KEMPSEY SHIRE COUNCIL

KINCHELA CREEK FLOOD CHANNEL
STAGE 2

OCTOBER, 1994
# KINCHELA CREEK FLOOD CHANNEL
## STAGE 2

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1. INTRODUCTION

Kempsey Shire Council commissioned Webb, McKeown & Associates to investigate a proposal to construct a Flood Channel between the Eastern Floodway on Kinchela Creek and the headwaters of Korogoro Creek. The purpose of the proposal is to divert floodwaters for floods less than a bankfull flood on the Macleay River direct to the ocean rather than allowing the floodwaters to pond temporarily in the Swan Pool Swamp. With the present scheme, the floodways on Kinchela Creek and the Belmore River are opened for such floods to ease pressure on the Macleay River and thus prevent early overtopping of levees elsewhere in the Valley. The overall scheme provides improved flood protection to the Belmore-Kinchela area, but not to the same level as elsewhere.

The investigation is being carried out in stages. Stage 1 considered the general hydraulic feasibility of the proposal. The Stage 1 Report, issued in July 1994, concluded that the proposal was hydraulically feasible, but substantial engineering works would be required.

This second stage of the investigation is concerned mainly with an economic appraisal of the proposal, involving an estimate of potential damages which could be prevented by the works and an order of cost of the works themselves. The assessment has been made on the basis of readily available information; detailed information provided by the Belmore-Kinchela Landholders Association; discussions with Department of Agriculture representatives with experience in the local area; discussion with an agricultural consultant, and Webb McKeown's own evaluation of the competing views.

A database of affected properties was provided by the Landholders' Association and this assisted greatly in the quantification of potential damages.

The report also includes a brief general discussion of issues which might be of concern if additional flow is allowed to pass down Korogoro Creek (the construction of the Flood Channel would necessarily lead to more frequent moderate to high flows in the creek, but
would not increase the peak flows for major floods). Separate studies are currently being carried out to investigate the flood flow in Korogoro Creek and the stability of the Hat Head Village levee.

Finally, the report examines two alternative proposals, one of which could replace the Kinchela Flood Channel. The first involves altering the operation of the Kinchela and Belmore Floodways so that the gates are opened at higher levels on the Kempsey Traffic Bridge (KTB). This would require earthworks to raise parts of the levee system along Kinchela Creek (and possibly minor earthworks on the Macleay and Belmore River levees).

The second proposal involves a second Flood Channel linking the head of the Belmore River to the ocean. This would involve closing of the present Belmore River Floodway in a similar manner to the Kinchela Flood Channel proposal.

The costs and benefits of the alternative proposals are canvassed and then compared with the original Flood Channel proposal for Kinchela Creek.
2. FLOOD DAMAGES

2.1 Preamble

The properties which may benefit from the construction of the Flood Channel are primarily used for raising beef cattle. Some dairy farming is also carried out.

The benefits accruing from flood mitigation works are the damages saved. Flood damages fall into three broad categories:

**Tangible Direct Damages:** these are directly attributable to the flooding and can be expressed in dollar terms. They would include for example, damage to property; costs of hand feeding cattle or agistment; loss of income because milk cannot be delivered.

**Tangible Indirect Damages:** can be expressed in dollar terms but are not directly caused by floodwaters. Examples would be: loss of dairy factory production; decrease in retail trade because of reduced buying capacity.

**Intangible Damages:** are matters which cannot be easily expressed in dollar terms but which are nevertheless recognised consequences of flooding. Such matters are: decline in health; increase in stress.

There is little published information on flood damages in the beef and dairy industries. Some work was carried out in the lower Macleay when the present flood mitigation works were investigated, however this is now nearly 30 years old and the industries have changed so much that the results are no longer applicable.

The Belmore-Kinchela Landholders Association (BKLA) took a survey among its members following a small flood in April 1990. The BKLA assured its members of confidentiality at the time the survey was taken and full details of individual properties surveyed could not
be made available to the present study. However, a substantial amount of information was provided and this has been of considerable value in compiling the following assessment. In addition to this flood damage information, the BKLA also provided detailed property related information on 108 properties in the vicinity of Kinchela Creek and the Belmore River.

