

DEVELOPMENT AND OPERATION OF THE MACLEAY RIVER FLOOD MITIGATION SYSTEM

In August, 1949 and again in June, 1950, floods approaching a 1 in 100 year recurrence interval occurred in the Macleay River, causing significant damage and loss of life in the Kempsey area. In May, 1963 a 1 in 15 year flood occurred.

Following those major floods there was significant pressure to provide some flood protection for the major towns in the flood plain and the Lower Macleay rural area.

A flood mitigation scheme was commenced in the 1950's and completed in the 1970's with the aim of:

- protecting the Kempsey township in a 1 in 10 year flood,
- protecting the lower Macleay agricultural areas from a 1 in 2.5 year flood,
- allowing rapid drainage of flood waters from inundated farmland
- providing erosion protection to stream and drain banks
- improving flood mapping, proofing and data
- providing a flood warning system for residents and landholders

Further improvements are currently being undertaken.

HISTORY OF THE SCHEME

1949 & 1950 - Disastrous floods in the Macleay, local government bodies ask for Committee of Inquiry.

1951 - Macleay Valley Flood Mitigation Committee set up by the NSW government.

1954 - Report of this Committee (the Jacka Report) produced. Macleay River County Council established and delegated powers to implement recommendations of the Jacka Report.

1955 - County Engineer, Mr George Walker appointed and construction work to commence.

1962 – Works to the value of \$8 Million (1976\$?) completed downriver. Funded 2:1 by State government and County Council.

1963 – Major flood to 7.1m at Kempsey (1 in 15 year event)

1963 – Funding received for further \$3.7M downstream and \$0.8M upriver. Funded 2:2:1 by Federal, State governments and County.

1969 – Further \$2.5M funding on 2:2:1 basis for further works.

1975 – Amalgamation of Kempsey Municipality, Macleay County Council and Macleay Shire to form new Kempsey Shire Council. Responsible for administration of flood mitigation.

1980 – Macleay Valley Flood Plain Management Study (a broad overview of total catchment topography, hydrology and major floods) completed.

1985 – Study of options for flood protection of Kempsey completed.

1989 – Macleay River Flood Study (hydrologic and hydraulic effects from Aldavilla downstream) completed.

1993 – Review of Kinchela Creek and Belmore River floodway capacities completed.

1994 – Study of proposed Kinchela Creek Flood Channel to Korogora Creek

1998 – Lower Macleay Flood Study completed.

1999 – Lower Macleay Flood Plan completed and adopted by Kempsey Shire Council.

BASIC AIMS OF MACLEAY FLOOD MITIGATION WORKS

1. To reduce flooding frequency by;
 - a) increasing stream carrying capacity
 - b) floodgating of tributary creeks, rivers and major drains
 - c) stabilisation of river banks to retain natural levees and induce stream scouring
 - d) constructing levee banks where natural bank is below required profile
2. To guide overbank flow and thus control floodwaters by;
 - a) construction of floodways and a control system
 - b) use of natural flood storage areas
 - c) providing new accesses to the sea
3. To lower the period of flood inundation by;
 - a) improving drains
 - b) providing new ocean cuts
4. To minimise the effects of a flood by;
 - a) raising and improving road accesses
 - b) providing an adequate flood warning system and emergency services
 - c) providing flood mapping, data and advice on flood proofing
 - d) controlling flood plain development

BASIC STRUCTURES USED IN LOWER MACLEAY

- Levees constructed of soil, rock or clay (eg First Lane, Left bank of river)
- Headworks which are concrete/ steel gated structures across major streams (eg Belmore River, Kinchela Creek, Gladstone drain) to prevent flood flow. Some are normally open (Belmore and Kinchela), while others operate as gravity gates under head.
- Drains excavated through banks to varying depths and widths
- Floodways which are natural or artificial channels designed to pass flood flow. Water may enter through control structures (Belmore, Kinchela), or by overtopping a levee at a designed level. Control structures are normally open.
- Ocean cuts which are artificial channels to the sea containing headworks to prevent salt water back flow (Killick Creek, Ryans Cut)
- Bank stabilisation consisting of stone armouring in some areas or soil, vegetation and grass cover to prevent erosion by floods.

