Floodplain Development Manual

the management of flood liable land

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New South Wales Government

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FOREWORD

The primary objective of the NSW Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods. At the same time, the policy recognises the benefits flowing from the use, occupation and development of flood prone land.

The policy promotes the use of a merit approach which balances social, economic, environmental and flood risk parameters to determine whether particular development or use of the floodplain is appropriate and sustainable.

In this way the policy avoids the unnecessary sterilisation of flood prone land. Equally it ensures that flood prone land is not the subject of uncontrolled development inconsistent with its exposure to flooding.

The policy highlights that primary responsibility for floodplain risk management rests with councils, which are provided with financial and technical support by the State Government. The Commonwealth has also historically shown a willingness to be involved by providing financial assistance to local government in partnership with the State Government.

This manual has been prepared in accordance with the NSW Government's Flood Prone Land Policy. It guides councils in the development and implementation of detailed local floodplain risk management plans to produce robust and effective floodplain risk management outcomes. The manual also outlines the technical assistance provided by the State Government throughout the floodplain risk management process.

The manual is concerned with the management of the consequences of flooding as they relate to the human occupation of the floodplain for both urban development and agricultural production. It addresses flood risk in full recognition of the fact that management decisions taken in respect of the human occupation of the floodplain need to satisfy the social and economic needs of the community as well as being compatible with the maintenance or enhancement of the natural ecosystems that the floodplain sustains.

In 1986 the NSW Government released the first Floodplain Development Manual to assist consent authorities to deal with flood liable land. It represented the practical expression of the Government's merit based Flood Prone Land Policy which had been introduced in 1984 to overcome the sterilisation of floodplains resulting from rigorous planning controls introduced in the 1977 Environment and Planning Circular No.15.

The 1986 manual was very successful in assisting local councils in their management of the use and development of flood prone land. In 2001, a revised Floodplain Management Manual was prepared to update the 1986 manual to make it consistent with a series of improvements to both policy and practice which has been introduced in the intervening period. Specifically the 2001 manual emphasised the need:

- to explicitly consider the full range of flood sizes up to and including the probable maximum flood (PMF) when developing a floodplain risk management plan;
- to recognise existing, future and continuing flood risk on a strategic rather than on an ad hoc individual proposal basis;
- for local councils, with support from State Government, to manage local overland flooding in a similar manner to riverine flooding; and
- to promote the preparation and adoption of local flood plans (prepared under the guidance of SES) that address flood readiness, response and recovery.

In 2003 major changes were made to the composition of agencies with responsibilities for floodplain risk management. In particular the creation of the Department of Infrastructure, Planning and Natural Resources means that one agency now has responsibility for both land use planning and natural resource functions on the floodplain.

This necessitated changes to the 2001 Manual and provided an opportunity, in light of experience with the 2001 Manual, to further clarify the intent of the policy. In particular, this clarification will reduce the potential for inconsistent interpretation by consent authorities, particularly with respect to the interaction between the determination of flood planning levels and the consideration of rare floods up to the PMF.

The 2005 Floodplain Development Manual replaces the 1986 Floodplain Development Manual as the NSW Government's Manual relating to the management of flood liable land in accordance with Section 733 of the Local Government Act 1993.

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LIST OF ABBREVIATIONS

1986 Manual	1986 Floodplain Development Manual
2001 Manual	2001 Floodplain Development Manual: the management of flood liable land
AAD	Annual Average Damages
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
AWRC	Australian Water Resources Council
BoM	Bureau of Meteorology
CMA	Catchment Management Authority
CMB	Catchment Management Board
Council	can be read as including councils and other consent authorities
DCP	Development Control Plan
DEC	Department of Environment and Conservation
DISPLAN	Local Disaster Plan
DIPNR	Department of Infrastructure, Planning and Natural Resources
DPI	Department of Primary Industries
EP&A Act	Environmental Planning and Assessment Act, 1979
EPAR	Environmental Planning and Assessment Regulation, 2000
EPI	Environmental Planning Instruments including SEPPs and LEPs
ESD	Ecologically Sustainable Development
FPL	Flood Planning Level
LEP	Local Environmental Plan
LG Act	Local Government Act, 1993
Local Policy	Local flood risk management policy
Management Committee	Floodplain Risk Management Committee
Management Plan	Floodplain Risk Management Plan
Management Study	Floodplain Risk Management Study
Manual	Floodplain Development Manual, 2005
NP&W Act	National Parks and Wildlife Act, 1974
NSW	New South Wales
NVC Act	Native Vegetation Conservation Act, 1997
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
Policy	NSW Government's Flood Prone Land Policy
SEPP	State Environmental Planning Policy
SES	State Emergency Service
TSC Act	Threatened Species Conservation Act, 1995
Water Act	Water Act, 1912
Water Management Act	Water Management Act, 2000
149(2)	Section 149 part 2 of the Environmental Planning and Assessment Act
149(5)	Section 149 part 5 of the Environmental Planning and Assessment Act

1. FLOOD RISK MANAGEMENT IN NSW

1.1 Flood Prone Land Policy

The primary objective of the New South Wales Flood Prone Land Policy, as outlined below, recognises the following two important facts:

- flood prone land is a valuable resource that should not be sterilised by unnecessarily precluding its development; and
- if all development applications and proposals for rezoning of flood prone land are assessed according to rigid and prescriptive criteria, some appropriate proposals may be unreasonably disallowed or restricted, and equally, quite inappropriate proposals may be approved.

1.1.1 The Policy Statement

The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. That is:

- a merit approach shall be adopted for all development decisions in the floodplain to take into account social, economic and ecological factors, as well as flooding considerations;
- both mainstream and overland flooding shall be addressed, using the merit approach, in preparation and implementation by councils of strategically generated floodplain risk management plans;
- the impact of flooding and flood liability on existing developed areas identified in floodplain risk management plans shall be reduced by flood mitigation works and measures, including on-going emergency management measures, the raising of houses where appropriate and by development controls; and
- the potential for flood losses in all areas proposed for development or redevelopment shall be contained by the application of ecologically sensitive planning and development controls.

To achieve its primary objective, the policy provides for:

- financial assistance by the NSW Government for works to reduce potential flood damage and personal danger in existing developed areas;
- technical support from the State Government to local councils in ensuring that the management of flood prone land is consistent with flood risk and that such development does not cause undue future distress to individuals nor unduly increase potential flood liability to them or the community;
- emergency management and flood recovery programs and their linkage with the floodplain risk management process; and
- the protection of councils, government agencies, and their staff against claims for damages resulting from their issuing advice or granting approvals on floodplains, providing such action was taken in accordance with the principles and guidelines in this manual.

The policy shall be implemented in the following manner:

- The management of flood prone land is, primarily, the responsibility of councils. In addition, the Department of Infrastructure Planning and Natural Resources (DIPNR) has a lead role in the development of regional strategies and plans under the Environmental Planning and Assessment Act (EP&A Act). Therefore, councils need to be cognisant of regional strategies and plans, when determining standards and implementation arrangements for flood prone land in their service areas.
- The NSW Government, through DIPNR and the State Emergency Service (SES), shall provide specialist technical assistance on all flooding and land use planning matters. This manual is provided to assist councils in the preparation of floodplain risk management plans.

- The establishment of local floodplain risk management committees by councils, through which local community groups and individuals can effectively communicate their aspirations concerning the management of the flooding problem.
- The State Government continuing to subsidise flood risk management studies, works and measures.

1.1.2 Policy Provisions

The policy provides for:

- a flexible merit based approach to be followed by councils, when dealing with development or redevelopment of flood prone land;
- high government priority for flood risk mitigation programs;
- a merit based approach to selection of appropriate flood planning levels (FPLs). This recognises the need to consider the full range of flood sizes, up to and including the probable maximum flood (PMF) and the corresponding risks associated with each flood, whilst noting that with few exceptions, it is neither feasible nor socially or economically justifiable to adopt the PMF as the basis for FPLs. FPLs for typical residential development would generally be based around the 1% AEP flood event plus an appropriate freeboard (typically 0.5m);
- councils to be responsible for the determination of appropriate planning and development controls, including FPLs, to manage future flood risk to an acceptable level based on social, economic and ecological, as well as flooding considerations. These controls should be cognisant of the relevant regional planning and any associated controls;
- an emphasis on the importance of developing and implementing floodplain risk management plans based on an integrated mix of management measures that address existing, future and continuing risk;
- the provision of NSW government technical and financial support to councils in relation to flooding matters;
- floodway definition to be based on hydraulic, hazard and potential damage considerations related to the effect of loss of flow conveyance on flood conditions, with provision for restricted development depending on circumstances;
- explicit recognition that flood risk management needs to take into account the principles of ecologically sustainable development (ESD) through consideration of relevant government policies and legislation allowing for the sustainable use of the floodplain as a natural resource. Planning and assessment requirements laid down in these policies and legislation must be complied with by all agencies associated with the use, development and management of the floodplain;
- recognition of the need to consider ways of maintaining and enhancing riverine and floodplain ecology in the development of floodplain risk management plans;
- recognition of the importance of the continuing flood risk addressed in the State Emergency Service Act 1989 and State Flood Plan, and the close relationship between the emergency management and floodplain risk management processes;
- recognition of the potential implications of climate change on flooding behaviour;
- detailed implementation arrangements as outlined in this manual;
- protection of councils and other public authorities and their staff against claims for damages, providing they act in accordance with the government's policy at the time; and
- relief from land tax, council rates and water and sewerage rates where vacant land cannot be developed because of its flood prone nature.

1.1.3 Enquiries

Enquiries should be directed as follows:

- general enquiries on the policy, its currency, and implementation to DIPNR;
- enquiries on flood liability of individual properties and proposals for development should be directed to the relevant council; and

- enquiries on flood warning, evacuation and community education matters should be directed to the SES.

1.2 Purpose of the Manual

The manual supports the NSW Government's Flood Prone Land Policy in providing for the development of sustainable strategies for managing human occupation and use of the floodplain considering the risk management principles outlined in Appendix B. These are based upon a hierarchy of avoidance, minimisation (using planning controls) and mitigation works.

This manual provides councils with a framework for implementing the policy to achieve its primary objective. It considers the costs and benefits of floodplain occupation in full recognition that associated management decisions need to consider broader issues in an integrated approach.

This manual updates the 2001 Floodplain Management Manual to reflect the significant change in the roles of State Agencies and to clarify some planning issues which have led to inconsistent interpretations. It replaces the 1986 Floodplain Development Manual as the Government's manual relating to the management of flood liable land in accordance with Section 733 of the Local Government Act 1993. This provides councils and statutory authorities, and their staff, with indemnity for decisions made and information provided in good faith from the outcomes of the management process.

The manual also presents general principles and a process for floodplain risk management to enable councils and their floodplain risk management committees to understand flood behaviour and impacts. It provides for evaluation of strategies and formulation of plans that achieve effective floodplain risk management outcomes accounting for social, economic, ecological and cultural factors, together with community aspirations for the use of flood prone land. This provides for sustainable use and development of the floodplain in a wise and rational manner on a flexible merit basis.

1.3 Who is the Manual for?

The Manual is written principally for local government, including councillors, senior managers, engineers, planners, environment officers, development assessors, reserve managers and others. However, the manual will also be of interest to other organisations and individuals involved in floodplain risk management such as government agencies, landholders, community groups and consultants.

1.4 Where does the Manual Apply?

The manual applies to floodplains across NSW, in both urban and rural areas. It is also used to manage major drainage issues in local overland flooding areas. As the 1986 manual was directed principally to mainstream flooding in urban areas Appendix C provides more details on the application of the manual to rural and local overland flooding.

1.5 How to Use the Manual

The manual is to be read and interpreted in a global sense with reference to the overall objectives of the policy, with particular reference to the primary objective.

The manual and policy are targeted at a strategic management level. To ensure that the underlying philosophies are applied in each case, without exception, individual portions or sections of the manual should not be interpreted outside:

- the overall philosophy of the manual and its application of strategic management; and
- the policy, as outlined in Section 1.1.

In the case of any inconsistency the main body of the manual takes precedence over the appendices.

The manual is broken down into sections as follows:

- Section 1 outlines the policy, the role of the manual in policy interpretation, and the principles and objectives of floodplain risk management;
- Section 2 describes the floodplain risk management process;
- Section 3 deals with the roles and responsibilities of participants in floodplain risk management; and
- Section 4 provides a glossary of terms used.

Appendices support the text in implementing the management process. Key appendices include:

- Appendix A discusses the history of policy development, improvements on previous manuals, and the cost of flooding in NSW;
- Appendix B provides a background on risk management;
- Appendix C outlines the floodplain risk management process, as shown in Figure 2.1, and references other relevant appendices;
- Appendix D discusses the need for, and role and make up of management committees;
- Appendix E outlines the necessary data and its collection;
- Appendix F outlines flood study preparation;
- Appendix G discusses issues addressed in, and preparation of, a floodplain risk management study;
- Appendix H discusses preparation and formalisation of a floodplain risk management plan;
- Appendix I discusses management plan implementation;
- Appendix J discusses floodplain risk management options;
- Appendix K discusses derivation of flood planning levels;
- Appendix L outlines hazard and hydraulic categorisation;
- Appendix M discussed flood damages; and
- Appendix N discusses emergency response planning for floods.

PLATE 1 - South Murwillumbah, 1954

1.6 Effective Floodplain Risk Management

Floodplain risk management specifically considers the consequences of flooding as they relate to human occupation of the floodplain. The policy and manual focus on this risk whilst recognising that natural resource management policies and legislation need consideration by all agencies managing floodplain development and use.

The policy and manual use a broad risk management hierarchy of avoidance, minimisation and mitigation, as discussed in Appendix B, to:

- reduce the social and financial costs from the risks associated with occupying the floodplain;
- increase the sustainable benefits of using the floodplain; and
- improve or maintain floodplain ecosystems dependent on flood inundation.

The most effective means of achieving sound flood risk management outcomes is to formulate and implement management plans through the floodplain risk management process, discussed in Section 2.

The process enables decisions to be made on a balanced consideration of economic, social and environmental issues from a flood risk management perspective so as to achieve effective robust outcomes in an informed and consultative manner.

Management plans need to be specific to individual floodplain and specific locations within the floodplain due to variation in flood hazard, exposure and vulnerability.

Balanced management plans must address each of the three types of flood risk, discussed below, in a comprehensive manner and evaluate all factors (including social, economic, ecological and cultural impacts and flood risk) that affect the use of flood prone land. The three types of flood risk are:

- **existing flood risk**, associated with current development on flood prone land. For example, this may be the risk to existing development areas that can be effectively managed by the construction of a levee;

- **future flood risk**, associated with any new development on flood prone land. For example, this may be the risk to future development areas that can be managed by adopting appropriate development limits, and minimum fill levels for lots and minimum floor levels for buildings; and
- **continuing flood risk**, is the risk remaining, in both existing and future development areas, after floodplain risk management measures, such as works and planning controls, are implemented. This is the risk from rarer floods which may result in levee overtopping or flooding of buildings with minimum floor levels. The consequences of these rarer floods may include danger to personal safety and damages to infrastructure, and both public and private property.

A balanced management plan therefore requires a range of different management measures. These measures (including both works and planning controls) and their cumulative impacts, need to be considered strategically. This involves:

- consideration of future development scenarios for a reasonable timeframe (say 20 years). Considering only existing planning or development scenarios cannot generally account for this future growth;
- cumulative assessment of decisions relating to mitigation works and measures, future development and environmental consequences on a long term strategic basis; and
- accounting for future growth in the numbers of occupants in the floodplain. Such growth increases the pressure on response and recovery agencies should an emergency occur.

Incorporating future land use elements of management plans into Environmental Planning Instruments (EPIs) and development control plans and policies will facilitate effective management of the floodplain.

Case-by-case decision making cannot account for the cumulative impacts on flood behaviour and risks, caused by individual developments or works. This form of ad hoc assessment contravenes the principles of the manual.

PLATE 2 - Nyngan, 1990
(Continuing Flood Risk - Floodplain Risk Management Measures Overwhelmed)

2. THE FLOODPLAIN RISK MANAGEMENT PROCESS

2.1 Introduction

The formulation and implementation of floodplain risk management plans is the cornerstone of the policy. Management plans can eliminate the ad hoc decision making which has contributed to many present day flooding problems.

As with other local planning processes, management plan formulation and implementation is generally a council responsibility. However, DIPNR has an expanded role in regional planning and in specific rural areas, as indicated in Section 3.2. To avoid confusion, Section 2 has been written assuming that council is the responsible authority. The process is identical where this role is performed by DIPNR.