Determination of the lateral extent of any benefits from the proposed Flood Channel requires professional judgement. Three distinct areas are involved:

* the eastern side of Kinchela Creek, which would clearly gain the most benefit. It is estimated that 32 properties are involved, but these do not tend to be the higher quality land,

* the area between Kinchela Creek and the Belmore River (referred to in this report as West Kinchela), which would benefit from the closing of the Western Floodway. From a total of 76 properties defined in this area by the BKLA, it is estimated that 51 properties would directly benefit from the proposed works,

* the western side of the Belmore River, which the BKLA claims may gain some benefit because it could be possible to delay the opening of the Belmore Floodway if the Kinchela-Korogoro Flood Channel were in place. The Landholders' Association has suggested that up to 70 properties would benefit in this area. These properties tend to be of higher quality than those east of Kinchela Creek, but any benefit would be nominal.

Based on the above assessment of relative benefits, it was determined that 83 properties should be included in the flood damages estimation that follows: 32 in East Kinchela and 51 in West Kinchela. The 70 properties on the western side of the Belmore River were not included.

The assessment only includes direct damages to affected dairy or beef properties. No attempt has been made to estimate indirect or intangible damages, or damages to other
industries such as fishing or tourism, as these should be relatively minor in the context of the proposed works and the size of the floods affected by the works.

The size of flood considered for the assessment is one which would be large enough to open the floodways but not large enough to overtop the Macleay River levees, i.e. similar to the flood of April 1990. Such a flood would render the lower areas unusable for up to 8 weeks in the case of improved pastures.

The flood damages were estimated using two independent approaches. The first established damages in terms of estimated unit costs per farm for basic damages plus costs related to the number of head of cattle. These were combined with information on the number of properties and cattle affected by a flood (using the BKLA database) to establish a total cost per farm. This is the normal method used in deriving flood damages.

The second approach took the available results of the BKLA 1990 damages survey to obtain a damage figure per flooded hectare. This was then multiplied by the flooded area to obtain the total flood damages.

2.2 Unit Cost Assessment

The Landholders' Association provided information on individual properties within the study area including estimates of herd sizes, the proportion of beef versus dairy properties and the percentage of land area flooded in a typical flood.

Each property considered to directly benefit from the proposed works was included in the damages estimate. It was assumed that significant direct damages, in terms of agistment or additional hand feeding costs, would not be experienced by properties with less than 60% of their land area flooded, as these properties would have a minimum of 40% of unaffected pasture available to temporarily support the herd. The damage estimates were based on the typical rates and values presented below.
2.2.1 Damages for a Typical Beef Property

The following scenario has been assumed for each beef property based on discussions with agricultural experts.

After a flood, approximately 40% of the herd would need to be transported to agistment for a period of 8 weeks. The remainder of the herd (60%) would be fed supplementary fodder for 2 weeks, improved pastures would have to be re-planted.

<table>
<thead>
<tr>
<th>Rate/Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>damage to fences, etc.; extra fuel costs</td>
</tr>
<tr>
<td>transport to and from agistment (say 50km)</td>
</tr>
<tr>
<td>agist for 8 weeks</td>
</tr>
<tr>
<td>supplementary feed for 2 weeks</td>
</tr>
<tr>
<td>replant pasture</td>
</tr>
</tbody>
</table>

2.2.2 Damages for a Typical Dairy Farm

The following scenario has been assumed for each dairy property based on discussions with agricultural experts.

After the flood it would be necessary to hand feed, say, half of the herd for 2 weeks and the other half for 8 weeks. This makes some allowance for gradually bringing land back into production with the best land available earliest and able to support half the herd after 2 weeks. One week's milk production (and income) would be lost due to lack of transport and/or access. No allowance has been made for reduced milking due to cows being stressed by changed fodder, etc.

<table>
<thead>
<tr>
<th>Rate/Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>damage to fences, etc.; extra fuel costs</td>
</tr>
<tr>
<td>hand feeding 2.8 bales/hd/w @ $4/bale</td>
</tr>
</tbody>
</table>
for 2 weeks $22.40/hd
for 8 weeks $89.60/hd
• loss of income - one week $20.00/hd/w
• replant pasture $500

2.2.3 Total Direct Damages

The above assumptions, together with information on stock numbers and area flooded provided by the BKLA, were fed into a computer program to enable computation of overall flood damages. Stock numbers used were for adult animals only. The numbers were multiplied by 1.2 to allow for costs associated with calves, weaners, etc. The program produced the following results for the properties which would directly benefit from the works.