STRUCTURES AND METHODS USED ABOVE THE TIDAL LIMIT

These works are designed to protect valuable alluvial land along creeks or the River from erosion by the stream meandering during a flood. Erosion of alluvium also impacts upon downstream areas as the sediment builds and obstructs flows. Methods used includes:-

- Stream clearing to reduce localised velocities and to increase waterway areas,
- Stream realignment to prevent high bank flows and to divert water away from alluvial banks
- Tree and concrete block barriers to direct water away from vulnerable areas, to collect silt and reclaim shingle beds
- Bank protection by designed batters, vegetation and grassing to prevent erosion

APPROXIMATE CONSTRUCTION TIMETABLE FOR STRUCTURAL WORKS IN LOWER MACLEAY

Pre 1930 - Eden Street levee raised to 4.1m, Seven Oaks bend overtopped at 3.6m, Highway blocked by a 4.3m flood. A 2.5m flood entered Belmore and Kinchela lands and open drains and commenced to enter Pola Creek, Glenrock, Tennessee, Austral Eden, Frogmore, Darkwater and Swanpool areas. Overbank flow in all these areas before 4.3m reached at Kempsey.

1955 Eden Street, Kempsey levee raised to 6.1m AHD (to suit 5.2m flood)

Pre 1958 – Killick Creek headworks, training wall and dune stabilisation.

Pre 1960 – Austral Eden, Seven Oaks, Belmore headworks, drainage, bank protection and levees

Pre 1960 – Kempsey to Frederickton bank protection and levees

Pre 1960 – Kinchela to Longreach bank protection

1960 – 62 Belmore Kinchela area, several drains and gates

1961 Belmore/ Kinchela headworks, drains, drainage improvements

1963 and 1967 Christmas Creek headworks and drains
 1964 Belmore to Killick Creek waterway
 1965 and 1967 Pola Creek headworks and drain
 1966 – 1970 Clybucca – Seven Oaks Headworks and drainage
 1966 – Kempsey, Frederickton bank protection
 1967 - Frogmore – Darkwater drains extensions
 1968 – Korogora Creek headworks, drain and levees
 1968 - Glenrock/ Tennessee – Willows drain
 1968 – Kinchela Creek fabridam floodways and barrage
 1967- 69 Gladstone, Glenrock, Saltwater headworks drains
 1969 - Yarrahappini headworks and drains
 1969 - Euroka Creek headworks and drainage
 1969 - Eden Street, Kempsey levee raised to 7.0m AHD (to suit 6.1m flood)
 1969 - Maria River headworks and drainage systems
 1971 – Gladstone bank protection
 1973 – Ryans cut ocean outlet, headworks and drain
 1974 - Scotts Drain headworks and drainage improvements
 1975 – Big Hill ocean outlet, headworks and drain
 1976 – Belmore River flood control and barrage
 1976 – Cochrane Street levee raised to 6.1m AHD
 1976 – Eden Street levee raised to 7.5m AHD
 1976 – Concrete levee constructed in vicinity of Traffic Bridge to 7.3m AHD
 1976 - 1978 – Kempsey and Macleay River levees raised for 5.2m flood
 1980 – Flood restoration and minor improvements
 1980 – Kinchela Floodway, replacement of fabridam with steel gates
 1990 – River Street, concrete levee constructed to 11m AHD near Cooks Lane
 1997 - Cochrane Street and Eden Street levees checked and adjusted,
 (Eden St = 7.52m AHD, Cochrane St = 6.15m AHD)
 1999 – Hat Head Control and Village levees reinforced
 1999 – Kinchela Creek and Belmore River Right Bank levees commenced raising

THE FLOOD WARNING SYSTEM

Kempsey Shire Council with the Bureau of Meteorology and the Department of Land and Water Conservation have developed a comprehensive system of automatic rainfall and river height gauging, which allows advance warning of approaching floods. The system was developed from 1963 until 1990 and was the first effective telemetred flood warning system in Australia.

In the upper catchment, there are “tipping bucket” rainfall gauges at Tia, Walcha, Wollomombi, Blue Nobby and Guyra, with an automated stream gauge at Wollomombi on the Chandler River. In the mid-catchment rainfall and stream gauges are at Georges Creek (junction with the Macleay), Bellbrook, Turners Flat, Wittitrin (Dungay Creek) and Moparrabah (Parrabel Creek). There is also a rainfall gauge at Millbank, with a further stream gauge at Kogal (Nulla Creek). In

the lower Macleay there are stream and rain gauges at Aldavilla, Kempsey, Seven Oaks, Belmore River, Kinchela, Jerseyville and several other locations.

