areas. No rise in the Macleay River is likely from such events.

Rains from the first three types of system noted above can persist for some days, especially in the case of east-coast low pressure systems which can cause heavy rain over periods of three to five days. Sometimes there may be two or more separate rain events a few days or weeks apart. In 1974, there were separate floods from these influences in January, March and April.

Very heavy rainfalls, in excess of 500mm in 96 hours at individual stations, are quite common in the Macleay River catchment. In 1949, an **average** of 300mm fell over the catchment over a four-day period, with 600mm being recorded at the Kookaburra Sawmill 50 kilometres west of Kempsey. In 1950, more than 650mm fell in 96 hours over the upper reaches of Georges Creek.

Most of the larger floods at Kempsey have resulted from events in which significant rain has fallen over the whole of the catchment. Lesser events may occur after rain falling over only parts of the catchment. The 1949, 1950 and 1963 floods all followed general catchment-wide rainfall.

North-eastern NSW experiences a distinct wet period between January and April, and about half of the recorded floods on the Macleay River have occurred between January and March. The **incidence** of flooding in the winter months is lower but winter floods have tended to be the most severe. The spring and early summer months are relatively dry and floods are infrequent during these times of year.

FLOOD HISTORY

Flood records are available from 1838, soon after the founding of Kempsey. Floods which are known to have exceeded 5.5 metres at the Kempsey Road Bridge gauge are shown on the table on the next page, along with the heights reached in these events, where known, at Georges Creek and Bellbrook. Some of the earlier values are approximations, but those since 1945 are believed to be accurate.

The table highlights the irregularity of serious flooding on the lower Macleay River. Several bad floods may occur in a short period of time, as was the case in the periods 1863-75 and 1890-93, and 1949 and 1950 saw Kempsey's worst two floods ever within eight months of each other. Equally, there may be long periods in which few if any serious floods are experienced (for example, between 1921 and 1949 and since 1967). The same irregularity applies for floods of lesser significance.

Since 1989, the **minor** flood level at Kempsey has been exceeded on only three occasions. These were in May 1996, February 1997 and July 1999. None of these floods reached the moderate flood level.

PEAK FLOOD HEIGHTS (IN METRES) AT GEORGES CREEK, BELLBROOK AND KEMPSEY, 1838-1999					
DATE	GEORGES CREEK	BELLBROOK	KEMPSEY (ROAD BRIDGE)	AEP (%) AT KEMPSEY (approx)	ARI (years)AT KEMPSEY (approx)
1838			6.7		
1841			6.7		
Aug 1848			5.8		
Feb 1863			6.1		
Feb 1864			7.4		
July 1864			6.3		
Aug 1864			7.3		
July 1866			6.3		
April 1867			6.7		
March 1870			6.3		
March 1875			7.6	2.5%	40
June 1879			6.1		
March 1890			6.1		
April 1892		8.8	6.1		
March 1893			6.7		
June 1893		17.1	7.5	3%	30
July 1921		16.16	7.32		
Feb 1928			5.56		
Feb 1929		12.20	6.25		
March 1946		12.73	5.99		
Aug 1949	14.10	17.22	7.92	1%	90
June 1950		18.06	7.77	2%	60
Aug 1952		13.03	6.02		
Feb 1954		11.23	5.79	20%	5
Nov 1959		9.75	5.59		
April 1962		8.15	5.54		
May 1963	13.50	15.54	7.14	7%	15
June 1967		10.24	6.02	16%	6
Jan 1968		8.84	5.77	20%	5
Jan 1974	8.63	7.70	5.56	25%	4
March 1974	6.78	7.11	5.69	22%	4.5
Feb 1976	8.64	7.56	5.54	25%	4
May 1977	7.60	6.75	5.56	25%	4
May 1980	7.00	7.14	5.73	20%	5
April 1989	6.72	6.34	5.57	25%	4

The lack of serious flooding in recent times, with no floods reaching even the 6.0 metre level since 1967, should not be taken as implying that the flood

threat has diminished. Periods of frequent, high-level flooding are likely to occur in the future.