• average damage/farm $ 2 610
• average adult stock/farm 80
• total damage for each flood (83 properties) $217,000

2.3 Belmore-Kinchela Landholders Association Damages Estimates

The Association’s survey following the April 1990 flood determined the following results for seven properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Area (ha)</th>
<th>Damage ($)</th>
<th>Damage/ha ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>225</td>
<td>35000</td>
<td>155</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>10000</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>10000</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>22000</td>
<td>245</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>15000</td>
<td>215</td>
</tr>
<tr>
<td>6</td>
<td>65</td>
<td>15000</td>
<td>230</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>28000</td>
<td>560</td>
</tr>
</tbody>
</table>
The damage/ha of the last property on the list is more than double the next highest and seems to indicate that special circumstances prevailed. For the remaining six properties, the average damage/ha is $143. The affected area covers a total of 4100ha. Based on these figures, the total flood damages for a typical flood would be $586,000. This is 2.7 times that estimated in Section 2.2.3.

2.4 Frequency of Flooding

The floods which could be avoided if the Flood Channel were constructed are those which require the floodways to be opened but do not overtop the levees along the Macleay River and Kinchela Creek.

The floodways are opened when the river level at Kempsey reaches 13'6" on the Kempsey gauge, while the levees overtop along the Macleay River at 17' on the gauge. The flood frequency curve for Kempsey indicates that the Average Recurrence Intervals (ARI's) of these floods are:

\[
\begin{array}{ll}
13'6" & 1.5 \text{ years} \\
17' & 2.5 \text{ years}
\end{array}
\]

If the economic life of the Flood Channel works is taken as 25 years, this implies that on average, within that period 17 floods would exceed 13'6" and 10 of those would exceed 17'. Thus statistically, there would be seven floods in the critical range.

It should be noted that it would only take a small adjustment to the estimated frequencies to change this figure significantly. For example, if 13'6" where a 1.25 year event, the number of critical floods would increase to 10.

An analysis of available records for Kempsey shows that, since the works were constructed in 1963, there have been 11 floods between the critical gauge heights over the ensuing 31
years. This is equivalent to nine over a twenty-five year period and this number was adopted for the following analysis.

2.5 Net Present Worth of Damages

Based on the costs derived in Section 2.2, and considering there are nine avoidable floods in 25 years, the Average Annual Flood Damages (AAFD) is therefore:

\[ \frac{9}{25} \times 217,000 = \$78,000 \]

The Net Present Worth (NPW) over 25 years is also dependent on the interest or discount rate assumed. This essentially represents the difference between investment interest rates and inflation. The NSW State Treasury has set a standard discount rate of 7%. At this rate, and for a period of 25 years, the factor for calculating NPW is 11.654. The NPW of the AAFD can then be calculated as 11.654 \times 78,000 = \$909,000. The BKLA damage estimate (Section 2.3) would place the NPW of damages at about 2.7 times greater than this figure.

2.6 Interpretation of the Results

The calculated damage estimates are significantly lower than the figures for the flood of April 1990 provided by the BKLA. A narrower range of items has been included in the former after assessment and discussion with agricultural experts. Further items could arguably be included. On the other hand, assumptions have had to be made on a range of other matters which potentially could affect the results even more.

No attempt was made at this stage to refine the range of the damages estimates given the uncertainties in all the other factors contributing to the final results.
3. **CONSTRUCTION COSTS**

Kempsey Shire Council estimated the cost of the proposed flood channel works as:

<table>
<thead>
<tr>
<th>PROPOSED FLOOD CHANNEL</th>
<th>KINCHELA CREEK TO KOROGORO CREEK</th>
<th>ESTIMATE OF COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Earthworks: 100800m³ loose for banks of Channel (all material hauled to site due to presence of Acid Sulphate Soils on site).</td>
<td>Win from Frederickton @ $3/m³ (including royalty) Load and Haul 20km @ $10/m³ Place and shape to banks @ $1.20/m³ Clear and shape base of drain</td>
<td>$1 431 360</td>
</tr>
<tr>
<td>2. Pipe Culverts:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>900ø RC Pipe Supply and Lay:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 units each 10m long @ $200/m</td>
<td>$160 000</td>
<td>$212 000</td>
</tr>
<tr>
<td>Headwalls 80 @ $400</td>
<td>$32 000</td>
<td></td>
</tr>
<tr>
<td>Flood Flaps 80 @ $250</td>
<td>$20 000</td>
<td></td>
</tr>
<tr>
<td>3. Provide a broad crested weir overflow structure at Kinchela Creek east bank.</td>
<td></td>
<td>$300 000</td>
</tr>
<tr>
<td>4. Channel Protection in Korogoro Creek.</td>
<td></td>
<td>$150 000</td>
</tr>
<tr>
<td>5. Adjust fences, poles, services, miscellaneous contingencies.</td>
<td></td>
<td>$130 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>$1 923 360</strong></td>
</tr>
</tbody>
</table>
4. **ECONOMIC ASSESSMENT**

The Net Present Worth of Benefits, based solely on direct damages, has been estimated in Section 2.5 as $909,000. The Present Value Cost of the works has been estimated in Section 3 as approximately $1.9 million. This gives a Benefit/Cost Ratio of 0.5.