Any change in water level of 1cm or rainfall of 1mm measured at any of these stations is sent as a radio signal to one of several radio repeater stations, then on to a central computer base at the Elbow Street Civic Centre. This data is also read by the local SES and the Bureau of Meteorology. When a significant rainfall event or river rise is noted, the Bureau are able to analyse the data and using computer programs estimate resulting river rises further downstream. Council is able to monitor the rise in river levels in all areas from Georges Creek to Jerseyville and create accurate graphs of the profile.

Normally the Bureau are aware of any approaching weather systems and issue to the SES and Council advance alert warnings for floods. Council then takes action to prepare for the possible flood by closing downriver gates and checking all equipment. As the flood approaches the Bureau issues formal flood warnings by fax to Council, the SES and also to all local radio stations for broadcast. Residents are able to contact the local SES for this information.

Flood warnings will predict the height of the Macleay River at Bellbrook, and Kempsey, list levels at Georges Creek and give a flood classification of either "minor, moderate or major". The following flood classifications will be used:-

- Minor flood – 4m on Kempsey Traffic Bridge (KTB) gauge, some inundation of low areas likely and stock may require relocation, flood controls at Belmore & Kinchela may need to be opened, all upriver bridges and some local roads closed
- Moderate flood – 5.2m on KTB gauge, river levees will be overtopped and significant areas will be flooded, stock and some residents may require evacuation, Pacific Highway and major roads closed
- Major flood – 6.1m on the KTB gauge will cause overtopping of Kempsey levees and inundation to depth downstream, major evacuation of up to 4000 residents plus movement of most stock to flood refuges

A formal warning should be issued to Council by the Met Bureau as follows:-

- 7 to 10 hours notice of a level in excess of 6m at Georges Creek
- 24 hours notice of a predicted height above 5m at Kempsey
- 12 hours notice of a river level of 5m at Kempsey

OPERATION OF THE FLOOD MITIGATION SYSTEM

The scheme, for which Kempsey Shire is now responsible, consists of 181 floodgated structures with 352 floodgates (including three major control structures), 147 km of drains and 34 km of levees and 37 km of bank protection. The levees have had the effect of reducing nuisance flooding over most of the lower Macleay. Land previously affected by a 2.5m flood is now unaffected up to

5.2m on the KTB gauge. To achieve this protection, during a minor flood (between 4.0m and 5.2m on the KTB gauge), it is necessary to discharge some flood water through control gates into natural swamps and wetlands.

When Council or the SES become aware of a possible river level of 4m at Georges Creek or a flood alert is issued by the Bureau, preparations commence for flood control. This is the level at which the upriver bridges (except Sherwood) will be covered by fast flowing water and will lead to a level of about 0.85m at Kempsey. Council will monitor the bridges, provide signs and barricades if appropriate and clear them immediately after the flood recedes.

At this time Council staff will check all flood controls, headworks and gates and make ready. The major control structures and headworks at Belmore River and at Kinchela Creek will be closed to contain flood flow in the main river and tributaries. The main ocean outlets at Ryans Cut and Big Hill will also be checked for sand build-up which may need to be removed later. Flood flaps on drainage pipes at Gladstone, Smithtown and other areas will be checked to ensure they will seal.

Observation of the levels at bridges and the main river gauges, Bellbrook, Turners Flat and Aldavilla via the computer will indicate the movement of the rise down the river. The SES will become active at a level of about 4m at Georges Creek or earlier in storms.

The intense rainfall will cause rapid rises in the Macleay River at Georges Creek. In 1949 the river flood level was about 16m (52 feet) above the normal level at Georges Creek and Bellbrook.

Table of approximate gauge levels and flow times (from Georges Ck)

Georges Creek	Bellbrook	Turners Flat	Kempsey Traffic Bridge	Comments
4m	3m (+8hrs)	2.65m (+16hrs)	0.85m (+24hrs)	Upriver bridges closed
8m	7m (+9hrs)	5.5m (+17hrs)	4.1m (+25hrs)	Minimum level for control gates opening
9m	7.3m (+9hrs)	6m (+16hrs)	5.2m (+24hrs)	General overbank flooding
13.8m	15.5m +5hrs)	13.7m (+11hrs)	7.5m (+16hrs)	1 in 20 year flood (1963)
17m	17.5m (+4hrs)	18m (+10hrs)	8.2m (+14hrs)	1 in 100 year flood (1949)
20m	21m	20m	12m (12hrs ?)	Probable Extreme Flood

NOTE: Levels and times may vary according to flood and seasonal conditions. These are gauge levels. To obtain mAHD at Kempsey, add 0.525m to gauge level.

