

**WALLAMBA RIVER**

**FLOODPLAIN RISK MANAGEMENT PLAN**

**For NABIAC, FAILFORD & MINIMBAH AREAS**

**Prepared for:**  
**GREAT LAKES COUNCIL**

**Prepared by:**  
**Department of Infrastructure, Planning and Natural Resources**  
**July 2004**

# EXECUTIVE SUMMARY

Nabiac, Failford and Minimbah are located in the Wallamba River catchment. This study concentrates on flooding from the Wallamba River and does **not** deal with flooding from the local urban area or the tributaries of the Wallamba River. It indicates the number of buildings affected by flooding and the approximate extent of flooding where sufficient survey information is available.

The total catchment area of the Wallamba River is 495km<sup>2</sup>. The catchment upstream of the Pacific Highway lies within the local government area of Greater Taree City Council, while the catchment downstream of the highway lies within the local government area of Great Lakes Council.

Flooding at Nabiac has not occurred for a number of years. Significant local floods in records at Nabiac occurred in 1927, 1929, 1947, 1957, 1978 and 1983. A flood event also occurred in February 2002. This event was a more localised flood event with above floor flooding experienced due to tributaries to the Wallamba River, such as Town Creek, rather than from flooding from the Wallamba River. The influence of the Wallamba River was not significant as the flood levels in the river were lower than those in town and the peak of river flooding happened well after the peak flood levels in the township. This storm does, however, serve as a timely reminder that whilst well located, Nabiac does have flood problems that need to be effectively managed.

The effects of major floods at these areas are relatively contained to the areas in the vicinity of the river. Flooding from the Wallamba River in the study area in the 1% annual exceedance probability (AEP) flood event will inundate around 18 houses and 3 non residential buildings above floor level with 9 of these buildings in Nabiac, 6 in Failford, and 6 in Minimbah. The potential flood damage in the 1% AEP event is estimated to be in the order of \$455,000 with the annual average damage for the full range of floods expected to be in the order of \$34,000. The 0.2% and extreme flood events are likely to impact upon 79 and 220 buildings respectively. Very few properties are affected above floor level in floods of less than a 1% AEP. Therefore, whilst development is generally protected from the majority of flood events, extreme flood events can have a significant impact on Nabiac (141 buildings), Failford (61 buildings) and Minimbah (18 buildings).

The development of a bypass flowpath from the Wallamba River through the township of Nabiac occurs in events of around a 0.2% AEP and the scale of this increases in larger events. This is a very rare event, but is important from an emergency management perspective. It can result in areas being isolated, as roads are cut off, and as water levels rise further both the land and the buildings are inundated. This needs careful consideration in the emergency management section of the Great Lakes Local Flood Plan that deals with Nabiac and is an issue for flood education and awareness of the community.

The low number of properties affected above floor level by flooding in a 1% AEP flood event, and the associated relatively low level of average annual flood damages means that it is unlikely for flood mitigation measures, such as levees, to be economically viable. This is further compounded by the large length of river bordering Nabiac, Failford and Minimbah. In addition, works, such as levees, may also impact upon flood levels resulting from local drainage and the Town Creek tributary.

The preliminary findings of the study were presented to the community as part of the consultation undertaken for the project. There appeared to be little community interest in riverine flooding and no particular option for mitigation was supported. Notwithstanding this council needs to manage three types of flood risk. Each of flood risk involves a component related to danger to personal safety and property damage. This plan documents the proposed methods of dealing with the three types of flood risk, namely:

- existing flood risk which relates to existing development in the floodplain;
- future flood risk which relates to the risk to future development in the floodplain; and
- continuing flood risk is the flood risk remaining after management measures are implemented.

The plan and the associated implementation plan, as outlined below, **are to be** exhibited by Council and comments were invited from the community. This plan recommends the following management measures in priority order:

- Priority 1 updating the Council’s 1985 Flood Management Policy and associated development controls as outlined in this report to manage future flood risk.
- Priority 2 emergency management planning to support the flood warning system and community education and awareness and data collection to aid in addressing continuing flood risk.
- Priority 3 review of this floodplain risk management plan as necessary.
- Priority 4 upgrading access in key areas identified in emergency management planning.
- Priority 5 a voluntary house raising scheme is recommended to reduce existing flood risk.
- Priority 6 a voluntary purchase scheme is recommended to reduce existing flood risk.

The implementation plan recommends implementation of Priority 1 immediately, Priority 2 should be progressively undertaken as funds are available. Priority 3 is recommended at a maximum of every 5 years, upon the completion of the study into flooding from local tributaries in Nabiac to include associated works or development controls, and indicate or where development or works are proposed that will significantly impact on flood risk or potential damages. Priority 4 relates to improving local flood access where emergency management planning highlights the need. Subsidised funding should be sought for Priorities 5 and 6 following canvassing of interest in voluntary house raising and voluntary purchase.

The summary table below provides additional detail on the recommended portions of the proposed floodplain risk management scheme.

**Table E1 - Program to Implement the Wallamba Floodplain Risk Management Plan**

Priority	Description	Indicative Cost	Target Start Time	Benefit Cost Ratio	Eligible for Funding
<b>1</b>	<b>Development Controls &amp; s149 Certificates</b>	Low-Medium, Council resources. Advice provided in Floodplain Management Manual.	<b>Year 1</b>	<b>N/a</b>	<b>No</b>
<b>2</b>	<b>Components 2a to 2c</b>	As below	<b>As below</b>	<b>1.7</b>	<b>See below</b>
2a	Flood Response Plan & Warning Procedures	Medium. Council/SES resources.	Year 2		Part
2b	Flood Education & Awareness	\$10,000 capital, \$2,000 annual maintenance	Year 2/3		No
2c	Ongoing Data Collection		Ongoing		No
<b>3</b>	<b>Review of this Floodplain Risk Management Plan</b>	following completion of investigations into flooding from local creeks and major drainage	<b>Max 5 years or as required</b>	<b>n/a</b>	<b>Yes</b>
<b>4</b>	<b>Access Issues identified in Emergency Management Planning</b>	<b>unscoped</b>	<b>Year 4</b>	<b>n/a</b>	<b>possibly</b>
<b>5</b>	<b>Voluntary House Raising of all below 2% AEP flood level that can be raised</b>	<b>\$120,000</b>	<b>Year 5</b>	<b>0.29</b>	<b>Yes</b>
<b>6</b>	<b>Voluntary Purchase of houses below 5% flood level that cannot be raised in worst locations</b>	<b>\$480,000**</b>	<b>Year 6</b>	<b>0.13</b>	<b>Yes</b>
<b>Overall Scheme</b>	<b>Integrated Scheme of Items 1 to 5</b>	<b>\$610,000 plus</b>	<b>Year 1</b>	<b>0.169</b>	<b>As above</b>

\* Great Lakes Shire Council has asked for funding under a separate Commonwealth Program for a number of these studies. Works to do with the local flood plan not eligible.