Considering that this is based on an estimate of direct benefits to both beef and dairy properties directly affected by the Kinchela Floodways, and takes no account of indirect or intangible factors, the results indicate that from a purely economic point of view the proposal is worthy of further investigation.

It should also be noted that adopting the figures from the BKLA 1990 damages survey would increase the ratio to around 1.4.
5. IMPACTS ON KOROGORO CREEK

The proposed Flood Channel would increase peak flows reaching the headwaters of Korogoro Creek from the Swan Pool area. The Stage 1 report indicates that peak flows at the Hat Head Road Bridge for the 80% 1980 flood would increase from 15m$^3$/s to 60m$^3$/s with the Flood Channel built and the Western Floodway blocked. The Flood Channel would deliver flow direct to Korogoro Creek and bypass the attenuation effect of the swamp. This would increase the flow rate for minor floods and also increase the frequency of freshes in the creek.

The impacts of these increased flows in Korogoro Creek have not yet been quantified. Council has commissioned a separate study to examine the hydraulics of the creek to assist in the review of the performance of the Hat Head Village levee. When completed, that study could be used to provide more quantitative information on flood velocities, etc., for the types of flows that would result from the construction of the Flood Channel.

The banks of Korogoro Creek show signs of erosion in the tidal zone but seem relatively stable above that level, where flood flows would impact on the banks. An allowance has been made in Council’s Cost Estimate for some limited bank protection works in areas where velocities might be increased sufficiently to cause scouring.

The Hat Head Village levee has been identified by Public Works as being below design standard. Public Works estimates that the levee would fail some 0.2m below the present design levels. This would not be an issue with the flows generated by the Flood Channel for smaller floods. For large floods, where general overtopping occurs along the Macleay River, the banks forming the sides of the Flood Channel would be submerged. They would therefore allow flows to enter Korogoro Creek in a similar manner to existing conditions.
Korogoro Creek enters the Pacific Ocean to the west of the Hat Head headland which provides protection from most ocean conditions. The entrance is normally open. The additional flow down the creek might cause some extra scour of sand on the beach, but this should not be significant and would soon be restored by natural processes. Given that the Flood Channel would on average operate once in 2.5 to 5 years, operation of the channel is unlikely to affect the entrance area.
6. REVIEW OF FLOODWAY OPERATION

6.1 Proposal

An alternative approach to building the proposed Kinchela Creek Flood Channel might be to change the operation of the Macleay Valley flood mitigation system so that the floodway gates are opened later than at present. If this were to be done, some of the levee banks along Kinchela Creek (and perhaps along the Macleay and Belmore Rivers) would have to be raised to prevent early overflow.

At present both the Kinchela Floodways and the Belmore Floodway are opened at a level equivalent to 13'6" on the KTB. At this level the Kinchela Creek levees are just overtopping at the low points near the floodways.

As noted in the Floodway Capacity Study, the Belmore Floodway operation has a greater effect on levels in the Macleay River than does operation of the Kinchela Floodways. A preliminary investigation showed that the Belmore Floodway had to be opened at about 15' on the KTB to prevent significant overtopping of the Macleay River levees. Should the Belmore Floodway be opened, the Kinchela Floodways could remain closed until about 16' on the KTB provided levee raising was carried out along part of Kinchela Creek (and possibly minor raising at other locations).

A model test run was therefore carried out with the Belmore Floodway opening at 15' on the KTB and the Kinchela Floodways opening at 16'.

Figures 1 to 3 show the water level gradient for a flood which reaches 16' at the KTB with the Kinchela Floodways closed and Belmore Floodway open. (Note that if the Belmore Floodway were left closed until 16' as well, levels in the Macleay River would be 0.2m to 0.3m higher and considerable infilling of levees would be required on the Macleay and Belmore Rivers).
From Figure 1 it can be seen that, if the 16' flood is to be contained within Kinchela Creek with the floodways closed, then the levees will need to be raised by a maximum of 0.6m at the Western Floodway. This raising will grade back to zero about 2km from the Macleay River junction.