Local Warnings

When a level above 8m at Georges Creek is predicted, a “minor flood warning” should be issued by the Bureau of Meteorology to Council, the SES and radio stations. Downriver farmers and property owners should be aware and warned that it is likely Council may have to operate the flood control structures about 24 hours later. Advance warning notices will be issued to local radio stations for

broadcast and several downriver farmers contacted to spread the word. This gives them time to evacuate stock to higher ground. (About 24 hours notice is needed). Council staff and the SES will also prepare to place out “Cattle on road signs” in advance of movement. Council has a person nominated as a “Flood Controller” who will oversee operation of the system.

Flood Control Structure Opening

Observation of the approaching flood continues until a level of 4m is reached at the Kempsey Traffic Bridge gauge. Previously all the control gates were gradually opened from 4.1m on to about 4.6m at the KTB gauge. However, with the raising of the Kinchela Creek levees, this will change. Until all the levees are raised it will be necessary to physically observe the situation and identify any low spots or problems. With the elimination of the lowest area on Kinchela right bank, it should be possible to delay opening the control gates until about 4.6m or later. Ultimately when all modifications are complete, the Belmore gates will be opened at 4.6m at KTB and the Kinchela gates at 4.9m at KTB. Local conditions will indicate opening times.

When the approximate time for the gate opening is known, a final notice of the intention to open the control gates will be issued over the radio about two hours in advance. This gives farmers a final chance to clear cattle and equipment from the floodways. Actual timing will depend upon tides, darkness, level, etc.

The control gates will be gradually opened in several stages until full outflow is reached or the peak in the flood has passed. It is preferred to have one operator at the Belmore gate and one at Kinchela, with the Flood Controller inspecting and liaising between the two by two-way radio. An additional person in the office will monitor the computers and relay any messages.

Opening the gates should not be delayed too long as operators may be stranded by floodwaters. Also late opening may cause water and debris to flow over the steel gates causing damage and possibly rendering the mechanism inoperable.

Once the gates are opened Council will continually observe the situation for problems and for future reference. Checks will be made on the ocean outlets at Ryans Cut and Big Hill to assess need for machinery to open the channel and any required work arranged.

All flood level information will be given out by the SES, who will operate their headquarters. Council is not required to provide information on levels, but will advise of actions on the control structures and liaise closely with the SES on the data and any problems encountered.

As the flood recedes, Council will assess when the control structures can be closed, which is as early as possible after the peak has passed. The control gates will be gradually closed to prevent damage and erosion. After the flood,

Council will repair any major road damage, bank slips, washaways, bridges, etc and place barricades if required.

The headworks gates at Belmore and Kinchela are normally kept closed for 7 days after these streams return to a tidal pattern (taken to be when a level of 0m is reached at the Belmore River entrance) to assist drainage of the flood waters back into the streams from the swamps and side drains.

Conclusion

The Flood Mitigation System is being constantly improved, monitored and updated to reduce environmental effects and impacts upon landowners. The estimated value of all the flood mitigation assets is \$62 Million. Council's annual budget for construction and maintenance of these assets is of the order of \$1 Million. Financial assistance for construction and maintenance is provided by the New South Wales and Federal Governments.

All residents should become aware of the flood level at Kempsey which is likely to affect their property and listen for warnings during floods. If they live in low-lying areas, they should prepare for a flood in accordance with the SES Flood Guide for their area. Any landowners with stock should be prepared to move them to higher ground if a "Minor Flood" of 4.0m on the Kempsey Traffic Bridge gauge is predicted. During a flood, level information is available from the Kempsey Shire SES (phone 6562 2228).

Residents should be aware that the Macleay Flood Mitigation System can only provide protection in the Lower Macleay up to the "Moderate Flood" level of 5.2m at KTB gauge when general overbank flooding will occur.

In Kempsey, protection will be provided up to the 6.1m on KTB gauge, 1 in 5 year level (Major Flood) when the Eden Street levee will be overtopped.. When that occurs rapid Water would quickly enter the town and filling of the Kempsey basin will occur.

Residents should also be aware that floods larger than the 1949 flood or the 1 in 100 year event can occur at any time.

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