\*\* Based on \$240,000 per property.

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# 1. INTRODUCTION

## 1.1 Floodplain Risk Management in the Great Lakes Council Area

Council is responsible land use planning, including the management of flood prone land, within its local government area in accordance with the NSW Government's Flood Prone Land Policy.

To support effective floodplain risk management Council has formed a Floodplain Risk Management Committee and is undertaking the floodplain risk management process in accordance with the NSW Government's Floodplain Management Manual. The process outlined in the manual aims at addressing the existing, continuing and future flood risks related to human occupation of the floodplain using a process of risk avoidance, minimisation and mitigation. This floodplain risk management plan is the third of four steps in this process, described in the table below.

**Table 1.1 - Steps in the Floodplain Risk Management Process**

1	Flood Study	-	Determines the nature and extent of the flood problem.
2	Floodplain Risk Management Study	-	Evaluates management options for the floodplain with respect to existing, future, and continuing flood risk.
3	Floodplain Risk Management Plan	-	Involves formal adoption by Council of a plan of management for the floodplain.
4	Implementation of the Plan	-	<ul style="list-style-type: none"><li>- May involves construction of flood mitigation works, where viable, to protect existing development and reduce existing flood risk.</li><li>- Uses planning controls to ensure that future development is compatible with flood hazards in controlling future flood risk.</li><li>- Uses flood warnings to provide the community of information on potential flooding through the local emergency services.</li><li>- Uses flood education and awareness to promote flood readiness to minimise continuing flood risk</li></ul>

This plan is one of a number that are being undertaken by Council for different locations within its service area. This plan concentrates on the impacts of the Wallamba River in the areas of Nabiac, Failford and Minimbah.

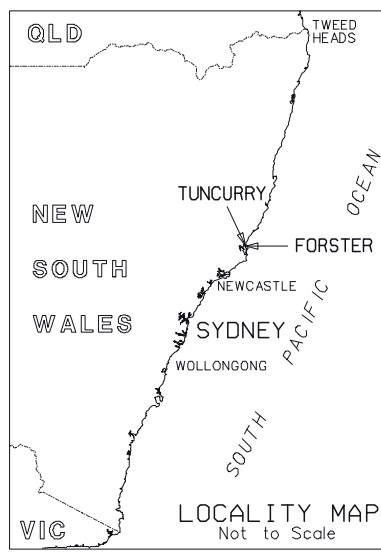
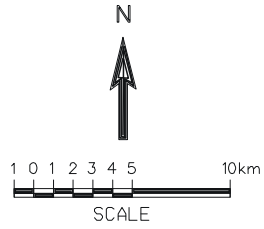
## 1.2 Wallamba River Floodplain Risk Management Plan

The Department of Infrastructure, Planning and Natural Resources (DIPNR) was engaged by Council to undertake a Floodplain Risk Management Study and Plan for the Nabiac and Failford areas on the Wallamba River. This study was extended to consider flooding in Minimbah.

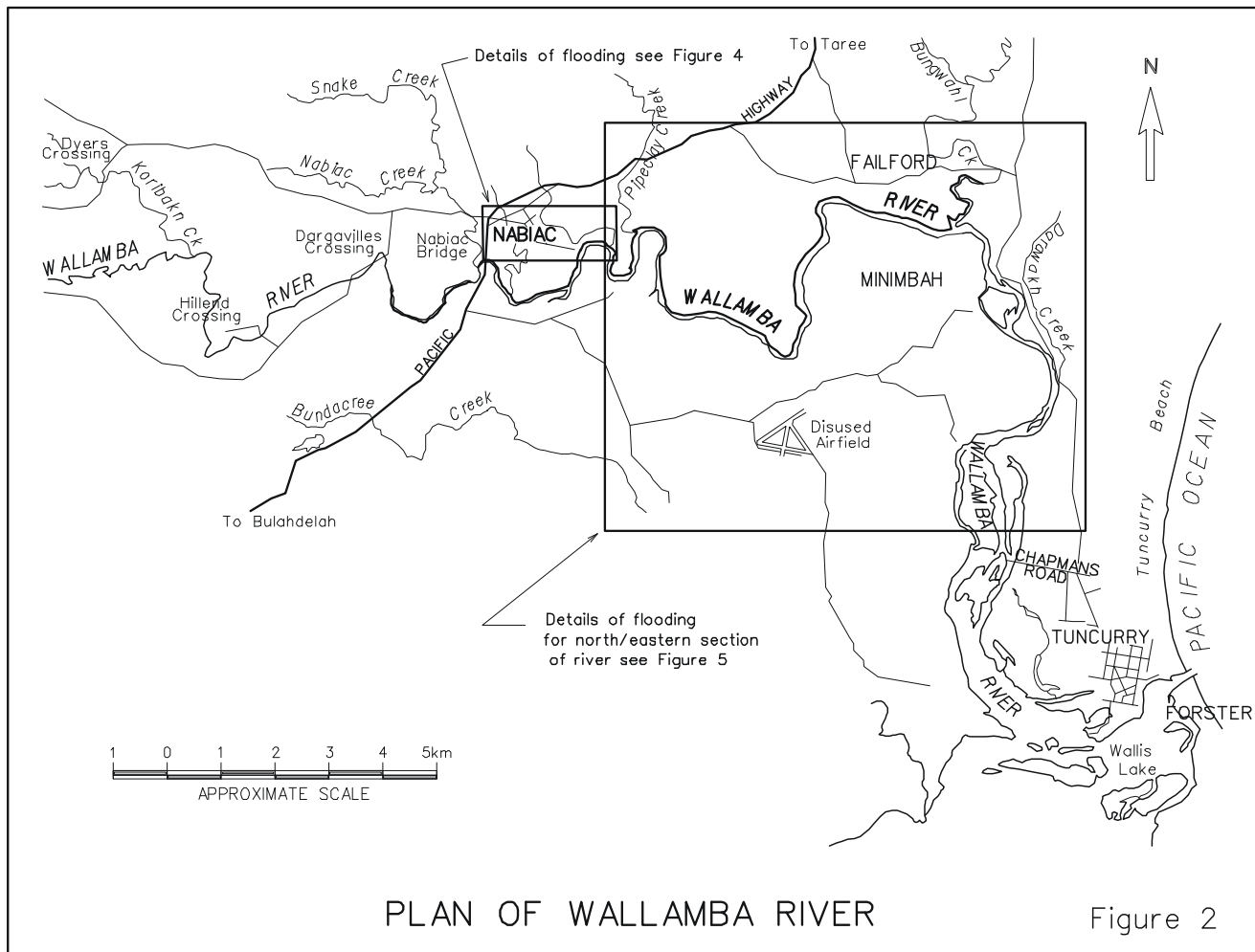
The Wallamba River flows in a generally easterly direction from the foothills of the Great Dividing Range to Wallis Lake, near the twin towns of Forster and Tuncurry, as indicated on Figure 1. The total catchment area of the Wallamba River is 495km<sup>2</sup>. The catchment upstream of the Pacific Highway lies within the local government area of Greater Taree City Council, while the catchment downstream of the highway lies within the local government area of Great Lakes Council.