6.2 Costs for Levee Raising

Assuming the levee is raised alongside the existing roads and has a profile of 0.5m top width and 1:4 side slopes, the following costs are involved:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment</td>
<td>15 000</td>
</tr>
<tr>
<td>Strip &amp; stockpile topsoil (21 000m² @ $1.00/m²)</td>
<td>21 000</td>
</tr>
<tr>
<td>Win, haul, place and shape fill (6 750m³ @ $20.00/m³*)</td>
<td>135 000</td>
</tr>
<tr>
<td>Replace topsoil (21 000m² @ $2.50/m²)</td>
<td>53 000</td>
</tr>
<tr>
<td>Grass Sowing (21 000m² @ $1.50/m²)</td>
<td>31 000</td>
</tr>
</tbody>
</table>

Contingencies (15%) 38 000

TOTAL $293 000

* This is a higher rate than for the channel because of the smaller quantities involved.

It may also be necessary to raise or modify the tops of the gates on the Kinchela and Belmore Floodways (this is not included in the above costings). Some minor levee infilling may be required on the Macleay and Belmore Rivers as well. Such costs have not been included in the costings because the benefits from this work will accrue to other areas.
6.3 Benefits in Levee Raising

The historical records from 1963 to 1994 show that there have been 11 floods in the period which exceeded 13'6" at KTB but did not exceed 17'. Of these, only two exceeded 16' and would therefore, under the alternative proposal, be allowed to enter the Kinchela area through the opened floodways. This means that, if the floodways had been opened at a 16' rather than at 13'6", a total of nine openings would not have occurred in the historical period.

In order to compare this proposal with the Flood Channel results (Chapter 4) a 25 year time frame needs to be adopted. Nine floods in 31 years approximates to seven floods in 25 years.

Using the same flood damage figures as before (Section 2.2.3) the Average Annual Flood Damages prevented is:

\[
\frac{7}{25} \times 217,000 = \$61,000
\]

The NPW of this figure at 7% over 25 years is $711,000.

Considering only the Kinchela area as before, the Benefit/Cost ratio of the proposal would be 2.4.

The proposal would also provide significant benefits outside the Kinchela area, especially in the Upper Belmore River. Some minor levee work would be required along the Belmore River to allow the floodway to be kept closed until 15' at the KTB and Figure 3 indicates that some minor infill might also be required on the left bank of the Macleay River. These works have not been costed but it is clear that the additional benefits would significantly outweigh the costs.
It should also be noted that the benefits (as yet unquantified) in the Belmore area referred to above, which would be obtained by closing the Belmore Floodway at 15' and minor levee raising, could also be obtained by carrying out similar works in association with the Kinchela Flood Channel proposal. Since they are the same in each case, the benefits do not affect the comparison of the two alternative proposals.
7. BELMORE RIVER FLOOD CHANNEL

It has always been recognised that, if a Flood Channel was found to be practical for the
Kinchela Creek area, this would raise the prospect of a similar channel being feasible from
the Belmore River direct to the ocean. An analysis of the hydraulic potential of a possible
Belmore River Flood Channel was therefore carried out.

The following assumptions were made about the possible Flood Channel.

**Location:** at the 7 mile mark on the Belmore, i.e. about 5km south of the floodway.
**Size of Channel:** 100m wide (same width as proposed Kinchela channel).
**Inflow Weir from Belmore:** 100m wide at 1m AHD.
**Ocean Control:** 100m wide at 2m AHD.

The existing floodway was closed and it was assumed that levees along the Belmore River
would be raised where required to prevent overflow in the 80% x 1980 flood. The model
showed that in such a flood only 85m$^3$/s would flow down the Flood Channel and that the
water level in the Belmore River at the existing floodway would be almost 1m higher. The
level at the Macleay/Belmore junction would be 0.25m higher than at present.

The results show that a Flood Channel from the Belmore River would not be able to take
the flow which is presently discharged through the Belmore Floodway (approximately
350m$^3$/s). This is largely because of inadequate capacity in the Belmore River itself (this
matter is discussed in some detail in the "Floodway Capacities" Report - Public Works
(July, 1994)). In addition to its hydraulic inadequacy, the Belmore Flood Channel would
cost more that the Kinchela Channel (of the order of $3 million) and would need to pass
through a National Park.

A number of alternative routes were considered for the Flood Channel, but all were found
to be less effective hydraulically and more expensive than the option tested.
8. ACKNOWLEDGMENTS

This study was carried out by Webb, McKeown & Associates Pty Ltd on behalf of Kempsey Shire Council. It was funded by NSW Public Works on a two thirds basis from the State Government's Floodplain Management Program with the remaining one third contributed by Kempsey Shire Council.

In completing this report Webb, McKeown & Associates have been assisted by advice and information from NSW Public Works, Kempsey Shire Council and the Belmore Kinchela Landholders' Association.