The manual has been prepared to assist councils in formulating management plans through the floodplain risk management process, as depicted in Figure 2.1. This process is directly linked to council's strategic planning process as council needs to examine the merit (including impacts on personal safety and property damage) of different types and extents of development in the various flood prone areas. Formulation of strategic plans provides for proper and full consideration of the complete range of land use and management options and their interaction with flood risk.

Broad community involvement in the plan preparation, from the beginning, should produce the best prospect for community acceptance of, and commitment to, the resulting management plan.

The remainder of Section 2 discusses the steps in the management process with more detailed information provided in the relevant Appendices. Appendix C links together the steps in the management process and the other appendices.

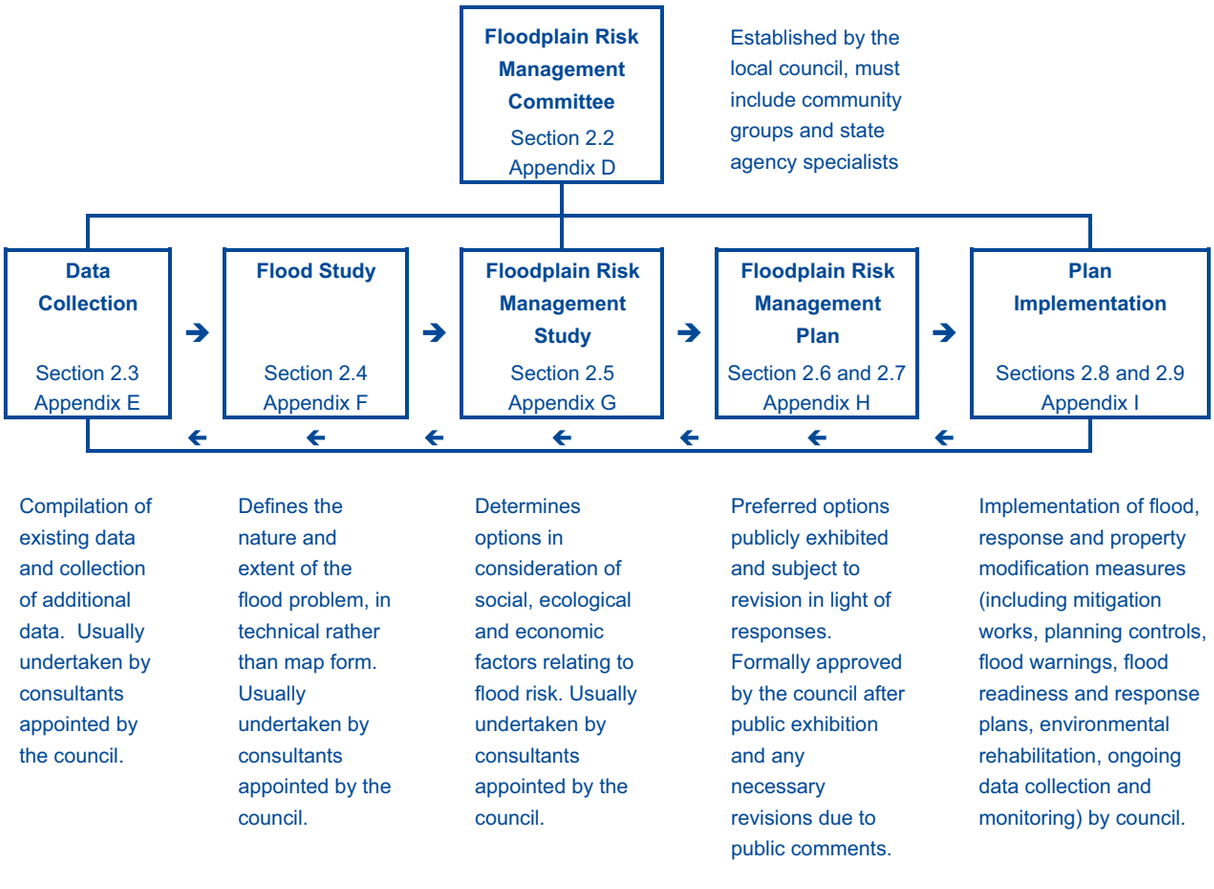

FIGURE 2.1 - The Floodplain Risk Management Process

2.2 Floodplain Risk Management Committee

The first formal step in the process is the formation of a committee chaired by council. It is advisory in nature, as responsibility for planning matters lies with council as a whole. Therefore it should report directly to council or its appropriate executive committee.

Membership of and the role of the committee are discussed in Appendix D. It's principal objective is to assist council in the development and implementation of one or more floodplain risk management plans for it's service area. The committee is both the focus of, and a forum for, the discussion of technical, social, economic and ecological issues and for the distillation of possibly differing viewpoints on these issues.

Local government boundaries rarely follow catchment boundaries, therefore it may be necessary to establish a committee involving a number of adjoining councils. One instance is where floodplain risk management measures in one council area are likely to influence the effectiveness of management measures or flooding behaviour in another council area. The establishment of a committee representing a number of council areas can result in a more holistic appraisal of flooding, social and ecological issues, successful implementation of risk management strategies, and more efficient use of expertise.

Once the committee has completed the prime task of developing the management plan including its implementation strategy, and council has adopted these, it is suggested that a limited group remain to oversee implementation.

2.3 Data Collection

A variety of data are required to assess flood behaviour and the effectiveness, costs and benefits of management measures. It is important to define the data currently available and that needed for the study, to identify information gaps. The management committee should initiate studies, where gaps exist, to collect the social, economic, flooding, ecological, land use, cultural, and emergency management data required in management studies. Where relevant data exists (discussed in Appendix E) this should be collated and referred to in investigations.

Data collection should not be seen as an end in itself, but as input to enable preparation of properly informed studies, management plans and floodplan risk management decisions.

2.4 Flood Study

A flood study is a comprehensive technical investigation of flood behaviour (Appendix F). It defines the nature of flood risk by providing information on the extent, level and velocity of floodwaters and on the distribution of flood flows across various sections of the floodplain (shown in Figure 2.2) for the full range of flood events up to and including the PMF.

Major components of a flood study involve determining discharge (hydrologic aspects) and water levels, velocities, etc (hydraulic aspects) for floods of varying severity.

A variety of analytical tools can be used in flood studies, depending on the data available, the flow situation, the nature and extent of development, and the level of detail required. Detailed studies are generally necessary in both urban and rural areas, because knowledge of flood characteristics is required to deal with existing problems, future development and the continuing flood risk.

The flood study also determines hydraulic and hazard categories within the floodplain for the potential range of floods and land use scenarios in order to consider cumulative affects. The manual recognises three hydraulic categories (floodways, flood storage and flood fringe) and two hazard categories (high and low), as described in Appendix L.

Investigating the full range of flood events up to and including the PMF enables changes in the nature and consequences of flooding to be assessed as flood severity increases. These may include increases in velocity and depth, changes in hazard category, the creation of 'islands' (which may be completely inundated in larger events), and the number of properties inundated etc.

Determining appropriate areas for and types of development generally depend upon flood exposure of the land, as defined by hydraulic and hazard categorisation in consideration of isolation (see Appendix L6).

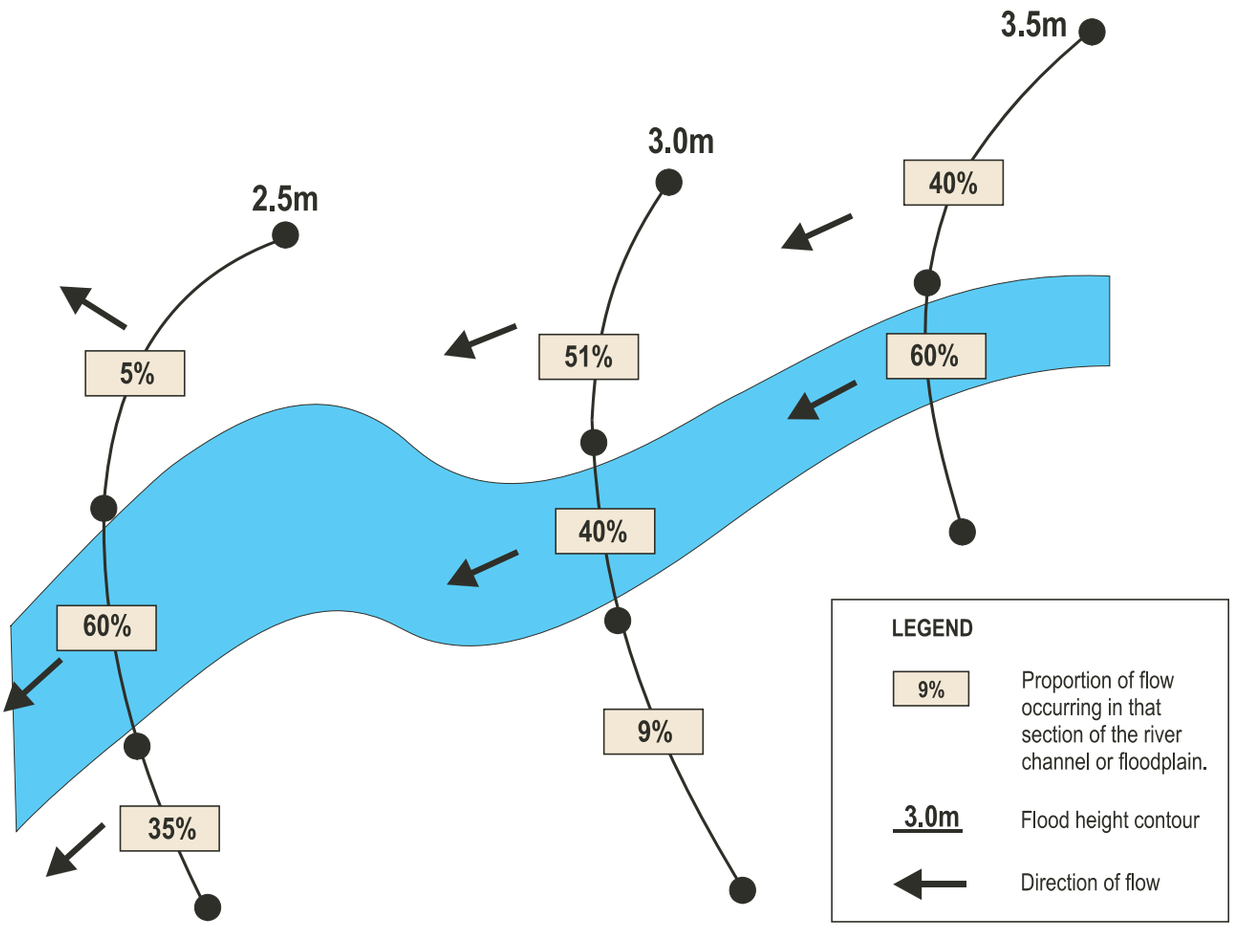

FIGURE 2.2 - Example of Basic Flood Study Information Presentation

This information is also weighed objectively in selecting FPLs (see Appendix K).

Finally, climate change which is postulated to occur due to the enhanced greenhouse effect will affect flood behaviour as sea levels may rise and the pattern of flood producing storms may intensify. The potential impacts need to be considered as discussed in Appendix F.

2.5 Floodplain Risk Management Study

The purpose of a management study is to identify, assess and compare various risk management options and consider opportunities for environmental enhancement as part of mitigation works, as outlined in Appendix G.

The management study draws together the results of the flood study and data collection exercises. It provides information and tools to allow strategic assessment of the impacts of management options for existing, future and continuing flood risk on flood behaviour and hazard and the social, economic, ecological and cultural costs and benefits of options. It also provides the basis for robust decision making in the management plan.

A management plan generally involves a mix of options as it is unusual for a single management option to manage the full range of flood risk. Determining the optimum mix of measures can require complex studies, exercise of professional judgement and extensive community consultation. Typical options considered are indicated in Table 2.1 and should include:

- property modification measures including development controls in new areas, and voluntary purchase and house raising in developed areas;
- response modification measures such as evacuation and associated operational logistics; and
- flood modification measures including levees and bypass channels.

Property Modification Measures	Response Modification Measures	Flood Modification Measures
Zoning	Community Awareness	Flood Control Dams
Voluntary Purchase	Community Readiness	Retarding Basins
Voluntary House Raising	Flood Prediction and Warning	Levees
Building and Development Controls	Local Flood Plans	Bypass Floodways
Flood Proofing Buildings	Evacuation Arrangements	Channel Improvements
Flood Access	Recovery Plans	Flood Gates

TABLE 2.1 - Typical Floodplain Risk Management Measures

The impact of management works or proposed developments on flooding behaviour elsewhere, should be assessed on a cumulative rather than individual or ad hoc basis within the context of the management plan. This includes both the effect of development on flood behaviour and the number of people who may require evacuation, particularly in rare flood events. Where mitigation works are considered, they should be designed to produce nett positive ecological outcomes, where practical and feasible.

Appendices J to M provide additional advice to aid in management study preparation including Appendix L, which provides advice on hydraulic and hazard categorisation and Appendix M, which has advice on flood damage determination. Appendix J provides details on the typical management options available to address the full range of risk, as indicated in Table 2.1.

Appendix K discusses the derivation of FPLs for works and development controls. FPLs can indicate the level of the protection provided by flood or property modification measures. As noted previously, it is generally neither feasible nor socially or economically justifiable to adopt the PMF as the basis for such FPLs. The FPL for residential dwellings would generally be based around the 1% AEP flood event plus an appropriate freeboard (typically 0.5m) unless there are clearly identified benefits from a higher FPL which outweigh the associated costs. The FPL for protection works, such as a levee, may be different due to the economics of the situation, ecological impacts, the physical limitations of the site, community concerns, and the height floods can rise above ground level in the area.

Unless the PMF is used as the basis for any FPL, a larger flood than the one used to determine the FPL, can always occur. It is not a matter of if but when. The difference in flood levels, damages, and the area of inundation and the number of dwellings to be evacuated in the PMF event relative to the event upon which the FPL is based, serves to alert a council to the upper limit of the costs and consequences of flooding.

2.6 Floodplain Risk Management Plan

The purpose of a management plan is to provide input into the strategic and statutory planning roles of councils. It does not, by intent, purport to be the only document relevant to development of flood prone land. The management plan provides the type of information necessary for adequate forward planning for flood prone land.

The advantages to both councils and the community in general of having a properly considered management plan in place include:

- having a proper basis for managing and using flood prone land to provide a balance between danger to personal safety and economic losses due to flooding, and social, ecological and cultural interests. This provides the current and future community best value from managing and using its floodplains;
- optimising use of community infrastructure, such as roads, water supply and sewerage;
- minimising personal danger to residents, visitors and emergency response personnel and community flood damage;
- strategically assessing future developable land so the impacts of its development on flooding and the affects of flooding on the development can be effectively considered. This provides a sound basis for incorporating floodplain

risk management outcomes in revising council's EPIs and development controls. It allows the community to grow in a responsible and socially cohesive fashion in consideration of flood issues. It also provides for increased certainty, from a flood perspective, for development applications in line with the relevant EPI requirements; and

- having a basis for more timely assessment of development applications for flood prone land, especially where council's EPIs and development control plans and/or policies have been altered, in light of the management plan, to incorporate appropriate zonings, and flood related controls. Individual development applications are thus limited to the best way to achieve the required outcomes on individual sites.

Preparation and finalisation of the plan is discussed in Appendix H.

2.7 Review of an Adopted Management Plan

Review of management plans should be triggered by the following instances:

- time, review regularly, around every 5 years;
- after significant flood events which provide additional data on flood behaviour;
- where significant changes occur to the factors influencing the decisions in the plan, including changes to local flood plans;
- where impediments to implementation exist that warrant a review; and
- where changes in future land use trends outside those considered in the management plan are proposed.

This review should account for changes across the full range of issues originally addressed and consider any associated emergent issues.

2.8 Plan Implementation

Once a management plan has been adopted, it needs to be implemented, as discussed in Appendix I.

Certain components can be implemented relatively quickly, such as incorporating flood related development controls into policy and EPIs and flood education including public awareness programs. Others require additional investigations and design, and funding.

It is unlikely that any management plan could be implemented immediately in its entirety. For example, availability of funding will determine when mitigation works can commence. Consequently, an implementation strategy is required to stage components dependent on funding availability and the management plan needs to consider adoption of interim measures. The implementation strategy should be developed during the preparation of the management plan and incorporated in the plan.