The largest urban centre in the catchment is the township of Nabiac, located to the north of the Wallamba River just downstream of the Pacific Highway, as indicated on Figure 2. The smaller community of Failford is located on the north side of the Wallamba River between Nabiac and Tuncurry, whilst Minimbah is on the other (south) side of the river from Failford.

Great Lakes Council, through its Floodplain Risk Management Committee, proposes to develop a strategy for management of the floodplain for Nabiac, Failford and Minimbah in accordance with the NSW Government's Floodplain Management Manual (2001). Whilst this study only examines flooding from the Wallamba River it



LOCALITY PLAN  
Figure 1



provides an essential platform for assessment of flooding for key tributaries, such as Town and Pipeclay Creeks, and examination of other local overland flooding issues in the area.

The management study indicated that the effects of major floods at these areas are relatively contained to the areas in the vicinity of the river. Flooding from the Wallamba River in the study area in the 1% annual exceedance probability (AEP) flood event will inundate around 18 houses and 3 non residential buildings above floor level with 9 of these buildings in Nabiac, 6 in Failford, and 6 in Minimbah. The potential flood damage in the 1% AEP event is estimated to be in the order of \$455,000 with the annual average damage for the full range of floods expected to be in the order of \$34,000. The 0.2% and extreme flood events are likely to impact upon 79 and 220 buildings respectively. Very few properties are affected above floor level in floods of less than a 1% AEP. Therefore, whilst development is generally protected from the majority of flood events, extreme flood events can have a significant impact on Nabiac (141 buildings), Failford (61 buildings) and Minimbah (18 buildings).

The development of a bypass flowpath from the Wallamba River through the township of Nabiac occurs in events of around a 0.2% AEP and the scale of this increases in larger events. This is a very rare event, but is important from an emergency management perspective. It can result in areas being isolated, as roads are cut off, and as water levels rise further both the land and the buildings are inundated. This needs careful consideration in the emergency management section of the Great Lakes Local Flood Plan that deals with Nabiac and is an issue for flood education and awareness of the community.

The low number of properties affected above floor level by flooding in a 1% AEP flood event, and the associated relatively low level of average annual flood damages means that it is unlikely for flood mitigation measures, such as levees, to be economically viable. This is further compounded by the large length of river bordering Nabiac, Failford and Minimbah. In addition, works, such as levees, may also impact upon flood levels resulting from local drainage and the Town Creek tributary.

This management plan has been developed in accordance with the NSW Government's Floodplain Management Manual, 2001. It outlines the Floodplain Risk Management Committee's proposed method of managing flood risk from the Wallamba River. This plan is to be put forward to Great Lakes Council's for their consideration in the adoption of a management plan for this area.

The plan deals with the management of both danger to personal safety and damage to property by addressing the 3 types of flood risk, namely:

- ❑ existing flood risk is the risk associated with current development on the floodplain;
- ❑ future flood risk is related to new development within the floodplain; and
- ❑ continuing flood risk is the risk remaining after floodplain risk management measures and development controls are in place. This exists in both existing and future development area.

The plan outlines Council's proposal to manage the floodplain in the study area and provides a program to implement the proposed floodplain risk management measures. Council exhibited and sought public comment on this plan. **(TO BE COMPLETED FOLLOWING EXHIBITION)**

This report is split in the following sections:

- Section 2 Management Plan, Implementation Program, Further Investigations, and Updating the plan;
- Section 3 Potential to Attract Funding Subsidy;
- Section 4 Acknowledgments;
- Section 5 Glossary. Provides a definition of the terms used in this report; and
- Section 6 References.



## 2. MANAGEMENT PLAN

### 2.1 WALLAMBA RIVER FLOODPLAIN RISK MANAGEMENT PLAN OVERVIEW

The objectives of floodplain risk management aim to managing the danger to personal safety caused by flooding and the damage to property resulting from flooding. The management of these risks can be broken down into three areas. Management of:

- ❑ existing flood risk (the risk faced by existing development in the floodplain);
- ❑ future flood risk (the risk that would be faced by future development in the floodplain); and
- ❑ continuing flood risk (the risk remaining after adopted floodplain risk management options have been implemented). This exists in both existing and future development areas.

The Wallamba River Floodplain Risk Management Study identified measures to manage the flood risk in the study area. Options investigated include voluntary house raising, voluntary purchase, emergency response planning, evacuation access, flood education and awareness, flood proofing and development controls.

Assessment of management options was undertaken relative to their effectiveness in meeting the objectives identified above and the following additional criteria:

- ❑ environmental impact in relation to the affects of any proposed works;
- ❑ opportunities for environmental enhancement;
- ❑ affect on the community and the associated community support and acceptance;
- ❑ economic efficiency; and
- ❑ ability and capacity to implement measures.

The Great Lakes Floodplain Risk Management Committee allocated the following priorities to floodplain risk management options recommended in the Wallamba River Floodplain Risk Management Study. In addition, flooding from local tributaries needs investigation and a data collection program has been identified.

Priority 1 Updating Development Controls. To manage future flood risk.

Priority 2 Flood Planning, Education, Awareness and Data Collection to manage continuing flood risk.

Priority 2a Updating the Flood Response Plan;

Priority 2b Flood Education and Awareness; and

Priority 2c Ongoing Data Collection.

Priority 3 Review of this Floodplain Risk Management Plan.

Priority 4 upgrading of access issues in key areas as identified in emergency management planning.

Priority 5 Voluntary House Raising to manage existing flood risk.

Priority 6 Voluntary Purchase to manage existing flood risk where dwellings cannot be raised.

Priority 2a, 2b and 2c are closely linked, as the objectives of these measures cannot be effectively met without all being implemented.

### 2.2 PRIORITY 1 - UPDATING DEVELOPMENT CONTROLS

#### 2.2.1 Flood Planning Level (FPL)

As part of the management study the planning level flood was considered and it was recommended that the flood planning level (FPL) remain at 0.5m above the 1% AEP flood for the control of development. Figure 3 shows this diagrammatically relative to the range of design floods. All land below this FPL, ie, within the flood

planning area, would have a minimum floor level set at the FPL. The management study highlights that this decision considered:

- ❑ The major flowpath for NABIAC is around the township in events up to the 1% AEP flood event. However, a major flowpath develops through town in events above a 0.2% AEP flood with flow through the township increasing as the magnitude of flooding increases.
- ❑ The ground level at the fringes of the floodplain increases steadily limiting any additional area of inundation. Therefore variation of the flood standard (eg raise to the 0.5% AEP flood or lower to the 2% AEP flood) would not have a major effect on the area of land subject to flood related controls.
- ❑ Given the limited impact of flooding of NABIAC from the Wallamba River, selection of the 0.5% or 2% AEP flood level instead of the 1% flood level would not have a major impact upon the area of land subject to flood related controls.
- ❑ There is land below the 1% AEP flood level that is available for development:
  - ◀ Development of the available land, considering controls related to the 1% AEP flood level will not significantly increase flood risk.
  - ◀ Developing this land to a reduced flood standard will be inconsistent with previous development control decisions. In addition it will increase the level of flood risk in NABIAC relative adopting the current development controls.
  - ◀ Developing with a higher flood standard will have only a minimal effect on flood damage potential and is unlikely to significantly alter levels of danger to personal safety.
- ❑ The flood behaviour in the extreme event does result in altered behaviour to that of the 1% AEP Flood in the area of NABIAC, due to the development of a flowpath through NABIAC, as shown on Figure 4, this flowpath starts to operate in events greater than a 0.2% flood event. This flowpath cuts off the eastern end of NABIAC, which would be ultimately inundated in an extreme event, with flood levels around 1.8m higher. Whilst this is an issue for consideration in assessing the Flood Planning Level, an appropriate warning system and associated emergency response plan is considered an appropriate method of managing the risk from these very rare events.
- ❑ The flood warning system for NABIAC is included in the overall system recently installed for the Wallis Lake catchment. This will provide assistance to the study area. However, a specific flood emergency response plan for NABIAC, Failford and Minimbah is needed in conjunction with flood warning to limit the hazard to existing and future development in floods greater than the 1% AEP flood.

In considering this information, there appears to be no valid reason to alter the current development control practice, as long as development is compatible with the level of flood risk and that self evacuation is practical and achievable in an extreme flood given the likely warning regime. Therefore it is recommended that development control remain linked to the 1% AEP flood event, but with consideration of evacuation in larger events, as appropriate.

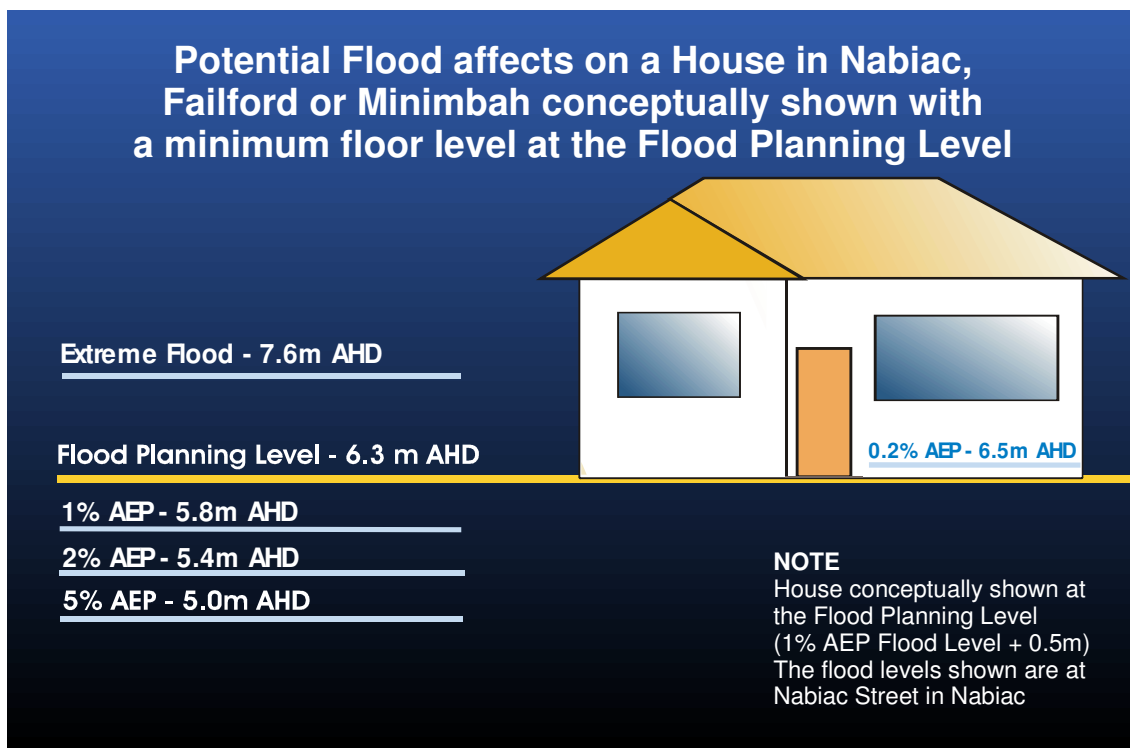
One particular inconsistency in the flood policy, identified in Section 3.5 of this report, relates to land filled to or less than 0.2m above the 1% AEP flood level. If a property was 0.1m below the 1% AEP flood level the required minimum floor level would be 0.5m above the 1% AEP flood level. However, if the property was at or above the 1% AEP flood level only a minimum floor level of 0.3m above the ground would apply. This situation means that freeboard above the 1% AEP flood level to account for wave action, local hydraulic effects and other factors is not being consistently applied.

## **2.2.2 Planning Instruments and Development Controls**

The adoption of the FPL does not impact upon the following planning instruments and controls:

- ❑ Great Lakes Local Environmental Plan, gazetted December 1996, last amended June 2000;
- ❑ Subdivision Development Control Plan, adopted September 1999;

## Potential Flood affects on a House in NABIAC, Failford or Minimbah conceptually shown with a minimum floor level at the Flood Planning Level



**RELATIVE LEVEL OF FLOODS AT NABIAC, FAILFORD and MINIMBAH**  
**Figure 3**

- ❑ Residential Development Control Plan for Urban Areas, adopted September 1999; and
- ❑ Exempt and Complying Development Control Plan, adopted August 1999.

However, it does impact upon the Council's Flood Management Policy, adopted on 10 December 1985. The policy requires revision to address the following issues:

- ❑ revision of definitions to avoid confusion with the new Exempt and Complying Development DCP and to reflect current terminology in the floodplain risk management field;
- ❑ alterations need to indicate that the hazard categorisation methodology recommended in the policy is preliminary only and should be over ridden by assessments in studies for specific areas.
- ❑ Deletion of Tables 1 to 6 of the Policy are similar to those in the superseded 1986 Floodplain Development Manual. Reference could be made to the Manual (2001) which has revised tables that are to only be used in limited situations, where studies are yet to be undertaken and care should be taken in their use. Flood hazards for Bulahdelah for the 1% AEP flood event are indicated on Figure 2.
- ❑ The adoption of the 1% AEP plus 0.5m adopted freeboard as the Flood Planning Level (FPL) for minimum floor levels for habitable development.
- ❑ Appendix A of the Policy relates to the NSW Government's Flood Prone Land Policy. This should be deleted as much of the background information is not relevant some 16 years after adopted of the policy and can refer to the Floodplain Management Manual: The Management of Flood Liable Land (2001).
- ❑ The Policy needs updating to make it consistent with the NSW Government's Floodplain Management Manual (2001) including the need to address issues such as major drainage, and flood awareness and education.
- ❑ The Policy should be renamed the Local Flood Risk Management Policy to be consistent with the Floodplain Management Manual.