The last two columns in the table refer to the frequency of floods of differing severity. The AEP (Annual Exceedence Probability) value is the percentage chance that a flood of this height will be reached in a particular year. For example, a 2% AEP flood has a 2% chance of occurring in any given year.

The percentage value corresponds with the ARI (Average Recurrence Interval), which is the average length of time which is estimated to elapse between floods of a given magnitude. A 2% AEP flood, for example, is expected to be experienced **on average** once in a 50-year period. In a **particular** 50-year period it could occur on several occasions or not at all. An illustration of this unevenness of occurrence is that Kempsey's two worst floods, both of them higher than the 2% AEP event, happened within nine months of each other. The estimated design flood levels for the 1%, 2% and 5% AEP floods at the Kempsey Traffic Bridge gauge are:

1%: 8.2 metres.
2%: 7.7 metres.
5%: 7.5 metres.

FLOOD MITIGATION WORKS

Rural Areas

Extensive rural flood mitigation works have been completed since the 1950s on the floodplain of the lower Macleay River. These comprise levees, barrages, drains, floodgates, floodways, training walls, ocean cuts and river bank stabilisation works. They are designed to reduce the frequency and areal extent of flooding and to facilitate drainage after inundation. These works are not intended to remove all flooding and in severe events their impacts will be relatively small.

Modifications to the rural flood mitigation scheme and its operation are currently under consideration by Kempsey Shire Council. It is possible that levees could be raised and floodgate operation altered so that the Belmore and Kinchela floodways take water less frequently. This would mean that slightly larger floods can be contained within the main river channel than previously.

The current operation of the Macleay River Flood Mitigation Scheme is described in Annex D.

Kempsey

The town has levee protection in the form of the Eden St and First Lane (Cochrane St) levees (see Map 5). The First Lane levee is designed to be

overtopped in a flood reaching 6.15 metres (a 15% AEP event) at the Kempsey Traffic Bridge gauge. The Eden St levee is overtopped at 6.55 metres, equivalent to the 10% AEP event (ie the once-in-ten-years flood). Some 12 flood events in Kempsey's history, the last of them in May 1963, have surpassed this height. When the Eden St levee is overtopped, the basin to its immediate north could fill within 90 minutes to a depth of 3-4 metres. Filling by backwater flow over the First Lane levee would be much slower.

Smithtown has levee protection to about the level of the 20% AEP (once-in-five years) flood on the Macleay River.

Hat Head has levee protection to about the level of the 1% AEP (once-in-100 years) flood.

EXTREME FLOODING

Worse floods than have been seen in the Kempsey Shire must be regarded as inevitable. They will occur when particularly severe weather conditions of the sorts described above are experienced. An estimate of the Probable Maximum Flood (PMF) at Kempsey is that it would reach a height of 11.2 metres at the Kempsey Traffic Bridge gauge. This flood, the worst possible on the Macleay River, would peak more than 3 metres higher than the level reached in 1949. Floods considerably smaller than this but bigger than the event of 1949 are more likely to occur and would have devastating consequences for the whole of the lower valley.

In an extreme flood on the Gara River, a tributary of the Muddy River in the New England Tablelands, it is possible that Malpas Dam could fail. This earth and rockfill dam north-east of Armidale impounds a small storage lake with a capacity of 13,000 megalitres. The dam has been assessed as being likely to fail in a flood with a volume equivalent to as little as 58% of the PMF at the dam site. Such a flood is thought likely to occur about once in 2000 years on the Gara River and could be caused by 600mm of rain falling in about six hours over the dam's catchment.

While the effects of a failure of Malpas Dam would be very severe within Dumaresq Shire, the flood level would attenuate very quickly downstream. It is thought that the incremental impact of dam-failure flooding in the Kempsey Shire – that is, the impact above whatever flooding was already occurring there – would be negligible.