2.9 Funding for Management Measures

If a council seeks State Government financial assistance for implementation measures, it is required to provide the following advice which may be derived from the management study, as a minimum:

- methods used to seek public comment and take account of submissions received;
- methods used to formulate a balanced, community acceptable management plan; and
- details of environmental and cultural assessment of mitigation works and safeguards proposed to minimise any adverse impacts and maximise positive ecological opportunities. All proposed works are subject to environmental assessment under the EP&A Act.

3. ROLES & RESPONSIBILITIES

The roles of councils (including other local government authorities ie county councils), State agencies, the Commonwealth Government, the Land and Environment Court, property developers and flood affected individuals in the management of flood prone land are discussed below.

3.1 Councils

Statutory responsibility for land use planning and management under the EP&A Act rest with councils. Councils need to be cognisant of regional planning in local planning.

In specific rural areas, defined under the Water and Water Management Acts, DIPNR has responsibility for development and implementation of floodplain risk management plans and licensing flood control works, as discussed in Section 3.2. Specific areas of responsibility of councils are outlined below.

3.1.1 Preparation of Floodplain Risk Management Plans

Floodplain risk management involves the planning and management of land subject to varying degrees of flood risk. As part of their normal planning responsibilities, councils need to plan and manage flood prone land in accordance with its flood exposure. Preparation of a management plan and associated studies (as described in Section 2) is an important step in this process.

3.1.2 Preparation of Local Environmental Plans

Councils are responsible for the preparation of LEPs under the EP&A Act. These local EPIs are normally required to be consistent with SEPPs, regional planning and strategies, directions made under Section 117(2) of the EP&A Act, and circulars issued from time to time by DIPNR. Directions have encouraged LEPs to be consistent with the principles of the manual.

Councils are encouraged to incorporate appropriate planning provisions of floodplain risk management plans into LEPs, DCPs and development control policies. The EP&A Act requires the public exhibition of draft LEPs, along with explanatory and supporting information.

3.1.3 Local Development Under Part 4 of the EP&A Act

Development types that are “exempt” and “complying” developments are introduced and need to be listed in EPIs. Until Councils develop their own exempt and complying development DCP and amend SEPP60 they are covered by SEPP60.

SEPP 60 lists a number of areas that are to be excluded from its operation. For example, SEPP 60 is excluded from land within 40 metres of a waterway. In addition, SEPP 60 provides councils covered by it, the opportunity to map and exclude areas they believe are unsuitable for these types of development.

It is recommended that councils exclude complying development from areas that require flood related development controls. Councils will need to consider the affect of flooding, among other factors, when preparing their LEPs.

(a) Exempt Development

Exempt development is minor development that will have minimal environmental impact and does not need development consent. It could include fencing, storage areas, sheds, carports, garages, pergolas and repair of existing structures. Careful consideration is needed to ensure that exempt developments do not have a significant environmental impact regarding flooding in the specific areas proposed.

The EPI will incorporate a list of the standard requirements that must be met to ensure that only development that is of minimal environmental impact can be exempt.

(b) Complying Development

Complying development is development that is permissible with consent and can be assessed against preset standards to gain approval. Complying developments depend upon the EPI that applies to the area, but may include dwelling houses and large sheds. Councils need to carefully consider suitable standards to apply to complying development to ensure minimal flood damage to property.

PLATE 3 - Mount Pleasant Street, Maitland, 1955
(20 houses stood in this street before the flood)

The EP&A Act provides for complying development to be excluded from environmentally sensitive areas identified in an EPI. All areas below the FPL for residential development should be considered environmentally sensitive.

(c) Development Requiring Consent

Council LEPs usually specify the development permissible on any area of land and whether council consent is required. Councils, when considering development applications, must have regard to the matters set out in Section 79C of the EP&A Act.

A fundamental principle of floodplain risk management is to assess development applications within the strategic framework of a floodplain risk management plan and not in isolation or individually. The relevant sections of the management plan are to be included in councils LEPs, and flood related DCPs and policy. If a type of development, outside those identified as appropriate in the management plan is approved, as discussed in Appendix I, the management plan should be altered to reflect this change.

3.1.4 Planning Certificates

When property is sold in NSW, the vendor must attach to the contract documents a copy of a planning certificate for the property issued by the local council under Section 149 of the EP&A Act. Schedule 4 of the Environmental Planning and Assessment Regulation (EPAR), 2000 lists the prescribed matters to be included in certificates. Councils should seek their own independent legal advice on the information they include, however, the following recommendations are made:

- in relation to item (12) in Schedule 4 of the EPAR, councils should only provide information under section 149(2) in relation to land subject to flood related development controls (land at or below an FPL for development control) where such controls are imposed by policies adopted by council in accordance with statutory requirements under the Local Government Act 1993;
- councils should not include such policies or extracts thereof in planning certificates. Copies of these policies should be available to potential purchasers and/or their solicitors upon request from council;
- for land above the FPL, councils may consider including “notes” on flood risk in planning certificates, which must be clearly distinguished from information relating to prescribed matters. Advice on possible wording is included in Appendix I;
- councils could also indicate, under section 149(5), that land above the FPL may be subject to flooding, (see Appendix I); and
- planning certificates are not, and therefore should not be used as, a general community education tool. Emergency response considerations are inappropriate matters for inclusion on planning certificates.

It is important that flood related information on planning certificates is clear and unambiguous. Care is needed to ensure that information provided is not interpreted by the general public to mean the land is flood free when in fact it is only free of development constraints. This is a common misunderstanding of the threat of rare flooding.

Planning certificates, whilst also satisfying their primary statutory requirements can, if used as indicated in Appendix I, be a supplementary means of informing prospective purchasers of the nature and extent of the flood risk for a property.

Under section 149(6) of the Act councils are provided with an indemnity from liability in respect of advice provided in good faith under section 149(5) (refer Section 3.8).

3.1.5 Asset Management

Councils are generally responsible for the investigation, design, construction and maintenance of flood mitigation works. The Commonwealth and State Governments provide financial assistance for some of these activities under programs administered by DIPNR.

Floodplain risk management measures, whether structural or otherwise, constitute a valuable community asset. As such, these measures need to be effectively managed and maintained to ensure that they will perform as required on those rare occasions they are needed.

Thus, as an essential part of ongoing floodplain risk management, each council needs to put in place a formal asset management program for management measures. This not only applies to structural mitigation works but is equally applicable to planning measures, local flood plans, and the biophysical environment in which public involvement, education and co-operation are essential.

3.1.6 Flood Education

In an attempt to reduce the social disruption and damage caused by floods, councils should promote flood readiness in their community. There are two separate target audiences for education.

The first is those residents who are not normally affected by floods. They require education targeted at preparing and reacting in rare events.

The second target audience is those people on the floodplain who are normally affected by floods. The thrust of this education campaign needs to consider the need to act differently (and more quickly) in rare floods compared to the more frequent floods they suffer from time to time.

Councils, in conjunction with the SES, should promote community flood readiness by supplying flood data and advice. Councils should focus on issues relating to land use, supplying data and advice to property owners, residents, visitors, potential purchasers and investors, whereas the SES focuses on the issues of public safety and property protection when flooding occurs. This information should be provided regularly due to resident turnover. The key is to promote a realisation of the extent and impacts of floods of different recurrence intervals.

Flood education, and appropriate tools for achieving this, are discussed in Section J3.

PLATE 4 - Inverell, 1991
(Evacuation during an event)

3.1.7 Emergency Response and Public Infrastructure

Council is a representative on the local emergency management committee, and has a role in the preparation of the local flood plan under the guidance of the SES and supporting SES with resources during flood emergencies in accordance with the plan. This role also requires council and SES to identify critical public infrastructure for:

- protection during the flood (for example, sewage and water supply facilities) and ready return to operation in the flood's aftermath; and
- use during the flood, for example, evacuation centres and associated key access routes.

This greatly facilitates flood response, clean up and recovery operations. Appendix N discusses emergency response planning for floods and the role of the community, councils, the SES and other agencies.

3.1.8 Post Flood Data Collection and Reviews

Councils should undertake post flood appraisals (to collect data on flood impacts (including flood damages refer Section M4), to assist future investigations into flood behaviour and to assist with review of local flood plans.

Reviews into flood behaviour are common after a major flood event. For example, reviews were completed following floods in Nyngan 1990, Coffs Harbour 1996 and Wollongong 1998.

PLATE 5 – Lismore 1974
(Clean up of debris)

3.2 State Government

In broad terms the State's role is:

- support of policy through legislation, as required;
- definition of broad policy objectives, such as this manual;
- provision of specialised technical advice;
- provision of financial assistance through a subsidised program of floodplain risk management works and measures; and
- provision of emergency management including recovery.

The prime responsibility for local planning and land management, including floodplain risk management, rests with councils. A floodplain risk management plan requires the integration of engineering, science, planning, and emergency management factors. This is a complex process requiring input of specialised technical knowledge and assistance provided by State agencies.

The principal agencies in the floodplain risk management process are addressed below.

3.2.1 Department of Infrastructure, Planning and Natural Resources

DIPNR has specific roles in both floodplain risk management and land use planning, as discussed separately below.

The role of DIPNR in floodplain risk management varies across the State. In urban areas and rural areas not designated under Part VIII of the Water Act or under the regulations of the Water Management Act, DIPNR is the State agency responsible for providing specialist technical advice and information on flooding to councils and their flood risk management committees. Specifically, DIPNR:

- employs professional engineers and scientists specialising in flood and environmental matters;
- collects and maintains flood data including heights, velocities and discharges;
- assists councils with the preparation of management plans and implementation of mitigation measures;
- advises and assists councils on evaluation of significant development proposals; and
- administers programs of financial assistance for studies and mitigation measures.

The role of DIPNR in floodplain risk management is fundamentally different in rural areas designated under Part VIII of the Water Act or under the regulations of the Water Management Act. In these areas DIPNR has prime responsibility for floodplain risk management and uses its statutory powers under these Acts in a similar manner to councils who have responsibility for land use planning under the EP&A Act. This involves DIPNR in approving controlled works (earthworks, embankments or levees) which can affect distribution of flood waters using licensing powers under these Acts. This results in DIPNR:

- having responsibility for preparation of management plans, including the background investigations and studies with extensive community involvement, that are strategic and consistent with stakeholder requirements and natural resource policies. These are statutory plans under these Acts and form the basis of assessing approval; and
- acting as an determining authority under Part 5 of the EP&A Act for approvals under the Water Act or the Water Management Act for controlled works including:

- assessment and approval of controlled work;
- issue and renewal of licenses for certain controlled work; and
- objections and appeals processes to ensure the protection of the interests of all landholders and other stakeholder groups.

PLATE 6 - Rural Flooding
Confluence Niemur River & Murrain Yarrein Creek

DIPNR also has a lead role in land use planning. This involves:

- leading the development of regional strategies and plans. DIPNR has responsibility for considering flood risk and development impacts in preparing regional strategies and plans. Technical advice would be sought from State Agencies and relevant local councils would be consulted. Decisions made at State Government level would consider the outcomes of floodplain risk management investigations and associated consultation;

  Councils retain ongoing responsibility for management of flood risk in accordance with the Flood Prone Land Policy in areas covered by regional strategies and plans; and
- dealing with the planning, policy and regulation of our natural and built environment, rural and urban management, including urban growth, renewal and consolidation. DIPNR is responsible for administering the EP&A Act.

From time to time SEPPS, regional strategies or plans, or S117 directions may be released which may have implications for the planning and management of flood prone land. DIPNR also issues rulings and explanatory information about EPIs and S117 directions to councils.

3.2.2 State Emergency Service

The State Emergency Service Act 1989 states that the SES is to act as the combat agency for dealing with floods (including the establishment of flood warning systems) and to coordinate the evacuation and welfare of affected communities.

This combat agency role has been recognised in the State Disaster Plan developed in accordance with the State Emergency and Rescue Management Act 1989. It places a responsibility on the SES to lead the development and maintenance of local flood plans for flood affected communities across the State. These plans address preparation for, response to, and initial recovery from, the effects of flooding. The responsibilities of the SES with regard to flooding matters are described in detail in Appendix N.

3.2.3 Other Relevant Agencies

Other relevant agencies in the floodplain risk management process are:

- the Department of Community Services provides welfare and relief services in the aftermath of a flood;
- the Department of Environment and Conservation (DEC) provides specialist environmental advice on water quality and flora and fauna conservation, particularly threatened species and Aboriginal heritage;
- Department of Primary Industries (DPI) provide specialist ecological advice on fish, particularly threatened species, and other riverine and estuarine fish and their habitats; and
- The Office for Emergency Services coordinates natural disaster mitigation program funding from the Commonwealth for the State Emergency Management Committee.

3.3 Commonwealth Government

The Commonwealth Government's role in floodplain risk management is limited to the immediate financial relief of natural flood disasters, provision of financial assistance for floodplain management investigations and mitigation measures, and flood forecasting and warning system development.

The Bureau of Meteorology provides flood forecasting in non-flash flooding catchments. These forecasts are essential to the SES in providing warnings to local communities and conducting flood response operations.

3.4 Other State Agencies

State agencies concerned with use, development and management of flood prone land must:

- comply with the provisions of the Flood Prone Land Policy;
- comply with State, regional and local EPIs;
- comply with DCPs, local floodplain risk management policies and floodplain risk management plans and liaise with councils accordingly;
- adhere to other relevant government policies; and
- comply with all relevant legislation.

They must also take into account the principles of sound floodplain risk management, which includes consideration of:

- the nature and extent of flooding across the whole range of floods;
- the impact of the proposed use or development on flood behaviour;
- the cumulative impacts of development;
- the social, economic and ecological impacts of the proposed development; and
- the impact that flooding may have on the proposed use or development and on any existing development in the vicinity.

State agencies are also to have regard for the need:

- to avoid causing any increase in the threat to personal safety and to property;
- to avoid any unwarranted increase in the potential for damage to public property and services;
- to protect and enhance the river and floodplain environment, including threatened species and ecological communities, in accordance with relevant State policies, legislation and EPIs; and
- to ensure that, where necessary, government services can be available during floods and that appropriate government developments and infrastructure can be used for flood emergency purposes.

In addition to liaison with councils, the advice of the DIPNR should be sought with respect to flood behaviour and planning, the SES with respect to flood response and readiness procedures, and DEC and DPI regarding threatened species.

The principles and guidelines described in this manual should be used in decision making by all government authorities in relation to flood prone land.

3.5 The Courts

The Land and Environment Court determines disputes between councils, objectors and applicants over development applications. In these matters the court will generally be presented with specialist technical evidence through expert witnesses.

Appeals in respect to matters relating to Part VIII of the Water Act or the regulations under the Water Management Act are in certain circumstances dealt with by the Land and Environment Court.

Claims from the victims of floods based on duty of care considerations should be dealt with in the Local, District or Supreme Court. As in the Land and Environment Court, the Supreme Court may hear specialist expert witness advice.

3.6 Developers

Councils determine developments under the EP&A Act. To assist councils in setting development conditions they should require developers of flood prone land to provide ground level information over the proposed development site. This information should be obtained by a certified surveyor and be used to assist in the determination of the site's vulnerability to flooding.

Where a development type is proposed that is outside those identified as appropriate in the EPI or management plan, a developer must have a detailed study undertaken, by suitably qualified consultants, to determine the impact of the proposed development. This study needs to address a broad range of issues to the same depth as the existing management plan and associated studies. Cumulative impact must be addressed at the global rather than development specific level. The study will form the basis for review, by council and the floodplain risk management committee, to determine whether the management plan can be altered to accommodate the proposal without affecting it's integrity.

The proponent should seek advice from council on the scope and detail of issues to be addressed in the study. If there are potentially significant adverse impacts, the development proposal must specify mitigation measures that will reduce the adverse impacts to acceptable levels. Any mitigation measures will require environmental approval and be subject to approval by consent authorities. Council should be satisfied that it is acceptable to alter the management plan to include this proposal for it to proceed.

It should be noted that a private or site specific flood plan (see Section N7) for the proposed development is not an appropriate measure to rectify adverse impacts or to manage the consequences of inappropriate decisions.

Where determined by council, developers may be required to contribute to the costs of management measures arising from the effects of their development.

3.7 Flood Affected Individuals

In existing flood affected areas floodplain risk management measures should be undertaken to reduce the flood risk, where ecologically and economically viable. However, in some areas, it will not be possible to undertake such works. In such areas it is important that individuals recognise the extent of the flood risk and be aware of evacuation routes and procedures in the event of major flooding. Councils and the SES should be approached for advice in this regard.

It is essential that management plans make specific allowance for regular education programs designed at creating community readiness for the risks associated with flooding. A wide range of educational measures are available as discussed in Appendices J and N. Their suitability needs to be assessed in management plan development.