- ❑ Emergency management in the extreme flood event should also be considered. This is particularly important in areas without direct evacuation routes to ground above the extreme flood levels. This is generally not an issue in Bulahdelah but may be for other areas of the Great Lakes Local Government Area.
- ❑ The policy should also outline information to be provided on Certificates under s149 of the Environmental Planning and Assessment Act (1979). This is discussed in Sections 3.2.4 and L6 of the NSW Government's Floodplain Management Manual with typical examples provided in Section L6.2 to L6.4.

Changes to the Council's Flood Management Policy should be made as a matter of priority.

In addition to updating the policy it may be effective to centralise flood related development controls into a flood specific Development Control Plan (DCP) to cover all developed areas of the LGA. This would facilitate administration of floodplain risk management controls, as well as the community's understanding of these controls.

The issue of further development in Nahiab, Minimbah and Failford needs to be considered. The available flood warning system and associated emergency management plan and raising of community awareness are important. Rezoning in the Minimbah area, the eastern areas of Nahiab and along Willow Point Road in Failford need to consider evacuation issues.

It is recommended that existing land in these areas not be subdivided further and development of these properties remain at the same density as current development, ie, generally single dwelling per lot unless evacuation issues are addressed.

Development or redevelopment of existing sites needs to be aware of the flood situation, consider the FPL, and the potential flood and debris forces and evacuation issues. Certification of the structural adequacy for flood forces, including buoyancy, by a registered structural engineer, is recommended.

## **2.3 PRIORITY 2 - FLOOD PLANNING, EDUCATION & AWARENESS**

Priority 2 is a combination of:

- ❑ improved flood response planning and warning dissemination;
- ❑ data collection; and
- ❑ public education and awareness.

These are dealt with as priorities 2a, 2b, and 2c respectively below. Flood warning, with an appropriate response plan, and community awareness and education enables a reduction of danger to personal safety and flood damage.

### **2.3.1 Priority 2a - Flood Response Plan & Flood Warning Procedures**

The Local Flood Plan is central to the effective management of flood risk. The plan includes a guide to the content of evacuation warning messages and identifies Nahiab Showground, Nahiab Street Nahiab as the site to be used as the evacuation centre. This site is located on flood free land on the east side of the Pacific Highway and is in close proximity to the inundated areas. The area, would however, be cut off during a flood event in excess of 0.2% AEP. Therefore arrangements need to be made for helicopter landing for medical emergencies and any logistics supplies to be bought to site. Even though the site is isolated the relative length of the flood should mean that the locality can be a viable evacuation centre. An alternative suggested by the SES is to evacuate to Taree, this would need to be undertaken relatively early in the event due to the potential for the Pacific Highway to be cut off.

No evacuation centre is identified for the Failford area. This needs to be developed. Evacuation centres should be identified for these areas. It may be logical to evacuate the eastern end of Failford to Forster and the western end to Nahiab, however, this needs to consider the relative levels of the bridges on the Failford Road and evacuation may need to be undertaken early in an event as Failford is cut off. Failford Road is cut west of

Bullocky Way and at Bungwahl Creek and the Lakes Way is cut for a large distance south of the Failford Road intersection. It may also be logical to consider a centre in the Failford township or alternatively evacuation up to Taree via the Bullocky Way. Bullocky Way has several low points which may be affected by local drainage, however, this access to the highway is generally high and would appear viable. The SES would need to consider this further to ensure that residents trapped between the Failford Road bridge and triple culverts could be effectively managed as these structures would be overtopped relatively early in a flood event.

Minimbah may be cut off from flooding from the Wallamba River in a number of places. Significant depths of floodwater would overtop sections of Glen Ora Road and Elliots Road. In addition this area would be cut off from Nabitac when the Pacific Highway cuts. Therefore evacuation from Minimbah would need to be early in a flood event due to inundation of the access roads and could be either to the north to Nabitac or Taree, dependant upon flooding of the Pacific Highway or to the south to Wang Wauk or Coolongolook. The local flood plan does not currently, but needs to specifically address this issue.

Examination of evacuation from some areas of Failford and Minimbah as part of the local flood plan and associated emergency management planning may highlight the need to upgrade works for access from Minimbah and Willow Point Road. If works are highlighted as necessary they should be considered for inclusion in the floodplain risk management plan.

The local flood plan has some shortcomings in relation to the study area, as shown on Figures 4 and 5. The proposed methodology to overcome these shortcomings are indicated below:

- ❑ Annex A identifies the flood threat. A higher level of detail could be provided for the Wallamba River at Nabitac, Failford and Minimbah similar to the information on Wallis Lakes.
- ❑ Annex B indicates specific risk areas. Some additional information could be included for Nabitac, Failford and Minimbah relating to typical warning times, likely depths of water in some areas, evacuation routes and early road closures. In addition, the provision of depth indicators may improve safety in low points. In addition, emergency management planning for key areas cut off need to be carefully considered. Some key low points are identified in Table 4.2. Evacuation planning may highlight the need to consider upgrade of some of these low points.
- ❑ Annex D provides a guide to the content of evacuation warning messages. Map 1 indicates that the Nabitac SES Unit is designated as operating in Nabitac, Failford and Minimbah. It would be useful if maps of townships indicating critical areas such as evacuation routes and centres were included.
- ❑ The current procedures are informal and rely on empirical information and the decisions of individuals based upon general Bureau of Meteorology warnings. These warnings give no prediction of timing or specific severity to enable plans to be enacted. As apart of the development of the warning system for Wallis Lake more detailed procedures for information dissemination would be required including the timing of this, including expected river level triggers. The procedures would need to consider the differences in an extreme event resulting in faster rise of water, less evacuation time, longer flood duration.

It is also suggested that Council liaise with the SES in order to advance the development of a detailed local flood evacuation plan. The plan should recognise that floods greater than the 1% AEP event may occur. The local flood plan could use the information on Figure 3 of this report as the basis for considering evacuation logistics. This plan should be referenced in the Local Flood Plan.

In addition, the Bureau of Meteorology does not issue flood warnings for watercourses within the Great Lakes Council area. However, the Council in conjunction with the Bureau have installed a flood warning system for the Wallis Lakes which includes gauges in the Wallamba River above Nabitac. This system is designed to provide information to the SES so that warnings can be issued for Nabitac, Failford and Minimbah.

The critical storm on the catchment for the 1% AEP event is the 36 hour storm. Analysing this design storm indicates that there is typically 5 hours for Nabitac and 6 hours for Failford and Minimbah between the occurrence of the maximum rainfall intensity in the upstream catchment and the peak flood level at Nabitac due to catchment runoff. However shorter times can occur due to shorter storms producing water levels of a similar magnitude, more severe storm intensities will result in water levels approaching critical levels for action and evacuation more quickly, and different spatial distributions may result in quicker flood level increases.