In areas where flood or property modification measures (examples in Table 2.1) are undertaken, individuals should be made aware that these measures do not entirely eliminate flood risk, and that problems can arise when floods greater than the flood used to derive the FPL for measures or development control occur. This is particularly important in areas where flood and property modification measures do not exclude very large floods and where floodways can develop, levees can be overtopped, water levels can rise quickly, or evacuation routes are cut.

All of these issues should be addressed in the local flood plan for the area. These plans should make flood affected individuals aware of the flood threat, the existing flood warning and evacuation systems, and appropriate actions to take when warnings are issued. This information is freely available from the SES and council. The general community, including flood prone and flood free individuals, should inform themselves of flooding matters in their area and keep up to date with appropriate action in the event of a flood.

3.8 Legal Responsibility and Indemnities

Section 733 of the Local Government Act, 1993 (LG Act) states:

(1) A council does not incur any liability in respect of:

(a) any advice furnished in good faith by the council relating to the likelihood of any land being flooded or the nature or extent of any such flooding; or

(b) anything done or omitted to be done in good faith by the council in so far as it relates to the likelihood of land being flooded or the nature or extent of any such flooding.

This indemnity is also extended, in Section (3) of the Act without limiting sections 1(a) and 1(b), to: making an EPI or DCP, granting,

conditioning and refusal of development consent, determining complying development certificate applications, advice in section 149 certificates, and carrying out flood mitigation works. The indemnity applies not only to councils, but also to council employees and statutory authorities representing the Crown and their employees.

Most relevantly, S733(4) and (5) relate to this manual, once it is notified, as follows:

(4) Without limiting any other circumstances in which a council may have acted in good faith, a council is, unless the contrary is proved, taken to have acted in good faith for the purposes of this section if the advice was furnished, or the thing was done or omitted to be done, substantially in accordance with the principles contained in the relevant manual most recently notified under subsection (5) at that time.

(5) For the purposes of this section, the Minister for Planning may, from time to time, give notification in the Gazette of the publication of:

(a) a manual relating to the management of flood liable land; or

(b) a manual relating to the management of the coastline.

The notification must specify where and when copies of the manual may be inspected.

It should be recognised that the indemnity offered by Section 733 is limited. For example, if a Council fails to make a real attempt to perform a task relating to the likelihood of any land being flooded, then the indemnity is not available (see *Mid Density v Rockdale Council* (1993) 44 FCR 290 and *Attrill v Richmond River Shire Council* (1995) 38 NSWLR 545). It should also be noted that mere adherence to this manual, without proper use of relevant statutory powers, could potentially void this statutory indemnity.

3.9 Changes in Policy, Legislation and Case Law

Considering the changing climate in floodplain risk and natural resource management and land use planning this manual will be subject to a 5 year review, as is the case for a number of major government initiatives.

During this period it is essential that councils be alert to changes in legislation, policy and legal precedent that impact on the application of this manual. As such, councils should ensure that any action taken pursuant to the manual accords with the legislation applying at the time the action is undertaken.

4. GLOSSARY

acid sulfate soils

are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.

annual exceedance probability (AEP)

the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. Eg, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger events occurring in any one year (see ARI).

Australian Height Datum (AHD)

a common national surface level datum approximately corresponding to mean sea level.

average annual damage (AAD)

depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time. Refer Appendix M.

average recurrence interval (ARI)

the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.

caravan and moveable home parks

caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.

catchment

the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

consent authority

the council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the council, however legislation or an EPI may specify a Minister or public authority (other than a council), or the Director General of DIPNR, as having the function to determine an application.

development

is defined in Part 4 of the EP&A Act

infill development: 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

new development: refers to development of a completely different nature to that associated with the former land use. Eg, the urban subdivision of an area previously used

for rural purposes. New developments involve re-zoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.

redevelopment: refers to rebuilding in an area. Eg, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either re-zoning or major extensions to urban services.

disaster plan (DISPLAN) — a step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.

discharge — the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

ESD — using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act, 1993. The use of sustainability and sustainable in this manual relate to ESD.

effective warning time — the time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

emergency management — 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.

flash flooding — flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.

flood — 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 (refer Section C6) before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

flood awareness — Awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.

flood education — flood education 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.
flood fringe areas	the remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	is synonymous with flood prone land (ie) land susceptible to flooding by the PMF event. Note that the term flood liable land covers the whole floodplain, not just that part below the FPL (see flood planning area).
flood mitigation standard	the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	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.
floodplain risk management plan	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.
flood plan (local)	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 SES.
flood planning area	the area of land below the FPL and thus subject to flood related development controls. The concept of flood planning area generally supersedes the “flood liable land” concept in the 1986 Manual.
flood planning levels (FPLs)	are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the “standard flood event” in the 1986 manual.
flood proofing	a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
flood readiness	Readiness is an ability to react within the effective warning time.
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.

flood storage areas — those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.

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 — provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. (See Section K5). Freeboard is included in the flood planning level.

habitable room — in a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.

in an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

hazard — a source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in Appendix L.

hydraulics — term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.

hydrograph — a graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.

hydrology — term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

local overland flooding — inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.

local drainage

smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.

mainstream flooding

inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.

major drainage

councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purposes of this manual major drainage involves:

- the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or
- water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or
- major overland flowpaths through developed areas outside of defined drainage reserves; and/or
- the potential to affect a number of buildings along the major flow path.

mathematical/computer models

the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.

merit approach

the merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains.

The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local flood risk management policy and EPIs.

minor, moderate and major flooding

both the SES and the BoM use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:

minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.

	moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered. major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	measures that modify either the flood, the property or the response to flooding. Examples are provided in Table 2.1 with further discussion in Appendix J.
peak discharge	the maximum discharge occurring during a flood event.
probable maximum flood	the PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
probable maximum precipitation	the PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	a statistical measure of the expected chance of flooding (see AEP).
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.
runoff	the amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to water level (both measured with reference to a specified datum).
stage hydrograph	a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	a plan prepared by a registered surveyor.
water surface profile	a graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	the horizontal distance in the direction of wind over which wind waves are generated.

APPENDICES CONTENTS – DETAILED LISTINGS

APPENDIX A BACKGROUND TO FLOODPLAIN RISK MANAGEMENT IN NSW

A1 Introduction

This appendix provides a short background on flood risk in New South Wales and its management.

A2 Flood Risk in NSW

Rainfall and flooding in New South Wales is sporadic with relatively insignificant seasonal effects. Thus, in the context of this manual, flooding may be considered as a random phenomenon. In essence, floods of any AEP can occur at virtually any time throughout any year and on any river. Table A1 documents key historic floods in some of the state's key catchments, shown in Figure A1.

Flood causing storm events vary significantly across the State from:

- thunderstorms, affecting the smaller creeks and urban catchments, resulting in flood events rising in minutes to hours with a similar duration; to
- "east coast lows" affecting coastal rivers resulting in floods rising in hours and lasting hours or days; to
- southward moving tropical systems or broad cloud bands for north to northwest resulting in inland flooding rising over days or weeks and lasting weeks.

Flooding may also be influenced by coastal effects, see Section C7.

The magnitude of floods can vary from small, relatively common discharges up to the extremely rare probable maximum discharge. The 'probability of flooding' is a measure both of the frequency and relative magnitude of flood size.

A2.1 Annual Exceedance Probability

When floods do sporadically occur they vary greatly in likelihood of occurrence, as measured by Annual Exceedance Probability (AEP). The AEP of a particular flood discharge at a particular point in a particular catchment is the probability that the discharge will be equalled or exceeded in any one year. Typically, AEP's are quoted in terms of percentages, for example, a flood with a 10% AEP has a 10% or one-in-ten chance of occurring in any year.

One advantage of AEP as a measure of the likelihood of flooding is that it is consistent between catchments. Thus, the 5% AEP flood on a catchment of 100 km² extent has the same likelihood of occurrence as the 5% AEP event on a catchment of only 1 km² extent, even though the magnitude and consequences of flood discharges of the two catchments will be very different. AEP's can be estimated by several methods. They are briefly described in Appendix F and in more detail in the current edition of Australian Rainfall and Runoff.

Key flood risk management events include the 1% AEP or 100 year ARI event and the probable maximum flood (PMF), as discussed below. More than one significant event at a location in a short time period is statistically possible and has occurred. This is discussed in Section K3.

A2.2 the 1% AEP Event

The 1% AEP flood is a statistical event occurring on average once every 100 years, ie, there is a 1% chance of a flood of this size or greater occurring in any given year. The 1% AEP flood event is generally used to limit flood exposure and damage to standard residential development (see Section G6 and Appendix K).

A2.3 the Probable Maximum Flood

The probable maximum precipitation (PMP) is the largest rainfall and the PMF the largest corresponding flood that could physically occur at the location of interest. Storm events with rainfall of the order of the PMP, although extremely rare, do occur. An example was the 1984 storm at Dapto that approached this intensity.

The PMF is an extremely rare event and no AEP can be meaningfully attached to it. Nevertheless, to allow, for example, a computable flood damage estimate, the PMF event is generally given an AEP of between 0.01% and 0.0001%, an ARI of between 10,000 and 100,000 years. In certain circumstances an extreme flood may be used in place of the PMF.

The PMF or extreme event provides an upper limit of flooding and associated consequences for the problem being investigated. It is used for emergency response planning purposes to address the safety of people.

A3 Cost of Occupying NSW's Floodplains

The great majority of the State's towns and cities are located on inland and coastal floodplains, because of our early reliance on maritime or riverine transport. These towns are subject to flooding and measures are needed to protect their future livelihood. Floodplains are also the commercial, social and environmental arteries of the State. Transport and communication infrastructure are often located in floodplains which, as generally the more fertile areas, are a base for a significant proportion of the State's agricultural business.

Regular flooding enhances agricultural productivity by increasing soil moisture, recharging groundwater and depositing fertile silt across the floodplain. However, flooding can also interfere with production, communication and agricultural practices, destroying high value crops. Therefore development and management of floodplains needs to consider a broad range of issues including balancing the benefits of occupation of the floodplain against the costs.

Floods in New South Wales cause considerable damage and community disruption. The following examples indicate damages escalated to December 2004 dollar terms. In 1955, a severe flood in the Hunter Valley took 14 lives, totally destroyed 160 homes, inundated some 5,000 houses and caused damage estimated at $700 million. In April 1990, a serious flood on the Bogan River overtopped levees protecting the town of Nyngan, inundating 720 houses and causing $65 million in damage.

More recently, intense rainfall over Coffs Harbour in November 1996 caused in excess of $40 million damage to 350 residences, the CBD and surrounding agricultural areas. Areas of Wollongong also suffered significant flooding in August 1998 resulting in $100 million in damage to 1000 residences, public property and infrastructure.

The average annual cost of tangible (financial) flood damage in New South Wales is estimated to be more than $150 million per year, which is broken down as follows:

- Urban: Local Overland $16 million
- Urban: Mainstream $84 million
- Rural: Farms $34 million
- Rural: Public Infrastructure $16 million

Source: 'Floodplain Management in Australia', Australian Water Resources Council (AWRC), Water Management Services, Report No. 21, 1992. Figures adjusted to December 2004 terms.

It is important to recognise that these figures are annual average damages. They do not reflect the potential scale of variation per annum or per event, as highlighted by events such as Maitland, Wollongong, Nyngan and Coffs Harbour.

Recent work by the Bureau of Transport Economics estimates the average annual flood damage in New South Wales for the period of 1960 to 1999 at around $138 million per annum (2004 dollar terms), noting that these figures only consider disasters resulting in damage in excess of $10 million. New South Wales has over 40% of national flood damage with flooding nationally producing the most damage of any disaster type.

Trends to increase the density of development on the floodplains will, without careful management of flood risk through appropriate land use planning, also lead to increased flood damage exposure.

In addition, climate change trends towards higher ocean levels and an increase in storm severity with more intense rainfall are likely to increase the prevalence and severity of flooding and associated damage.

Quite apart from tangible damage, floods also impose high levels of intangible damage, in the form of increased levels of stress on affected communities and associated medical problems. Although difficult to meaningfully quantify in monetary terms, intangible damages are a real and often long-lasting cost of flooding. Appendix M describes tangible and intangible flood damages in some detail.

A4 Historical Evolution of Floodplain Risk Management in NSW

Since 1955, floodplain risk management measures in NSW have progressed through

three phases. These phases respectively addressed the existing flood risk in isolation (mitigation only), the existing and future flood risks together (mitigation and development control), and finally, the combination of existing, future and continuing flood risks (strategic management).

A4.1 Mitigation Only

In the aftermath of the 1955 flood on the Hunter River, the NSW Government established a statewide program for the construction of structural mitigation works aimed at reducing the existing flood risk.

Despite the expenditure of many millions of dollars by local, State and Commonwealth Governments to address existing flood risk, the cost of restoration, relief and assistance following floods continued to grow.

A4.2 Mitigation and Development Control

A formal NSW Government review in the mid seventies clearly demonstrated that this increase in costs was associated with development of flood prone areas being approved with little or no consideration of flood risk, rather than because of any failure of the structural works.

In response to the review the NSW Government introduced stringent planning controls over the most flood prone land to curb inappropriate development. The concept of floodplain risk management was thus expanded to address both existing and future flood risk.

A4.3 Strategic Management

Whilst the uniform planning control approach was successful in curbing growing losses, it also seriously, and in some instances quite inappropriately, constrained the use of large tracts of flood prone land. This was because the blanket nature of the controls could not account for the wide range in flood risk between locations within individual floodplains and across the State. As a result, by the early eighties, public objection to stringent planning controls over flood prone land reached untenable levels. The NSW Government responded through the introduction of a merit based flood policy in 1984.

The merit approach was restricted in its initial application to addressing existing and future flood risk. However, it became increasingly apparent that, notwithstanding attempts to protect existing properties at risk and action to control the growth in future flood damage, a continuing flood risk exists in most flood prone areas. This continuing risk is derived from floods larger than those which protection works are designed for, or land use planning controls are based, clear examples include floods in Nyngan 1990, Coffs Harbour 1996, and Wollongong 1998.

In recognition of the significance of this continuing flood risk, local flood plans are prepared under the guidance of the SES to address flood readiness, response and recovery from an emergency management viewpoint. They are now a common and necessary component of responsible, strategic floodplain risk management.

A5 Improvement on Previous Manuals

Since the release of the 1986 Floodplain Development Manual successive governments have introduced revisions to effect a series of improvements whilst maintaining the fundamental merit approach and the associated and essential community consultation, inherent in the original manual. This has involved the development of both the 2001 Floodplain Management Manual and this manual.

The 2001 manual embodied substantial revision of the 1986 manual and incorporated:

- the results of a detailed public review of floodplain risk management issues in NSW;
- significant improvements to policy and practice introduced by successive governments; and
- increased emphasis on the integrated and strategic management of floodplains, both urban and rural.

Specific changes and new areas incorporated since the 1986 edition include:

- an emphasis on the importance of developing floodplain risk management plans that address existing, future and continuing flood risk for flood prone land on a strategic rather than an ad hoc or individual proposal basis;

- an emphasis on the need to incorporate the relevant portions of management plans into councils EPIs;
- more explicit recognition that floods rarer than those used for design of mitigation works and control of development will occur and need to be considered in managing flood risk. Therefore the full range of flood sizes, up to and including the PMF, need to be assessed with particular an emphasis on danger to personal safety and critical infrastructure rather than property protection;
- recognition of the need for local flood plans that address readiness, response and recovery;
- recognition of the importance of house raising as a floodplain risk management measure in existing developed areas;
- recognition that private or site specific flood plans written for individual developments and separate from the overall floodplain risk management plan or local flood plan are ineffectual and should not form the basis of development consent (see Section N7);
- the addition of rural flooding in the management process through Part VIII of the Water Act or under the regulations of the Water Management Act as discussed in Section C5;
- the inclusion of local overland flooding as discussed in Section C6;
- strategic consideration of flood risk related development policies within the framework of the floodplain risk management plan rather than on an ad-hoc basis at the development consent stage. This enables the effective consideration of cumulative impacts and long term strategic planning;
- providing the basis for councils amending EPIs and planning controls with respect to new types of development activity in flood prone land outside those identified as appropriate in the existing management plan;
- an emphasis on maintaining and enhancing the riverine and floodplain environments, including consideration of the needs of threatened species, populations and ecological communities, as part of flood modification measures;
- an emphasis on considering acid sulfate soils and their associated problems;
- incorporation of the principles of ESD when managing risks associated with human occupation of the floodplain;
- an increased emphasis on catchment considerations through links to the local catchment management board (CMB) ;
- consideration of Aboriginal and European cultural significance on the floodplain; and
- recognition of the potential implications of climate change on flood behaviour.