**NOTE: FLOODING FROM WALLAMBA RIVER ONLY.**

PACIFIC HIGHWAY  
overflow approx.  
9.7m AHD

Approx. Extent of 1% AEP Flood Event

Approx. Extent of Extreme Flood Event

In 1% AEP Event Backup  
to approx. 5.6m AHD

Backup from Wallamba River  
in 1% AEP to approx. 7.3m A.H.D.  
Flood Level in Extreme Event  
approx. 9.4m A.H.D.

**LEGEND**

Floor levels of buildings affected by flooding

- + above 1% to Extreme Flood Level
- ◀ above 5% below 2%
- above 2% below 1%
- ◻ below 5%

- \* Residential below 1% AEP unsuitable for house raising
- 2 two storey
- C Commercial
- IN Industrial

- ID- Depth at intersection in Extreme Event
- LP- Depth at Low point in Extreme Event
- 5.8/7.6
- 1% AEP/Extreme Flood Levels 5.8/7.6

**DISCLAIMER**  
This Plan is based upon available survey information. Flood extents are approximate and based on aerial photography which has limited accuracy. No flood extents shown on south/west side of river. Beyond scope of report.

**BUILDINGS/PROPERTIES AFFECTED IN VARIOUS FLOOD EVENTS FROM THE WALLAMBA RIVER AT NABIAC**

**Figure 4**

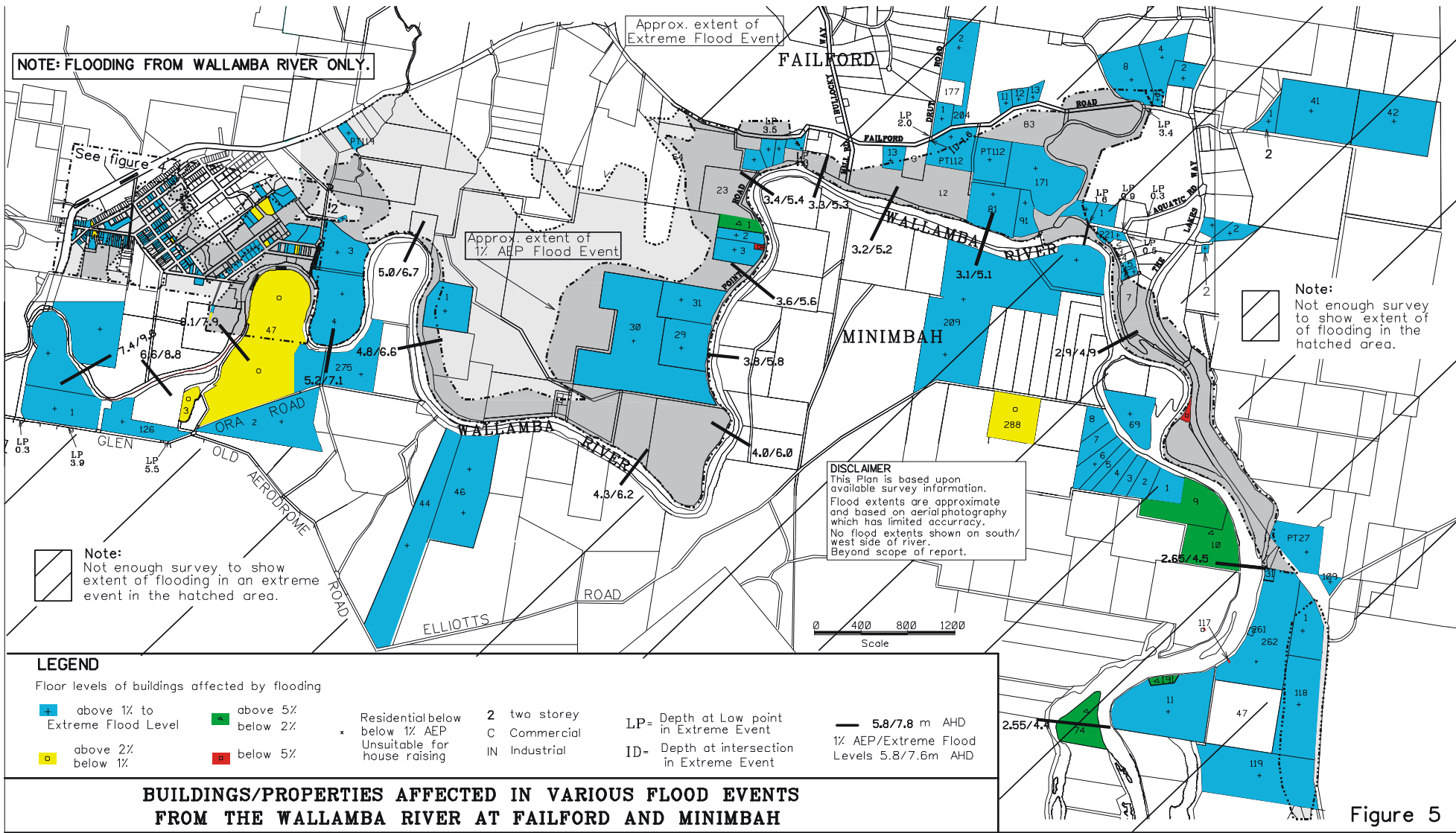


Figure 5

To utilise the potential warning time flood forecasting models are required to provide predictions of flood heights using the data collected from the flood warning system together with meteorological forecasts. The hydrologic model (and possibly the hydraulic model) developed for this study could be of assistance for this purpose. The models could be used to develop general relationships between catchment rainfall, river heights and flood levels at Nabiac, Failford and Minimbah. These relationships could then be readily applied during actual flood events. Flood warning, with an appropriate response plan enables a reduction of danger to personal safety due to flooding by providing a better indication of flood levels and more warning time for evacuation if used with a more formal flood response plan for SES.

### **2.3.2 Priority 2b - Flood Education and Awareness**

Ongoing education is necessary to ensure that the community in the floodplain has a high level of flood awareness (an accurate perception of the flood risk) and flood preparedness (knowledge of the appropriate course of action during a flood). Knowing what may occur and knowing what to do and being ready to do this is considered to be flood readiness.

Given the time since the event, the arrival of new residents, and the tendency for the general level of flood awareness to diminish over time after floods in the absence of appropriate education campaigns, the current level of flood awareness is likely to be low. The Council in conjunction with the SES should conduct regular flood awareness campaigns such as:

- ❑ installation of permanent marks showing the levels reached by the largest historical floods;
- ❑ installation displays of plans indicating the flood situation in the local information centre;
- ❑ sending out regular information with rate notices, which could include information indicating that compliance with development controls still leaves a rare flood risk, see Figure 4; and
- ❑ SES displays and talks by SES officers to community groups.

Flood preparedness campaigns should educate the flood-affected community on issues such as:

- ❑ storage or removal of important items, memorabilia and treasured items as high as practicable and, at least, above the 1% AEP flood level;
- ❑ procedures for lifting and evacuation of possessions;
- ❑ provide an understanding of any warning system;
- ❑ indicating what is expected of individuals;
- ❑ indicate the roles of the various players in emergency management locally;
- ❑ indicating where to evacuate to and who to report to once you arrive at the evacuation centre; and
- ❑ the need to react and listen to direction by the appropriate response agencies.

The estimated cost of an initial flood awareness and public education program would be between \$5,000 and \$10,000. The cost of ongoing activities to maintain flood readiness would be around \$2,000 per annum.

### **2.3.3 Priority 2c - Ongoing Data Collection**

Council needs to be committed to the collection, collation and assessment of data from flood events to verify that the flood behaviour documented in the Floodplain Risk Management Study is consistent with actual behaviour in flood events and to enable further calibration of the proposed flood warning system.

## **2.4 PRIORITY 3 - REVIEW OF THIS FLOODPLAIN RISK MANAGEMENT PLAN**

This plan should be reviewed at least once every 5 years and in the following instances:

- ❑ completion of investigations into local tributaries to incorporate works/development controls in this plan;



- ❑ if emergency management planning highlights the need for flood access upgrades. These should be added to the plan.
- ❑ when any significant changes in development are proposed in the floodplain;
- ❑ where works or measures significantly alter the level of flood risk; and
- ❑ after a significant flood event.

## 2.5 PRIORITY 4 - UPGRADING ACCESS IN KEY AREAS IDENTIFIED IN EMERGENCY MANAGEMENT PLANNING

Emergency management planning under priority 2a needs to consider the need to upgrade access to key areas. Key areas include Willow Point Road and access to Minimbah. This is likely to result in the need for some access improvement in these areas. As this is an issue relating to personal safety this should be undertaken as a priority, once identified and included in the management plan.

## 2.6 PRIORITY 5 - VOLUNTARY HOUSE RAISING

Voluntary house raising may be a practical measure to reduce the potential for flood damage to existing houses and their contents. It does not, however, address danger to personal safety. Council has identified 6 houses of timber or fibro-cement construction in the study area which would be inundated above their floor levels by the 1% AEP flood and which could be suitable for house raising. The voluntary raising of these houses would have a negligible effect on flood behaviour or on the community.

The voluntary raising of these houses would have negligible effect on flood behaviour nor would it be likely to have significant social impacts on the community, although streetscape issues may need to be considered.

The estimated cost of raising a fibro-cement or weatherboard house is around \$30,000. The benefit-cost ratios for individual houses will vary considerably with the regularity and depth of flooding. Table 2.1 indicates the benefits and costs for properties affected by above floor flooding in the 2% and 1% AEP events.

**Table 2.1 Benefits/costs of House Raising dependant upon regularity of above floor level flooding**

<b>Flooding Above Floor Level in AEP event</b>	<b>Number of Houses</b>	<b>Indicative Cost</b>	<b>Benefit. Reduction in flood damages if houses raised to above 1% AEP level</b>	<b>Benefit to Cost Ratio</b>
All below 1%	9	\$270,000	\$44,000	0.17
Only those between 2% & 1%	5	\$150,000	\$9,000	0.09
Only those affected in events 2% or more frequent	4	\$120,000	\$35,000	0.29

Voluntary house raising is recommended as a management measure. Its implementation needs to consider:

- ❑ the make up of the scheme, does it cover all houses below the 1% AEP flood level or just those below the 2% flood level. It is recommended that a scheme raising all houses below the 2% event be adopted but that preference is given to houses that have the highest depth of inundation. The benefit cost ratio of raising all 4 below the 2% would be 0.29.
- ❑ determine a procedure for its implementation. Implementing the scheme could involve calling for expressions of interest from the affected public and offering funds to those interested in house raising in a priority order based upon depth of inundation.
- ❑ given the current level of community flood awareness there maybe little interest in house raising. This could change significantly if a significant flood event were to occur on the catchment.
- ❑ floodplain risk management funding (discussed in Section 3) and particularly how the local component is funded. House raising schemes vary between councils with some Councils contributing toward the cost of damage reduction works in part or full and others not. The ability to implement the scheme may depend upon the option selected by Council and therefore the ability of the individual owners to contribute toward

house raising. A part payment by Council may make house raising more affordable and implementation easier or more feasible.

Appropriate building standards. Ensuring buildings being raised can withstand flood forces is an essential part of any house raising scheme. This may require special conditions in the Flood Risk Management Policy in relation to house raising and should incorporate the requirement for structural certification. A typical clause could be as follows:

*House raising requires the raising of floor levels to a minimum of 0.5m above the 1% AEP flood level. In raising the house, all the materials used should be flood resistant and structurally sound in accordance with Council's Flood Risk Management Policy and considering the likely flow velocities in the floodplain. In determining design flood loadings consideration should be given to the additional loadings caused by flood debris. Information on flood levels and flow velocities in the area based upon current studies is available from Council. A certificate from a NPER registered Structural Engineer as to structural adequacy and appropriateness of material will be required prior to approval being given to raise the house.*

## **2.7 PRIORITY 6 - VOLUNTARY PURCHASE**

Voluntary purchase of houses needs to be considered when it would be impractical or uneconomic to mitigate the effects of flooding in high hazard areas. The intent is to cease occupation of properties in high hazard areas, in order to free both the residents and potential rescuers from danger to personal safety and to reduce damage costs in future floods. The inclusion of properties in such a scheme is based on the level of hazard to each property such as remoteness from high ground and the combination of depth and velocity of floodwaters and the depth of inundation over floor level. Recommendations on restriction on development in high hazard areas are discussed in Section 2.2.2.

Voluntary purchase of the 2 properties below the 2% flood level, and in the worst locations has an indicative cost of \$480,000, a benefit of \$59,300, and a benefit-cost ratio of 0.13. It is recommended that these 2 houses be purchased. The sites, once cleared, could then be considered for more flood compatible development. This could include elevated dwellings on the properties where evacuation time and routes and flood warning is considered appropriate.

## **2.8 INTEGRATED SCHEME**

The recommended integrated scheme is as follows:

- Updating Development Controls. To manage future flood risk.
- Flood Planning, Education and Awareness to manage continuing flood risk.
  - ◀ Updating the Flood Response Plan and warning procedures;
  - ◀ Data Collection; and
  - ◀ Flood Education and Awareness.
- Flood Access improvements. These have currently not been costed awaiting emergency management planning highlighting their need or otherwise
- Voluntary House Raising for 4 suitable houses with floor levels below the 2% flood event to 0.5m above the 1% flood event.
- Voluntary Purchase of 2 houses not suitable for house raising which are poorly located and below the 2% flood event.

The total cost of this scheme would be around \$610,000 plus flood access improvements. The potential benefit of the overall scheme is \$94,300 with a benefit cost ratio of 0.15.