This manual also involves significant changes to the 2001 manual due to changed agency roles and to clarify, in light of experience with the 2001 Manual, the intent of the Manual particularly with respect to the determination of FPLs and the consideration of rare floods up to the PMF. This will reduce the potential for inconsistent interpretation by consent authorities.

PLATE 7 - River Gums in Flood

A6 International and Australian Practice

This section discusses international relative to Australian management practice.

A6.1 The United States of America

The 1% AEP standard is used widely in the National Flood Insurance Program in the United States of America. The special flood hazard areas are within the 100 year average recurrence interval flood boundary, or inundated to a depth of more than 1 foot (approximately 0.3 metres) in the 1% flood.

However there is concern that the 1% AEP standard, which was established as a minimum standard, has been interpreted by many as the level above which one does not need to worry about flooding. Historically, approximately one third of claims paid under the National Flood Insurance Program are for flood damage in areas above the 1% AEP flood level. More flood damage is sustained by property outside the area covered by the 1% AEP flood than is sustained inside the 1% AEP flood area.

The 500 year (0.2% AEP) flood level is also used as a flood standard. It is the general practice for critical or high hazard facilities to be protected from or located above from the 0.2% AEP flood. Critical facilities are those properties that, if flooded, would result in severe consequences to public health and safety. Critical facilities in a town might include fire, ambulance and police stations, hospitals and nursing homes, schools, water and electricity supply installations, interstate highways, the bus station and chemical plants.

A6.2 The Netherlands

In the south-west of the Netherlands, the delta plan has been implemented with the aim of guaranteeing protection against the North Sea storm event which has an estimated 1 in 10,000 chance of occurring each year.

For most of the river dykes along rivers such as the Rhine and the Ijssel, the accepted design event is the 1 in 1250 event. Along the Meuse, where flooding has been a lesser problem, measures are being taken to reduce the average chance of water damage in towns to 1 in 250 per year.

A6.3 Australian Practice

Until 20 or 30 years ago the biggest recorded flood in a valley was the most commonly used for the basis of the FPL. The community accepted that anything below that level could expect to be flooded at some time in the foreseeable future, and anything higher than the flood-of-record was quite unlikely to be flooded.

The Australian Capital Territory, in the early 1970's, adopted the 1% AEP flood for derivation of the FPL. A major factor in this decision was the loss of seven (7) lives during the 1971 Woden Valley flood, which had an AEP of about 1%.

In the mid-1970's, the AWRC proposed the adoption of the 1% AEP event as an appropriate standard for Australia. This preference was based on its widespread use in the United States of America. Also, a series of major floods with 1% and 2% AEP's occurred in Australia during the early and mid-1970's and caused considerable devastation. The 1% AEP flood event was therefore seen as being indicative of a big flood with potentially disastrous consequences. Moreover, this flood was likely to be experienced at least once in a lifetime (Table K1). In this context, Table A1 indicates that significant floods are not particularly rare in NSW. Figure A1 indicates some of the major river systems in NSW.

Over the last 25 years it has become more common to adopt the 1% AEP flood to derive an FPL, particularly for residential development in urban areas, in communities all around Australia, as states have updated their floodplain risk management procedures.

The problem with adopting a standard level of risk, such as that embodied in the 1% AEP flood, is that it has tended to preclude investigation of risk levels that may be more critical to the community particularly in relation to evacuation and recovery strategies. It also led to minimal consideration or planning for larger floods, having provided the same false sense of security that the 1% AEP flood event is the limit of flooding.

Since the release of the NSW Flood Prone Land Policy in December 1984 councils have been responsible for determining appropriate FPLs for their flood prone land. Whilst councils are encouraged to consider a full range of floods up to and including the PMF when determining FPLs it is expected that the FPL for residential development will generally be based upon a 1% AEP flood event. FPLs are considered on the basis of social, economic, cultural and environmental factors, as well as flooding considerations.

The benefits from assessing the full range of floods up to the PMF is principally derived from a much greater understanding of continuing risk and the management measures needed to deal with it. As part of this, it provides key information on controls and consequences for emergency response and recovery planning, to input into local flood planning.

FIGURE A1 - The Location of Some of the Major River Systems in NSW

RIVER SYSTEM	YEARS										
Adelong/Tarcutta Cks	1984	1983									
Bega	1971	1934	1919	1898	1873	1870					
Bellinger	1974	1954	1950	1946	1876	1875	1870				
Berkeley Vale	1981	1978									
Billabong Creek	1984	1974	1956	1952	1931	1891					
Bogan	1992	1990	1976	1955	1950	1928	1920	1896	1892	1890	1875
Border Rivers	1996	1988	1983	1976	1956	1921	1890				
Brunswick	1987	1978	1954								
Camden Haven	1995	1980	1974	1963	1956	1929					
Castlereagh	1974	1971	1955	1950	1920						
Clarence	1996	1967	1963	1954	1950	1893	1890	1887			
Coffs Creek	1996	1991	1977	1974							
Cooks	1961	1956	1889								
Darling	1998	1990	1976	1974	1956	1950	1890	1864			
Erina Creek	1990	1989	1988	1978							
Fairy Ck (Wollongong)	1998	1991	1984	1975	1974	1961	1959	1958	1950		
Georges	1988	1986	1956	1950	1949	1914	1898	1873			
Gwydir/ Mehi	1984	1976	1974	1971	1956	1955	1950	1949	1921	1910	
Hastings	1968	1954	1950	1929	1894	1864					
Hawkesbury	1990	1978	1964	1961	1956	1900	1879	1870	1867	1817	1809
Hunter & Patterson	1992	1990	1978	1971	1955	1952	1949	1930	1893	1820	
Lachlan	1998	1993	1990	1976	1974	1961	1956	1952	1951	1916	1891
Lake Macquarie	1990	1981	1964								
Macintyre	1996	1991	1983	1976	1956	1921	1890				
Macleay	1963	1950	1949	1921	1893	1875	1864				
Macquarie	1990	1986	1971	1964	1956	1955	1952	1950	1941	1926	1890
Macquarie Rivulet	1998	1991	1984	1975	1959	1930					
Manning	1990	1978	1930	1929	1895	1875	1866				
Moruya	1975	1925	1914	1898	1870						
Mullet Creek	1984	1978	1975	1961	1955	1950	1930				
Murray	1993	1992	1981	1980	1978	1975	1974	1956	1931	1917	1870
Murrumbidgee	1993	1974	1956	1952	1931	1925	1905	1894	1891	1870	1852
Nambucca	1974	1963	1954	1950	1890						
Namoi	1990	1984	1976	1974	1971	1964	1955	1920	1910	1900	1864
Narara Creek	1992	1989	1988	1985							
Parramatta	1988	1986									
Peel	1984	1962	1955	1910	1864						
Prospect Creek	1988	1986	1956								
Richmond	1989	1974	1962	1956	1954	1945	1893				
Shoalhaven	1990	1988	1978	1925	1916	1873	1870	1860			
South & Eastern Cks	1988	1986	1956								
Tweed	1989	1974	1956	1954	1931						
Warrego/Paroo	1997	1990									
Northern Wollongong	1998	1991	1988	1985	1978	1975	1974				
Woronora	1956	1950	1949	1933							
Wyong	1964	1949	1930	1927							

TABLE A1 - Years in Which Significant Floods Occurred

APPENDIX B RISK MANAGEMENT

B1 Introduction

Floodplain risk management involves balancing the relative costs and benefits of using the floodplain. By applying risk management techniques to an appropriate detailed understanding of the full range of flood behaviour in the location, robust long term management decisions regarding the floodplain can be made with some confidence.

Governor Macquarie recognised the costs and benefits of using the floodplain when, in 1810, for each settler with a farm on the frequently flooded Hawkesbury River flats, he assigned an additional allotment for a dwelling house on relatively high ground in one of the townships.

The correct application of risk management principles is critical to the success of the floodplain risk management process. This approach looks at how often floods will occur, the consequences of floods, the vulnerability of the community and its resilience to recover from flood events (refer Figure B1).

It then seeks answers through management measures such as:

- risk reduction; or
- benefit increase to match the risk; or
- reducing the consequences of flooding.

This appendix provides a general introduction to the risk management approach and its application to the floodplain risk management process. It is not a comprehensive guide to risk management and AS/NZS 4360:2004 Risk Management provides a detailed guide for following a risk management process.

B2 Terminology

Risk the chance of something happening that will have an impact. It is measured in terms of likelihood and consequences.

Risk exposure arises from the possibility of economic, financial or social loss or gain, physical damage or injury or delay.

Risk analysis is a systematic process of identifying risks, estimating their likelihood and evaluating potential consequences.

Risk consequences are the impacts from the event occurring.

Risk likelihood is the probability of an event occurring.

Risk management is the set of activities concerned with identifying potential risks, analysing their consequences and devising and implementing responses. This involves management of risks associated with natural and built assets and agricultural uses on the floodplain. In the floodplain context this is done so as to ensure optimal use of the floodplain (considering economic, social, environmental and cultural impacts) whilst controlling flood losses to an acceptable level.

B3 A Risk Management Model

A risk management model involves four interrelated activities:

- Establishing the context of how risk management will be applied to flooding. The floodplain risk management process shown in Figure 2.1 and discussed in Section 2 provides this context.
- Risk identification involves identifying the flood risk to be managed (mainstream

Resilience	Will the community be able to recover ?
Vulnerab**I**lity	How prepared is the community ?
Con**S**equences	What will happen ?
li**K**elihood	How often might the event occur ?

FIGURE B1 - The Risk Management Questions

and/or local overland flooding) and the study area requiring investigation. This is discussed in Section F2.

- Risk analysis is the part of risk management which addresses questions such as "What might go wrong ?", as discussed in Section B4.
- Risk management or treatment looks at the answers to that question, and seeks to resolve the issue, "What should be done about the problem ?" Section B5 discusses this further.

The risks involved in floodplain risk management arise because of limited knowledge, experience or information about the future. This may be partly because past events have not been acknowledged or the lessons of those events forgotten.

The risk management approach is aimed at providing a structured way of identifying and analysing potential risks, and devising and implementing responses appropriate to their impact. These responses generally draw on strategies of:

- risk prevention;
- risk (reduction) mitigation;
- risk transfer; or
- risk acceptance.

Within a single project or proposal each of these strategies may have application for different individual risks.

Risk management processes are designed to assist planners and managers to systematically identify and analyse risks and develop measures to address them and their consequences. The aim is to produce more reliable planning, greater certainty about financial and management outcomes and improved decision making.

The New South Wales floodplain risk management process, set out in Section 2, is a particular example of risk management and is in accordance with the guidelines set out in AS/NZS 4360:2004.

B4 Risk Analysis

There are many risk management issues that are relevant in the preparation of floodplain risk management plans and local flood plans. This appendix presents some of the issues (not a comprehensive list) in question form.

Floodplain risk management has an impact on many different users of the floodplain including:

- residents of and visitors to the floodplain;
- investors and businesses in the floodplain;
- those who depend on the businesses in the floodplain to provide a service or for employment;
- the environment, including native species and ecological communities; and
- those who simply wish to cross the floodplain.

Background studies should provide an estimate of community flood readiness by asking the following questions:

- What is the recent flood history ?
- How many of the residents have experienced a flood ?
- Is there an effective warning system ?
- Is there an effective plan for responding to the flood event ?
- Is there an effective educational program ?

The floodplain risk management study raises the following questions:

- What use of the floodplain is considered desirable ?
- What are the costs of various floodplain risk management measures ?
- What are the benefits from various floodplain risk management options ?
- Will the community support the proposed floodplain risk management measures ?

The risk analysis for existing or proposed uses of the floodplain will include questions such as:

- When will that part of the floodplain be used ?
- Will the site to be used during floods ?
- What inconvenience during floods will the users accept ?
- What risk will the owners or operators accept ?
- Is there an alternative use for this site that is more compatible with the flood risk ?

- Is there an alternative site that is as convenient for users when there is no flood, but is less vulnerable to the effects of flooding ? (ie, that may be more flood risk compatible for this particular land use)
- What limitations and conditions might be applied to the development ?
- What is the chance of a flood larger than that used to derive the FPL occurring ?
- What are the consequences of a flood larger than that used to derive the FPL occurring in relation to both safety of people and property damage ?
- What are the consequences of overbank flow from the creek through the riverside park ?
- What are the consequences of a levee overtopping ?
- What are the consequences of floodwaters entering a residential subdivision ?
- What are the consequences of floodwaters entering a commercial or industrial area, or farmland ?
- What are the consequences of floodwaters cutting roads, or water, sewerage, electricity and telephone services ?
- What is the effectiveness of warning message distribution ?
- How well will warning messages be understood ?
- Will effective action result from the warning messages ?

These questions are relevant for better risk management of existing development in the floodplain and when development of part of the floodplain is being considered. This is not a complete list. The risk analyst will need to ask other questions relevant to the particular floodplain.

Flood events with less chance of occurring in a year than the flood event used to derive the FPL will eventually happen. When they happen the consequences can be very diverse in different floodplains. The different consequences of major floods are illustrated in Figure B2 with some important considerations being depth of flooding, an ability to provide effective flood warnings and evacuation difficulties.

B5 Risk Assessment and Treatment

Risk analysis examines both likelihood and the consequences of an event. It should be followed by:

- an assessment of the consequences**:** *Are they acceptable?*
- and treatment**:** *How can the consequences be mitigated?*

As an example, the consequences of dams overtopping when the design flood is exceeded is generally recognised, and upgrading of dams is carried out to limit losses to more acceptable levels. Application of similar considerations to the floodplain is part of floodplain risk management.

The direct cost of flood damage to a small number of commercial or industrial premises may exceed the direct cost of flood damage to a large number of residential properties. But the commercial and industrial operations may be better able to recover their costs and return to business as usual. The social cost of flooding of residential areas may be orders of magnitude greater than the social cost of floods through a shopping centre or an industrial estate.

B6 Conclusion

Floodplain risk management is an application of risk management principles. Effective floodplain risk management recognises that floodplains are a valuable natural resource and that their management requires a balance of the costs against the benefits of using the floodplain.

Some communities may decide to accept a greater flood risk, because there are significant benefits from occupying the floodplain. Other communities may see little advantage in remaining at risk to flooding and accept the cost and benefits of management measures including mitigation works.

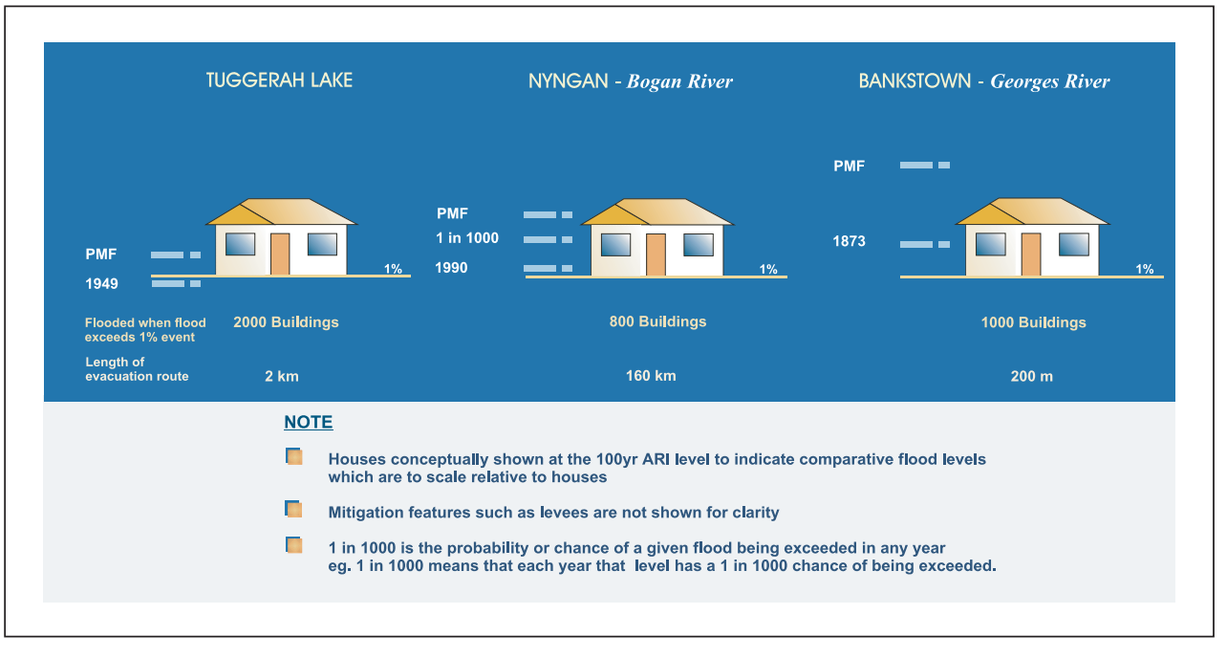

FIGURE B2 - The Varying Consequences of a Large Flood

APPENDIX C FLOODPLAIN RISK MANAGEMENT PROCESS

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C					
Floodplain Risk Management Committee →	Data Collection →	Flood Study Preparation →	Floodplain Risk Management Study Preparation →	Floodplain Risk Management Plan Preparation →	Floodplain Risk Management Plan Implementation
Appendix D	Appendix E	Appendix F	Appendix G	Appendix H	Appendix I

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)								
Floodplain Risk Management Measures		Flood Planning Levels		Hydraulic & Hazard Categorisation		Flood Damages		Emergency Response Planning for Floods
Appendix J		Appendix K		Appendix L		Appendix M		Appendix N

C1 Introduction

This appendix outlines the application of the floodplain risk management process (see Figure 2.1). The process aims to meet the objectives of the NSW Government's Flood Prone Land Policy (outlined in Section 1.1) through the preparation of floodplain risk management plans.

C2 Where Does the Process Apply

The manual applies to urban and rural floodplains across NSW and is used to manage both mainstream (riverine) and local overland flooding. As the 1986 manual was traditionally applied to mainstream flooding in urban areas Sections C5 and C6 provide more details on the respective application to both rural and local overland flooding issues. It also applies to coastal flooding, discussed in Section C7, but does not cover tsunamis, as discussed in Section C8.

C3 Management Process Objectives

The objectives of the floodplain risk management process are to:

- reduce the danger to safety and flood damage (and associated losses) to property and infrastructure in the existing community;
- manage the risk to critical infrastructure, during and after a flood event to ensure it is available in a suitable form as and when required;
- ensure future development is controlled in a manner compatible with the flood risk and associated danger to personal safety;
- manage the flood risk to future infrastructure to reduce potential damages;
- protect and where possible enhance the river and floodplain environment and be consistent with the objectives of relevant State Government policies;
- satisfy the objectives and requirements of the EP&A Act;
- ensure the management plan is fully integrated with the local flood plan, catchment management planning, and council's existing corporate, business and strategic plans and existing and proposed EPIs. It also needs to meet council's obligations under the LG Act;
- ensure that the management plan has the support of the local community;
- ensure actions arising out of the management plan meet with ESD principles, are socially sustainable, economic, and maximise positive and minimise negative impacts;
- establish a program for implementing the management plan that should include a funding mechanism, priorities, staging, responsibilities, constraints and monitoring;

- write or update a local flood risk management policy for the study area through the various stages of the process to control development during preparation of the management plan and associated background studies (discussed in Section C9); and
- consider how best to incorporate management plan findings into council's EPIs, development control plans and policies.

The management plan preparation process, described below and in subsequent appendices aims to achieve these objectives.

C4 Floodplain Risk Management Plan Preparation Process

The preparation of the management plan involves a number of stages:

- the floodplain risk management committee (discussed in Section 2.2 and Appendix D) is responsible for overseeing the process;
- data collection (see Section 2.3 and Appendix E) determines the historical and background data available to be collected and used in studies;
- the flood study (discussed in Section 2.4 and Appendix F) determines flood behaviour in the study area;
- the floodplain risk management study (see Section 2.5 and Appendix G) is the major multi-disciplinary task. It involves assessment of all management options and provides all the major inputs to the management plan. It includes:
  - floodplain risk management options (see Appendix J);
  - hydraulic and hazard categorisation (see Appendix L);
  - flood damages assessment (see Appendix M);
  - consideration of limits on, and conditions for, future development (see Sections G6 and J2)
  - FPLs, including flood events and freeboard to base these on (see Appendix K);
  - information provision on planning certificates under Section 149 of the EP&A Act (see Appendix I);
- the floodplain risk management plan. This is the decision making part and formulation of the process (Section 2.6 and Appendix H); and
- implementation of the management plan as discussed in Section 2.8 and Appendix I. This includes the local flood risk management policy, approvals for recommended works, incorporation of planning controls into EPIs and development control plans and policies.

C5 Rural Flooding

This manual and its predecessors deal with floods causing danger to life and damage to property as a result of occupation of the floodplain. In the 1986 manual, application and usage tended to focus on urban floodplain areas where a higher proportion of the population lives, where development pressures are greatest, and where local councils control development.

Since 2001 the manual has also been applicable to rural areas where, although councils are also responsible for land use planning and management, additional mechanisms are often needed for floodplain risk management. For example, in areas designated under Part VIII of the Water Act or under the regulations of the Water Management Act approval from DIPNR may be required for certain works. The roles of councils and DIPNR in this regard are discussed in Sections 3.1 and 3.2.

The essential difference between urban and rural areas is the final use of the management plan. Management plans prepared by councils for urban or local areas provide a basis for consideration of development constraints in relation to flooding into their EPIs.

However, DIPNR prepare and use management plans for rural areas designated under Part VIII of the Water Act or under the regulations of the Water Management Act to ensure development of the floodplain provides for flow of floodwaters within paths identified in the plan. Therefore the management plan is used to control development which is likely to affect flood flowpaths in the area covered by the plan.

As with flooding in urban areas, there is a suite of available management, planning and mitigation options that can be selected to address flood problems in rural areas. Apart from typical residential issues, such as the

chance of damage to farmhouses and buildings and rural residential development, the whole question of impact of flooding on agricultural activity needs to be considered. This often involves special problems associated with scale, for example:

- the area of land under investigation;
- the complexity of flood behaviour;
- impacts of protection works for valuable crops on flood behaviour;
- the period of inundation;
- the uncertainties associated with flood related data; and
- the environmental values associated with flood dependant ecosystems on rural floodplains.

This indicates the need for a different emphasis and possibly different risk management measures in rural areas, rather than the need for a separate management process.

C6 Local Overland Flooding

Local overland flooding problems were included in the policy and manual in 2001 as the distinction between mainstream and local overland flooding was found to be artificial for several reasons:

- it matters little to flooded residents whether the floodwaters flowing through their property originate from a local catchment or from a river overflowing its banks;
- whilst the magnitude of local overland flood damage in New South Wales is less than that of mainstream flood damage, it is still substantial. The average annual mainstream flood damage in urban areas of New South Wales is $84 million per annum, whilst the corresponding figure for local overland flood damage is $16 million per year. In deriving these figures, it was acknowledged that local overland flood damages could be substantially under-estimated (AWRC, 1992);
- mainstream and local overland flooding behaviour interact, with flooded mainstream channels often impeding local overland drainage and so contributing to local overland flooding; and
- it is often impossible to define a meaningful boundary between local overland and mainstream flooding.

Therefore, this manual treats local overland flooding as a significant problem that needs to be considered along with mainstream flooding.

Local overland flows can be generated from a variety of sources. At the lower end of the scale these would typically include direct surface runoff, surcharges and overflows from low points in kerbs, or overflows from smaller pipes. These can be categorised as local drainage as discussed in Section C6.2. At the upper end of the scale overland flows involve the floodplains of original watercourses whether still natural or altered (piped, channelised, diverted or restricted due by urban development) and/or may be associated with overflows from trunk drainage systems. These can be categorised as major drainage as discussed in Section C6.1.

The definition in the manual of major and local drainage problems relate to the scale of problems occurring throughout urban areas. It is not to be interpreted as the classifications of major and minor drainage system design under Australian Rainfall and Runoff, which is restricted to new urban areas developed over the last two decades. The principles in the manual apply to all overland flow associated with major drainage.

Whilst the manual does not specifically deal with local drainage, councils should consider the principles in the manual when addressing these problems.

C6.1 Major Drainage

Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. However, in terms of this manual, major drainage problems will typically involve:

- the floodplains of original watercourses or trunk drainage systems (which may now be piped or channelised or diverted), or sloping areas where overland flows occur along alternative paths once system capacity is exceeded; and/or
- water depths generally in excess of 0.3m (in the storm event used to derive FPLs). These conditions may result in danger to

personal safety and damage to property (both premises and vehicles); and/or

- major overland flowpaths through developed areas outside of defined drainage reserves; and/or
- the potential to flood a number of buildings along the major flow path.

Good building practice can reduce flood frequency and damages. However, due to the relative depth of flooding, general building controls cannot control all problems.

Problems can be minimised in new development areas by good subdivision design practice. Good practice considers the potential for overflows, due to system capacity exceedance and blockage, and determines how to pass these excessive flows through the subdivision via drainage reserves and public pathways rather than having them enter private property and buildings.

Strategies to address problems will normally be similar to mainstream flooding. Evaluation of local scale changes (increased capacity, altered flowpaths etc) should be considered in the context of the impacts on the entire system so as to identify and evaluate potential adverse impacts.

Particular consideration needs to be given to the impacts of upstream urbanisation on downstream flooding and to any developments which block flow paths. The costs of mitigation works can, in certain cases, be offset by the associated economic and social benefits.

Overland flow paths associated with major drainage problems should be subject to information on Planning Certificates under Section 149 of the EP&A Act as discussed in Section I7 along with the suggestion of an initial subjective assessment for a preliminary determination of affected properties.

C6.2 Local Drainage

Local drainage problems occur randomly throughout urban areas and fall outside the definition of major drainage (Section C6.1).

While outside the scope of the manual, it is important that councils give due recognition to these problems. However, as these problems are not amenable to rigorous analysis, councils are not obliged to convey information on local drainage problems on Planning Certificates under Section 149 of the EP&A Act.

Local drainage problems invariably involve shallow depths (less than 0.3m) with generally little danger to personal safety. These problems generally result from building practice where floor levels are at or near finished ground levels adjacent to the house.

Local drainage problems can generally be minimised by adoption of general urban building controls requiring a minimum difference between finished floor and finished ground levels (to cope with shallow water depths) and adequate site drainage. Areas without these controls may have damage potential but the level of damages is generally relatively small. Therefore, councils cannot justify the cost of remedial measures for these problems in relation to the benefits in economic cost alone.

Whilst not amenable to rigorous evaluation, it is important that local drainage problems are recognised and that councils consider:

- the impact of upstream catchment change on downstream areas;
- the need to ensure that any upgrading works consider: the consequence of translating the problem from one location to another; the potential to alter flowpaths; and the consequences for downstream properties; and
- setting standards for development that address local drainage issues.

Public education is of necessity limited to generalised media warnings of impending storms and possible localised flooding.

C7 Coastal Influences

On inland streams and in the non-tidal reaches of coastal rivers, the size and frequency of a flood at any point depends on the volume and timing of runoff from the catchment. However, in the lower estuarine areas of rivers, flooding is far more complex as it depends not only on rainfall, but also on tides, storm induced increases in the ocean water level or a combination of both. Therefore it is important to consider coastal influences in determining and managing flooding under the floodplain risk management process.

Tailwater induced ocean affects occur when normal tidal behaviour is combined with one

or more of the following to increase the ocean water level:

- a rise in water level due to a drop in barometric pressure (barometric effect);
- strong onshore winds (wind stress);
- wave set-up;
- wave run up;
- longitudinal shelf waves; and
- temperature and salinity variations (steric effects).

Elevated ocean levels can increase flood levels in the lower reaches of rivers, by either preventing floodwaters from discharging into the ocean or by filling up low lying land and estuarine flood storage areas before the river flooding arrives.

Flooding can occur around coastal lakes and lagoons from a possible combination of: elevated ocean levels (as discussed above); entrance constriction by fluvial sedimentation or closure due to normal coastal processes; floodwaters from rivers and streams discharging into the lake or lagoon; and wind generated waves in the lake itself.

The effects of tides on flooding in the estuarine reaches of rivers on flooding in coastal lagoons is discussed in some detail in the NSW Estuary Management Manual 1992.

C8 Tsunamis

Tsunamis occur regularly around the Australian coastline. The 1960 Chile Tsunami, which would appear from studies to be the largest affecting NSW since 1867, resulted in water levels oscillating through the range of 0.84m at Fort Denison and induced strong currents in Sydney Harbour and nearby ports and bays causing some damage to boats and the shoreline.

The management process and measures established in this manual are designed to consider flood risk caused by a combination of storm surge and hydrological and hydraulic processes. They do not extend to the management of tsunamis.

C9 Controlling Development During the Management Process

The most effective way of managing flood risk to future development areas is through incorporation of management plans outcomes into zonings and development controls in EPIs and development control policies and plans in combination with an effective local flood plan for emergency response.

However, it is important for councils to control development during the preparation of management plans and associated background studies. In this regard councils need to:

- undertake development control based upon current knowledge of the flood behaviour and hazard;
- improve knowledge of flood behaviour and hazard through the management process; and
- manage flood risk to future land use strategically considering the full range of flood risk, as this information becomes available.

During the management process, a local flood risk management policy consistent with the principles of the manual (Section I.6) can help councils to control development whilst the management plan is completed.

The content of the policy is likely to vary with the available information. The policy can be updated during the process to reflect the improved knowledge and the higher degree of information available, and incorporate any management decisions made by council during this period.

Advice on the controls that could be considered with different levels of information is provided below. Changes following the completion of the management plan and associated requirements are discussed in Appendix I.

C9.1 Controls Based on Historical Flood Information

Historical flood information gives an incomplete picture of flood risk. The scant information often available does not provide an understanding of the range of potential flood risk, their likely frequency, nor a good understanding of the variation in hazard across the floodplain. Hence exposure to hazard and the cumulative impacts of development decisions would not be fully understood.

Therefore, until a flood study is completed (providing a better understanding of flood

behaviour and hazard) it is important that consideration and implementation of appropriate limits and controls for different scales of development are set. These could include:

- small scale and infill development outside known significant flow areas.

  These may require minimum fill and floor levels based upon known historical flood levels and a freeboard allowance, typically 0.5m for residential development though a higher freeboard may be considered appropriate due to the degree of uncertainty. For infill development minimum fill levels may not be feasible and it may be more appropriate to require minimum floor level and structural certification of below floor components;

- larger scale developments or developments in areas known or expected to have significant flood flows.

  The proponent may be required to submit a flood assessment to determine potential impacts on flood behaviour, set appropriate minimum floor and fill levels. No significant impacts on flood behaviour on other properties should be acceptable. Emergency management should be considered in relation to the local flood plan, with self-sufficient evacuation a requirement; and

- additions and extensions to existing development should be considered in light of the philosophy of merit based decision making and the information available on flood risk.

C9.2 Controls Based on a Flood Study

A flood study generally provides flood levels, indicative flood extents and some information on flow velocities, for a range of flood events.

It provides a more detailed understanding of flood behaviour but does not necessarily detail the variation in hazard across the floodplain, nor consider cumulative impacts. Therefore until the management study is completed appropriate development controls could include:

- small scale and infill development outside known significant flow areas.

  These may require minimum fill and floor levels for all new development. This requires selection of an appropriate design standard and freeboard (typically 1% AEP or key historical flood plus 0.5m) for residential development. For infill development minimum fill levels may not be feasible and it may be more appropriate to require minimum floor level and structural certification of below floor components;

- larger scale developments or developments in areas known for or expected to have significant flood flows.

  It may be appropriate to require the proponent to submit a flood study determining the potential impacts on flood behaviour. No significant impacts upon flood behaviour on other properties should be acceptable. Emergency management should be considered in relation to the local flood plan, with self-sufficient evacuation a requirement; and

- additions and extensions to existing development should be considered in light of the philosophy of merit based decision making and the information available on flood risk.

C9.3 Controls Based on a Floodplain Risk Management Study

A management study should include categorisation of both true hazard (discussed in Appendix L) and an assessment of the cumulative impacts of future development options (discussed in Sections G6 and G9.1).

It provides a basis for recommendations on appropriate land use limits, types and associated controls (discussed in Section G6) considering flood risk. These recommendations would generally be translated into the management plan.

Controls based upon the outcomes of the management study and plan are likely to be the most comprehensive form of flood related development control. Therefore these recommendations should be implemented as soon as possible to ensure that future development is compatible with the variation in flood hazard across the floodplain.