## **2.9 IMPLEMENTATION PROGRAM**

The implementation program is provided in Table E1 (page ii) for the recommended integrated scheme discussed above. This program is subject to funding availability as discussed in Section 3.

## **2.10 FURTHER INVESTIGATIONS**

Investigations into local creeks in the Nabitac and Failford areas are necessary. Once these investigations are complete their findings should be considered in relation to development controls, and potential upgrading works and how these should be incorporated into the management plan. No other investigations are considered warranted at this time. However, a review of the floodplain risk management study and associated modelling should be undertaken following any significant flood event.

### 3. POTENTIAL TO ATTRACT FUNDING SUBSIDY

Funding through the NSW Government's Floodplain Management Program in the last few financial years has seen projects with a priority in the lower to mid 30's or more using the Floodplain Management Authorities (FMA) assessment system receiving financial assistance. Based upon the available funds and the volume of projects ranked in this region this is not expected to change in the near future.

This assessment system was used to check the potential for subsidised assistance for the proposed management options. The outcomes given in Table 3.1 indicate that there would be a reasonable potential for subsidised assistance for the flood warning system, voluntary house raising and voluntary purchase and the overall integrated scheme.

**Table 3.1 Indicative FMA Assessment Scores for Recommended Works**

<b>Priority</b>	<b>Description</b>	<b>Indication of Cost</b>	<b>Approximate FMA System Score</b>
<b>1 ##</b>	<b>Development Controls S 149 Certificates</b>	<b>Low-Medium, Council resources. Advice provided in Floodplain Management Manual.</b>	<b>Ineligible</b>
<b>2a ##</b>	<b>Flood Response Plan</b>	<b>Medium. Council/SES resources.</b>	<b>Ineligible</b>
<b>2b ##</b>	<b>Flood Education and Awareness</b>	<b>\$10,000 capital, \$2,000 annual maintenance</b>	<b>Ineligible</b>
<b>2c ##</b>	<b>Ongoing Data Collection</b>		<b>Ineligible</b>
<b>3</b>	<b>Review of this Floodplain Risk Management Plan</b>		Not an implementation work therefore not scored
<b>4##</b>	<b>Upgrading Flood Access as identified in emergency management planning</b>	unscoped	possible
<b>5</b>	<b>Voluntary House Raising</b>		
	All below 1% that can be raised	\$270,000	26
<b>##</b>	<b>All below 2% that can be raised</b>	<b>\$120,000</b>	<b>26</b>
<b>6</b>	<b>Voluntary Purchase</b>		
	All below 2%	\$960,000**	26
<b>##</b>	<b>Worst Located below 2%</b>	<b>\$480,000**</b>	<b>26</b>
<b>Recommended Eligible 2-6 items ##</b>	<b>Integrated Scheme of Recommended Eligible Items marked ##</b>	<b>\$610,000 plus (excludes unscoped items)</b>	<b>27</b>

\* Great Lakes Shire Council has asked for funding under a separate Commonwealth Program for a number of these studies. Works to do with the local flood plan are not eligible.

\*\* Based on \$240,000 per property.

## **4. ACKNOWLEDGEMENTS**

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This plan has been prepared by the Flood Unit of the Ecosystems Branch in DIPNR with the assistance of Great Lakes Council and Council's Floodplain Risk Management Committee.

## 5. GLOSSARY

Following is a glossary of the terms used in this management plan.

<b>annual exceedance probability (AEP)</b>	the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m <sup>3</sup> /s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a peak flood discharge of 500 m <sup>3</sup> /s or larger occurring in any one year.
<b>Australian Height Datum (AHD)</b>	a common national surface level datum approximate to mean sea level.
<b>development</b>	defined in Part 4 of the Environmental Planning & Assessment Act. <b>infill development:</b> refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. <b>new development:</b> refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power. <b>redevelopment:</b> refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
<b>emergency management</b>	a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
<b>flood</b>	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
<b>flood education, awareness &amp; readiness</b>	<b>flood education</b> seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness. <b>flood awareness</b> is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures. <b>flood readiness</b> is an ability to react within the effective warning time.
<b>floodplain</b>	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
<b>floodplain risk management options</b>	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
<b>floodplain risk management plan</b>	a management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
<b>flood plan (local)</b>	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
<b>flood planning levels (FPLs)</b>	are the combinations of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans. The concept of flood planning levels supersedes the “standard flood event” of the first edition of this manual.
<b>flood prone land</b>	is land susceptible to flooding by the probable maximum flood event. Flood prone land is synonymous with flood liable land.

**flood risk**

potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below.

**existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain.

**future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain.

**continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.

**floodway areas**

those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

**freeboard**

a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted flood planning level and the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as “greenhouse” and climate change. Freeboard is included in the flood planning level.

**risk**

chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

## 6. REFERENCES

1. PUBLIC WORKS DEPARTMENT NSW  
Wallamba River Flood Study PWD Report No. 84021, January 1985
2. PUBLIC WORKS DEPARTMENT  
Forster/Tuncurry Flood Study Report No. 88036, September 1989
3. INSTITUTION OF ENGINEERS, AUSTRALIA  
Australian Rainfall and Runoff A Guide to Flood Estimation,  
Volumes 1 and 2 Revised Edition, 1987
4. NEW SOUTH WALES GOVERNMENT  
Floodplain Development Manual December 1986
5. STATE EMERGENCY SERVICE  
Great Lakes Local Flood Plan  
A Sub-Plan of the Great Lakes Local Disaster Plan Draft, September 1995
6. DEPARTMENT OF LAND AND WATER CONSERVATION  
Forster/Tuncurry Floodplain Management Study April 1998
7. WATER STUDIES PTY LTD  
User Manual “FLDAMAGE” March 1992
8. NSW GOVERNMENT  
Floodplain Management Manual: the management of flood liable land 2001
9. GREAT LAKES COUNCIL  
State of the Environment Report 1998/99
10. GREAT LAKES COUNCIL  
State of the Environment Supplementary Report 2000/01
11. GREAT LAKES COUNCIL  
Great Lakes Community Profile 1999
12. GREAT LAKES COUNCIL  
Forster/Tuncurry Conservation and Development Strategy 2002
13. SINCLAIR KNIGHT MERZ  
Environmental Impact Statement – Bundacree Creek to Possum Brush Upgrade of the  
Pacific Highway 137.5km to 147.2km north of Newcastle. For RTA 2001
14. ECOTONE ECOLOGICAL CONSULTANTS  
Threatened Species Assessment – Bundacree Creek to Possum Brush Section of the  
Pacific Highway Upgrade. Appendix M in Sinclair Knight Merz (2001) EIS Bundacree  
Creek to Possum Brush Upgrade of the Pacific Highway 137.5km to 147.2km north of  
Newcastle. Volume 3. Prepared for the RTA 2000
15. DAINTRY GERRAND AND ASSOCIATES  
Great Lakes Greening Strategy. Prepared for Great Lakes Council 2002