APPENDIX D FLOODPLAIN RISK MANAGEMENT COMMITTEE

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C										
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)								
Floodplain Risk Management Measures		Flood Planning Levels		Hydraulic & Hazard Categorisation		Flood Damages		Emergency Response Planning for Floods
Appendix J		Appendix K		Appendix L		Appendix M		Appendix N

D1 Introduction

The establishment of a floodplain risk management committee by council is the first formal step in the floodplain risk management process. It may be formulated as a new committee or its role may be incorporated within an existing council committee. Council will need to decide on the appropriate approach to ensure the committee is effective for its area.

The management committee acts as both a focus and forum for the discussion of technical, social, economic, environmental and cultural issues and for the distillation of possibly differing viewpoints on these issues into a management plan. It achieves this by ensuring that all stakeholders (often with competing desires) are equally represented. As such, the composition and roles of committee members are matters of key importance.

D2 Need for a Committee

The development of a management plan, for either urban or rural areas must, take into consideration a number of diverse issues which include:

- the risk, danger to personal safety and property damage, imposed on existing land uses (the existing risk);
- the cumulative impact of flooding on potential future land uses and occupants and of development on flooding (the future risk);
- the management of the continuing flood risk remaining in both existing and future development areas after works and controls are implemented;
- the environmental impact of existing and potential future developments and floodplain risk management measures;
- the broad scale catchment issues such as water quality, riverine and floodplain enhancement and land management;
- cumulative impacts as a result of changes in hydrology, floodplain geometry, or other factors;
- the potential economic cost and benefits to both the private and public sectors of floodplain occupation;
- the potential economic benefits of proposed risk management measures;
- potential intangible flood costs, including physical and psychological effects of flooding;
- social factors, including the needs and aspirations of the local community, both existing and in the future;
- planning options and restrictions, including special zonings and planning controls, opportunities; and

- the protection of Aboriginal sites and places and European heritage.

The expertise necessary to address these issues needs to be drawn from a variety of sources, including:

- the local council itself (both elected representatives and council staff);
- the local community;
- key industry groups;
- environmental interest groups;
- State and Commonwealth Government agencies; and
- specialist consultants, as engaged.

The development and implementation of a floodplain risk management plan is solely a local council responsibility in urban situations. The local government role is discussed in Section 3.1. The role of DIPNR in the rural areas in western New South Wales designated under Part VIII of the Water Act is outlined in Section 3.2.

Given the complexity and range of issues to be addressed in the process as outlined above, the committee needs to be able to coordinate and disseminate the interests, advice and expertise available from State and Commonwealth Government agencies and the local community. The committee should also consider the establishment of a specialist technical sub-committee (discussed in Section D6) to deal with complex technical issues, if required.

In certain circumstances it may be necessary to establish a single committee involving adjoining council(s) to effect coordinated planning. This may be appropriate where the floodplain under investigation embraces more than one local government area and where structural, land use or flood response measures in one council area are likely to influence the effectiveness of management measures or flood behaviour in other council areas. Consideration should also be given to the relationship with adjoining councils, and if necessary, the establishment of an overall committee to address the flooding problems on a catchment wide basis.

D3 Role of the Committee

The management committee does not have any formal powers. Rather, it has an advisory role, but an important one. The principal objective of the committee is to assist the council in the development and implementation of a management plan for the area(s) under its jurisdiction. However, the committee also assists in:

- formulating objectives (in accordance with ESD principles), strategies and outcomes sought from the process (see Section C3);
- providing a link between the local community and council;
- identifying the flood problem to be assessed and the study area (see Section F2);
- considering and making recommendations to council on appropriate development controls for use until the management plan is completed, approved and implemented (see Section C9);
- supervising the collection of necessary data (Appendix E) and supervising and monitoring the progress and findings of studies being undertaken in the various stages of the management plan;
- providing input into known flood behaviour as part of the flood study;
- identifying management options and providing input into their consideration as part of the management study;
- identifying implementation strategies for the management plan;
- monitoring and assessing the effectiveness of the management plan during and after its implementation;
- coordinating and monitoring the public education programs essential to the long term viability of the management plan; and
- coordination with catchment management boards, emergency management planning and other advisory bodies.

Once the committee has completed the prime task of developing a management plan and associated implementation strategy, and the council has adopted these, it is suggested that a limited group remain to oversee implementation.

D4 Membership of the Committee

The membership of the committee needs to be a balanced representation of stakeholders such as agencies, groups and/or individuals effecting, affected by or coordinating floodplain risk management. Membership should be flexible to ensure the right mix of interests are represented. Typically, membership would include:

- elected members of council;
- council staff from engineering, planning and environmental disciplines;
- an appropriate number of representatives of the local community (for example, local flood affected landholders (residential and business), relevant industry bodies (eg the chamber of commerce), and environmental groups);
- representatives of relevant industry bodies;
- officers from the DIPNR; and
- representative(s) from the SES.

Officers from other relevant government agencies or departments or catchment management authorities may be co-opted to the committee as and when required.

Because the responsibility for planning matters lies with council, the committee should report either to council or to its appropriate standing committee, which has the final decision making power.

As discussed in Section D2, a single committee on a floodplain shared by a number of council areas may be desirable or necessary.

D5 Role of Committee Members

The primary role and responsibility of the various members on the management committee are described below. This outline does not aim to limit the contributions made by members, but rather attempts to ensure that all important aspects are given due consideration. It should be noted that the committee is tasked with seeking solutions to the existing, future and continuing flood risk issues, not solely on addressing the past.

It is also important to note that State Government agency representatives do not have committee voting rights but provide advice in relation to their departmental functions and their area of expertise.

D5.1 Elected Members of Council

Elected members of council are the leaders of this process and should assess the community, political and policy implications of any actions contemplated with the objective of producing an equitable result for the local government area served.

D5.2 Council Staff

Council staff must include a mix of engineering, strategic and development assessment planning, and environment representatives. They should provide local specialist advice and coordinate:

- input from council, the local community and other committee members;
- the production and presentation of agendas and reports;
- the management of consultants (including preparation of study briefs);
- the management of financial assistance for the project; and
- formulation of draft recommendations to the committee.

The recommended final management plan requires significant input from staff before submission to council.

D5.3 Local Community Representatives

Community representatives play an important role in the success of the committee and every attempt should be made to have representatives who can make the necessary commitment as indicated in Section D8. Local community representatives should:

- form a link between the committee and the local population in the flood prone area. They therefore need to be able to effectively inform the affected community of the deliberations of the committee and so foster a wider understanding of the process;
- provide historical advice on local problems and perceived solutions;
- consider in detail implications of matters which may impact on the local community; and
- facilitate formal representations to the committee on behalf of the public.

D5.4 Local Environmental Group Representatives

Local environmental group representatives should provide a link between environmental groups and the committee and enable adequate local environmental input into committee deliberations.

D5.5 Local Industry Body Representatives

Local industry body representatives should provide a link between the industry body and the committee, where necessary. These may be drawn from the chamber of commerce or other relevant local bodies.

D5.6 The DIPNR Representative

DIPNR provides representation from both a floodplain risk management and land use planning perspective.

From the floodplain risk management perspective DIPNR's representative should provide technical expertise and steering advice to ensure that the management plan is prepared in accordance with the principles of the NSW Government's Flood Prone Land Policy. The representative should also monitor the progress of the studies and plan, particularly as they relate to current and future government funding programs. A key role of the representative is to provide technical advice, to both council staff and the committee, throughout the process.

From a land use planning perspective DIPNR's representative should ensure that the planning approaches considered and adopted in the management plan are consistent with other areas within the region and State. In addition, DIPNR should provide technical advice to the committee on planning issues throughout the process, on the implications of State or regional planning policies and the provisions of the EP&A Act.

DIPNR also provides advice on other natural resources policies, such as the State Rivers and Estuaries Policy and Wetlands Policy, that link with the Flood Prone Land Policy and the Water Management Act.

D5.7 The SES Representative

The SES representative (or controller) should consider the implications of any actions contemplated in regard to risk assessment, flood warning and response plans for the management and evacuation of flood-prone areas, and with regard to the State Emergency Service Act 1989. The SES representative should also provide input from the emergency management viewpoint and ensure that the management plan is developed parallel to and complementary to the local flood plan (prepared under the guidance of the SES).

The SES representative must not be requested to:

- approve private or site specific flood plans or flood emergency response plans prepared for proposed developments (see Section N7); or
- approve incorporation of private or site specific flood plans prepared for proposed developments into the local flood plan.

Private or site specific flood plans or flood emergency response plans (Section N7), written for specific developments and separate from the local flood plan, are ineffectual and should not form the basis of development consent.

Inclusion of specific development proposals in the local flood plan is limited to those assessed and incorporated in the adopted floodplain risk management plan.

D5.8 The Bureau of Meteorology

The Bureau of Meteorology should provide advice with respect to flood forecasting and warning, as appropriate.

D5.9 Representative of Welfare Services

Representatives of welfare services (for example, the Department of Community Services) should provide advice regarding the plans in place to deal with flooding, their consistency with the proposed management plan and in the development of contingency plans for post-flood recovery.

D6 Technical Sub-Committee

The role of this sub-committee of the floodplain risk management committee should be to provide technical assistance to enable the committee to fulfil its advisory role to council efficiently, confident that studies and option

assessments are technically adequate and the options proposed are practical and feasible. The roles of the technical sub-committee may include:

- preliminary development of process and individual study objectives, as outlined in Appendices C through H for further consideration by the full committee;
- collection of background data for studies available to council, DIPNR and SES, as outlined in Appendix E;
- preparation of technical project briefs in consultation with the committee;
- review of proposals from consultants in consultation with the committee;
- review of modelling, management options, reports and presentations for technical adequacy prior to presentation and review by the full committee; and
- advice on any other technical matters upon request by the committee.

The technical sub-committee should have membership from council staff (both engineering and strategic planning) and DIPNR. A representative of SES may also be included when the sub-committee is considering emergency management issues.

D7 Community Consultation

The local community, both flood prone and otherwise, has a key role to play in the development, implementation and success of a management plan. If it is to be accepted and successful, it is essential that clear and concise communications flow between the committee and the community so that affected individuals and community groups can 'have their say' and learn of their roles and responsibilities.

The following format is suggested to establish and maintain communication between the council, committee and the local community.

Council should arrange to:

- involve and inform the community (through media releases, newsletters and public meetings) on a range of issues.

  These include the role and responsibilities of the committee, its intention to instigate a study/studies for preparation of a management plan, the work council is undertaking for the flood study, and progress on the studies and plan.

  Affected residents should also be informed of the length of time until finalisation of the management plan and implementation of management measures, and of the nature of development controls pending management plan completion;
- call for representatives of the general community and action groups to self nominate for the committee, clearly stating the expected role of members at this time;
- use established local community groups, where they exist, and encourage their representation on the committee;
- make one or two contact people known to the community, usually staff members of council, who can be contacted regarding questions relating to floodplain risk management, during the development and implementation of the management plan;
- define clear goals for each study and estimate the time to complete each investigation and when direct community consultation and feedback is proposed;
- release information to the community and members of the committee at regular intervals, rather than waiting until the completion of one of the formal stages of the management plan, or associated formal meetings of the committee;
- consider appropriate development controls for use until the management plan is completed (see Section C9) considering recommendations of the management committee;
- ensure that simple, clear messages are used to explain the situation in uncomplicated language and relate any implications to property owners and potential development applicants when disseminating information;
- formally adopt the management plan at the completion of the preparation and consideration process; and
- consider changes to the local flood risk management policy and council's strategic planning instruments and associated development controls

during the implementation phase, where strategies result in altered flood behaviour.

D8 Commitment of Committee Members

The floodplain risk management process is neither short nor simple, nor is it the singular responsibility of council officers, consultants or government officers to have input to the process.

The management committee must comprise members who are committed to and actively involved in the preparation and implementation of the management plan. It may take 3 to 5 years to develop the plan and the implementation of all recommendations may take much longer.

In view of the length of time involved the turnover of committee members, including both council staff and elected representatives, can be a problem. Whilst little can be done with respect to the potential turnover of council and government officers, the structure of the committee should be decided with consideration of its long term viability and relationship with other committees in operation in the local area. Attempts should be made to co-opt local community members who are enthusiastic, energetic and likely to 'see the distance' to complete the management plan.

D9 Tradeoffs

By necessity, the adopted management plan will be a compromise involving trade-offs. Certain individuals may be disadvantaged, others advantaged, but the community as a whole will be better off.

An important role of the management committee will be to assist in the presentation and resolution of conflicting desires and requirements on the part of various community groups and individuals. Public meetings, often spirited, are an important part of this process.

APPENDIX E DATA COLLECTION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
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TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)								
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E1 Introduction

Data collection along with investigations under the floodplain risk management process provides the basis for robust and informed decision making by the committee and council. It highlights the available background information and associated data gaps that may need to be filled as part of investigations.

Data collection is a key step of the floodplain risk management process, though it is generally undertaken as part of both the flood study and management study, as without appropriate data these studies cannot be effectively completed.

Data collection is not an end in itself. Data is required to enable preparation of properly informed flood studies, management studies and plans.

E2 Initial Considerations

Prior to commencing any studies and data collection the management committee need to consider the:

- overall objectives of the floodplain risk management process, outlined in Section C3;
- known community information sources, concerns or aspirations in relation to floodplain risk management and any associated constraints on potential management measures; and
- the objectives of the step being undertaken, as discussed in Sections F3, G3 and H2.

This knowledge enables the committee to determine the data necessary for studies and associated decision making.

E3 Objectives

The objective of data collection is to clearly define the data currently available and that necessary for studies (see Section E4). Where relevant information exists this should be collated and referenced in investigations. Where information gaps exist, studies should be initiated to collect this, where necessary.

E4 Necessary Data

Data to be collated, or estimated, where relevant should include:

- historic flood and land use data and past reports, flood behaviour in general, major flow paths, peak flood levels, flood damage, flow velocities, rate of rise of flood waters, travel time, the effects on the community of flooding to different heights including road closures, isolation and the need to evacuate, etc;
- rainfall records and projections of future rainfall characteristics;
- topography and the geology of area, including soil types (for example, acid

sulfate soils) and rates of erosion and deposition;

- current floodplain risk management measures, their effectiveness and deficiencies, including environmental disturbance and impacts on water quality;
- current and potential future land use and development trends within the catchment including available land and future demand for different types of development (see Section E5.1);
- information on current flood related zonings and development controls;
- current levels of community and individual flood readiness;
- likely community disruption caused by flooding;
- groundwater and local recharge areas;
- aquatic and terrestrial flora and fauna surveys and habitat information, especially on threatened species, endangered populations and ecological communities (see Section E5.2);
- areas of Aboriginal and historical cultural significance (Section E5.3); and
- Relevant climate change data (see Section E6).

The floodplain risk management committee should establish its objectives in this area, be aware of the need for information and instigate appropriate studies as early as practical to enable consideration of the associated constraints in developing management options.

E5 Complementary Studies and Plans

There is a range of complementary studies (land use, cultural and environmental) that can provide valuable background information for consideration in floodplain risk management decision making.

The associated information may impact on decision making or may highlight additional issues that need consideration or potential opportunities for environmental enhancement. It is important that these issues are considered for compatibility in deriving and assessing floodplain risk management measures.

Land use and social and environmental impacts cannot be considered in isolation as they are highly interactive. The long term balancing of these is the most appropriate optimal solution. Studies and other data may exist and should be collated as part of data collection and be considered and referenced in the management study.

Where this information does not exist and it is seen as central to effective and robust decision making consideration should be given to deriving it in the management study.

Key data gaps can be considered in scoping the management study. These additional investigations may be limited to highlighting the area where potential constraints may exist that need consideration in management options, the relative significance of the issue (will it effect option viability or simply be a design constraint) and the need for, and preliminary scope of, future investigations, if necessary.

Without effective consideration of these potential constraints non-viable options may be recommended or adopted.

E5.1 Land Use Planning Studies

An important consideration in the management study is the desired or likely mix of future land use, future growth areas and associated supply and demand issues, in consideration of regional as well as local factors.

Management studies provide an ideal opportunity to assess the long term future direction of the study area, its exposure to flood hazard, the cumulative impacts of development strategies and associated limits and conditions to manage development.

This is particularly important where land is unzoned, land use planning has not been previously determined, or changes to land use are being considered. Management studies can aid decision making by providing information on:

- the flood hazard on the land;
- cumulative impacts of development on flooding;
- impacts of flooding on potential development; and
- information on appropriate development limits, types, and associated supporting development conditions.

Studies also involve examining flood risk in existing development areas. This may highlight opportunities or issues that need consideration if areas are to be redeveloped.

Council may already have a great deal of relevant land use information to provide the basis for the assessment of the flood risk to both existing and future development. This may include:

- information on existing land uses;
- information on existing zonings which may provide some future direction for development;
- information on existing and past development controls;
- strategic studies for long term development of the study area;
- the long term future demands for land, which may be highlighted by population growth and development trends (residential, commercial and industrial);
- the availability of land to satisfy the associated needs, both within and outside the floodplain. This may include a combination of land currently zoned for the particular use, and other land that council may consider has potential to meet these future needs; and
- the location of existing urban infra-structure services, and any excess capacity therein. For example, excess capacity of infrastructure (water, sewer and roads) serving a flood-prone area may well justify additional risk management measures. The cost of these measures may be offset by the savings in not having to provide additional infrastructure elsewhere.

Use of this information in managing future flood risk is discussed in Section G6.

E5.2 Environmental Studies and Plans

The natural attributes of floodplains are very important to both the NSW economy and the natural environment. Clearing for agriculture, urban development and flood mitigation, drainage and irrigation works has extensively modified the environment of most floodplains.

Depending on the characteristics of the environment where the management study is being undertaken, analysis of the riverine and floodplain environment, including the identification of key habitat areas and the importance of a natural flooding regime to surrounding areas, needs to be considered.

The environmental characteristics of the floodplain needs to be considered in most management studies, especially in areas where there are flood-dependent ecosystems such as freshwater wetlands or river red gum forests, or in areas with acid sulfate soils.

These considerations should ensure compatibility of floodplain management measures to the relevant environmental issues.

There may be a range of relevant data already available that need to be considered in management studies. Native vegetation and water management planning undertaken by CMAs and DIPNR need to be considered through reference to both. Other key data sources are indicated in Sections E5.2.1 to E5.2.5 with other potential sources listed below:

- state of the environment reporting;
- environmental impacts statements for other purposes in the local area;
- flora and fauna studies and information;
- aerial photography and land use maps;
- stormwater management plans;
- estuary management plans; and
- specific environmental investigations.

E5.2.1 Catchment Management Plans or Interim Environmental Objectives

Catchment management plans prepared by CMBs or interim environmental objectives developed through the water reform process provide agreed catchment objectives that need to be considered in assessing management options.

E5.2.2 Stream Processes

Consideration should be given to potential changes resulting from proposed works and their impact on stream processes. Stream straightening, widening and vegetation removal can affect stream processes outside the extent of works.

For example, stream widening and straightening results in increased downstream velocities due

to reduced energy losses through the altered section and associated decreased flow times. This impacts on the downstream stream bed level and bank stability through increased erosion rates. Localised scouring can further affect channel equilibrium. In addition, alteration of the stream grade can initiate the migration of headcuts in an upstream direction. This in turn leads to increased bed and bank instability and extensive upstream erosion and downstream sedimentation.

Preliminary investigations based upon inspection of catchments, similar areas and experience with similar soil and vegetation types may provide a basis for making decisions upon the significance of the issue to a management option in a particular location.

E5.2.3 Environmental Studies

Floodplain environments provide important habitat for a range of flora and fauna species with the importance of the riparian zone being well understood. It provides corridors, refuge, shelter and shade for fauna species and contributes organic matter essential for healthy floodplain ecosystems. Riparian vegetation can also act as a filter and reduce nutrient inputs to water bodies from adjoining agricultural areas.

Traditionally, riparian zone ecosystems have not been well conserved. Extensive clearing for agriculture, subsequent invasion by exotic plant species and fragmentation and isolation of functional stands, have comprised the ecological integrity of floodplain vegetation communities and dependent fauna species.

Floodplain risk management studies should include an assessment of the condition and diversity of riparian vegetation, with particular reference to the likelihood of an area supporting threatened species, populations or ecological communities listed in the Threatened Species Conservation Act 1995 or Fisheries Management Act 1994 (discussed in Section E5.2.4). This is particularly important in areas where flood modification measures are proposed, an assessment of the impact of the proposed measure on ecological communities and aquatic ecosystems should be undertaken.

It is also important to ensure that information collected during environmental studies is used to determine where environmental restoration and enhancement projects may be undertaken, as discussed in Appendix J.

There is a range of government legislation and policies that cover these activities and all should be sourced to ensure comprehensive coverage of this issue.

E5.2.4 Threatened Species

The Threatened Species Conservation Act (TSC Act) provides for the preparation of Recovery Plans and Threat Abatement Plans by DEC. The Fisheries Management Act provides for the preparation of Habitat Protection Plans for threatened fish species. Recovery and habitat protection plans will be prepared for endangered and vulnerable species, populations or ecological communities under these Acts. Similarly, threat abatement plans are prepared for "key threatening processes" listed in the TSC Act. Information about any plans existing or being prepared under the TSC Act relevant to the area covered by the floodplain risk management plan may be obtained from the relevant DEC office.

E5.2.5 Acid Sulfate Soils

Acid sulfate soils have been identified as a significant issue on coastal floodplains. DIPNR has produced risk maps that identify the location of these soils. These soils, if exposed to air, can become extremely acidic due to the oxidation of pyrite materials. The Acid Sulfate Soils Management Advisory Committee has prepared the Acid Sulfate Soils Manual that should guide the development of floodplain risk management plans for these areas. This is especially the case if new flood mitigation works or modification to existing works are proposed that may either physically disturb these soils or result in alteration to the water table level.

Consideration should also be given to modifying operating procedures (particularly during non-flood periods) of flood mitigation structures (especially floodgates) to ameliorate acid discharges from acid sulfate soils.

Coastal councils in the worst acid sulfate soils affected areas have generally developed LEPs that require development consent for acid sulfate soils disturbance, whilst others are still developing or considering development of acid sulfate soils related LEPs.

E5.3 Cultural Studies

Protection of Aboriginal sites and places should be considered as part of any activities or works likely to affect floodplains. Section 90 of the National Parks and Wildlife Act (NP&W Act) makes it an offence to impact known Aboriginal sites and places without the consent of the Director-General of DEC. A known Aboriginal site is one which:

- is listed on the Aboriginal Sites Register of New South Wales;
- is known to the Aboriginal community and not listed on the Aboriginal Sites Register of New South Wales; and/or
- is located during surveys or test excavations prior to work commencing.

An Aboriginal Place is one declared by the Minister for the Environment due to its significance to Aboriginal culture.

Where an area is likely to contain Aboriginal sites, survey work must be undertaken in consultation with the local Aboriginal community to assess the presence and significance of sites and, if present, approval as indicated above is required. Where an impact on Aboriginal sites or places is unavoidable, Aboriginal communities should be asked to indicate their consent to impacts on areas of cultural significance as part of any Section 90 application to the DEC.

Consultation and reference in respect of activities or works likely to affect floodplains should include:

- the Director General of DEC where works are likely to effect known Aboriginal sites and places as defined by the NP&W Act;
- where an area is likely to contain Aboriginal sites, survey work must be undertaken in consultation with the local Aboriginal community to assess the presence and significance of sites and if present approval as indicated above is required; and
- Aboriginal communities should be asked to indicate whether proposed mitigation works impact on areas of cultural significance considering the application of NP&W Act 'Aboriginal place' provisions.

In addition, consideration should be given to the occurrence and likely impact on European heritage items of local, regional, state and national significance. Consultation should be undertaken with the local council, NSW Heritage office or the Australian Heritage Commission in this regard.

E6 Climate Change

The greenhouse effect refers to the inferred gradual warming of the earth and its atmosphere due to the accumulation of certain gases, such as carbon dioxide, in the atmosphere. It is a naturally occurring process, but atmospheric emissions of so called green house gases have accelerated the process giving rise to the enhanced greenhouse effect.

The greenhouse effect has possible implications to flooding behaviour and associated management decisions. Scientists and governments at an international level have accepted that the enhanced greenhouse effect is likely to result in climate change.

Inferred effects of climate change include increases in ocean levels and altered weather patterns which may have a number of possible adverse effects on flooding behaviour:

- increases in sea level (mainly due to thermal expansion) will exacerbate flooding problems in coastal areas, estuaries and along the tidal reaches of coastal draining rivers and creeks.

  Many of the flooding problems in these areas, particularly in intermittently closed lakes and lagoons would be exacerbated by additional build up of berms at ocean entrances bought about by higher ocean levels; and
- altered weather patterns may intensify storms and so increase the severity of the resulting floods. In effect, an increase in storm severities means that what is currently the 1% AEP (100 year ARI) rainfall event will become more frequent, for example, the 1.25% AEP (80 year ARI say) rainfall event due to climate change.

Scientists also predict that the incidence of extreme events would increase under climate change scenarios. This means that there would be more floods and droughts. Therefore, it is important to consider climate change in the:

- flood study (see Section F6), particularly in relation to the potential effects on flood behaviour; and
- management study (see Section G9.8), to consider the potential impacts upon management measures or associated decisions.

Current data on potential greenhouse effects should be discussed with DIPNR officers and reference should be made to www.greenhouse.gov.au, the Australian Greenhouse Office website. This site provides linkages to international projections and work, by CSIRO and the Bureau of Meteorology, amongst others, on projections for Australia.

APPENDIX F FLOOD STUDY PREPARATION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation	
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I	

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)									
Floodplain Risk Management Measures		Flood Planning Levels		Hydraulic & Hazard Categorisation		Flood Damages		Emergency Response Planning for Floods	
Appendix J		Appendix K		Appendix L		Appendix M		Appendix N	

F1 Introduction

A flood study is a comprehensive technical investigation of flood behaviour that defines the variation over time of flood levels, extent and velocity for flood events of various severities, up to and including the PMF. The flood study constitutes the major technical foundation from which a floodplain risk management plan is formulated. The floodplain risk management committee must establish the objectives of the flood study so that the technical information arising from the study is determined with all end-users in mind.

F2 Initial Considerations

Prior to commencing the flood study the management committee must consider the:

- the role of the committee, its members and the technical sub-committee, and necessary community consultation, as outlined in Appendix D;
- overall objectives of the floodplain risk management process, outlined in Section C3; and
- requirements for data collection, outlined in Appendix E.

The study area, or the area in which flood behaviour needs to be assessed in detail, and the catchment area contributing to the study area need to be established. In deciding on the study area, it is critical not to simply focus on the current problem area. This decision should consider:

- both existing and future development areas considering a reasonable future time frame;
- the source of flood problems. Whether riverine or local overland flooding, or both;
- potential downstream impacts from other catchments or coastal influences;
- the additional potential impacts of extreme events, such as possible cross catchment flows; and
- that future management studies and plans to address specific flood problems may be for smaller areas than the original flood study. Management studies may concentrate on specific areas with particular management issues. Therefore a flood study may cover a larger area and may provide the basis for a number of management studies and plans.

The study area is critical, as studies need to be planned. It should be described and justified in the flood study.

These initial considerations enable the committee to determine the objectives of the flood study and to ensure that the study area is sufficient to consider the issues that are relevant to the community.

F3 Objectives

The flood study identifies the hydraulic categories (floodway, flood storage or flood fringe) and hazard categories (high hazard or low hazard) for flood prone land (see Appendix L). In addition, it also identifies aspects of flooding behaviour that require special consideration. For example, if the rate of rise of floodwaters is especially rapid, the level of hazard is increased because of shortened warning and evacuation times. Similarly, the hazard is increased if rising floodwaters create new floodways or islands from which evacuation is difficult or impossible. This is discussed further in Appendix G.

The flood study also provides valuable information for the primary end users of the study, as discussed in Section F8. Primary end users include:

- council staff, for controlling and assessing development (including that occurring during the management process, as discussed in Section C9);
- the SES which use flood intelligence information as part of the preparation of local flood plans. For example, the flood study may determine the time it takes for floodwaters to cut evacuation routes and isolate key facilities; and
- public infrastructure providers, so risk can be considered in future planning and designs or upgrading of existing works.

There are two major components to a flood study:

- the estimation of flood discharges for floods of various severities (hydrologic aspects), including the probable maximum flood; and
- the determination of water levels, velocities and depths of flooding for those floods (hydraulic aspects).

These combine to fulfil the prime objective of a flood study, which is to define the flood behaviour of the watercourse and its associated floodplain.

Another important objective of the flood study is to develop hydrological and hydraulic models, as detailed below, which are appropriate for use in future steps of the project, ie, to model development and management options in future floodplain risk management studies.

F4 Hydrologic Analysis

The discharge of floodwaters past a given point on a river system is measured in volumetric terms (for example, cubic metres per second [m^3/s] or megalitres per day [ML/day]) and varies throughout the course of a flood event. Figure F1 shows a typical discharge hydrograph, or variation of discharge with time, which is characterised by a relatively rapid rate of increase in discharge on the rising limb up to the peak discharge, followed by a slower decline in discharge on the falling limb. Depths and velocities can be determined from either the entire hydrograph or the peak discharge (giving only maximum results). Two techniques, are commonly used to estimate peak flood discharges and hydrographs:

- flood frequency analyses or studies; and
- rainfall runoff routing modelling.

Two approaches are made in undertaking these techniques with choice dependant upon the available data. The first approach involves the use of recorded flood and/or rainfall data near the point of interest and on the upstream catchment. In the absence of any recorded data a second approach using regional methods is adopted.

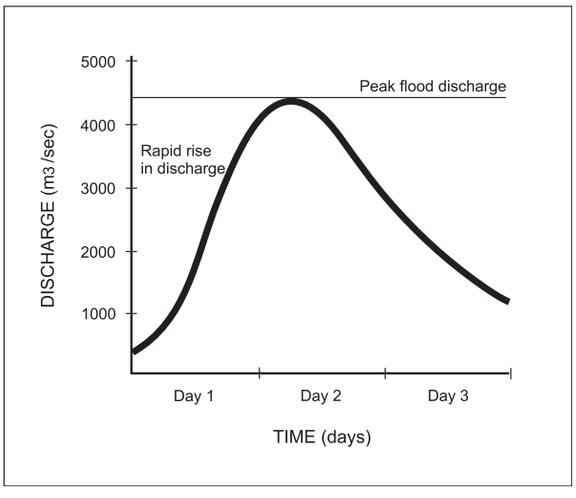


FIGURE F1 - Discharge Hydrograph

More detailed information on hydrologic analysis using both recorded data and regional methods is available in the current version of Australian Rainfall and Runoff.

F4.1 Flood Frequency Studies

A flood frequency study is a means of determining the relationship between peak flood discharge at a location of interest and the likelihood of occurrence of a flood event of that size or greater.

Flood frequency studies are generally based on the annual flood series, which comprise the highest or peak instantaneous rate of discharge at a stream gauging station close to the location of interest in each year of record. In general, creek and river discharges are not measured directly. Rather, discharges are estimated from water levels (using rating curves), which can be measured relatively easily and inexpensively (for example, automatic water level monitors are commonly used these days to record the change in water levels as a flood passes downstream). A rating curve is derived to relate measured water level to estimated discharge. The rating curve is based on actual measurements of discharge (made with a current meter and commonly referred to as a gauging) and on hydraulic analyses.

Due to the relative infrequency of high (flood) flows, most discharge measurements made with a current meter are taken in the low discharge range. Thus, whilst a rating curve may be reliable for low discharges, it usually becomes increasingly unreliable for higher discharges, especially larger flood discharges. Hydraulic analysis is used to extend the rating curve into the range of water levels characteristic of larger floods. This analysis is approximate rather than exact.

As a consequence, discharge estimates obtained from recorded water levels at a gauging station are probably at best only accurate to within only ± 20%, even when made by an experienced hydraulic engineer.

Figure F2 shows the rating curve for the stream gauging station at Kyogle on the Richmond River. Gauged discharges are shown as solid circles. The curve indicates that for a gauge height of 15m, the discharge is some 800m^3/s. Note that the highest gauged discharge is 720 m^3/s, or about 20% of the estimated 1% AEP flood discharge of 3800 m^3/s.

Once a rating curve has been defined, the peak annual flood levels recorded at a stream gauging station can be converted to peak annual discharges and a frequency analysis of the discharges can be undertaken. Figure F3 shows the frequency distribution for the Richmond River at Kyogle. According to this curve, the discharges of the 25% and 1% AEP events are 1300 m^3/s and 3800 m^3/s respectively.

Also shown on Figure F3 are the 95% confidence limits. Based on statistical theory these limits define the range in which the actual frequency curve is expected to lie for a selected level of probability. In this case there is a 95% chance that the actual flood frequency curve lies within the range defined by the confidence limits. The range is narrowest about the mean annual peak discharge (approximately 40% AEP) and increases in width with increasing and decreasing discharge and frequency of occurrence. The implications of this increase in uncertainty in estimates of peak discharges, particularly for the size of events used in a flood study, needs to be considered.

Because of the generally short periods of record at gauging stations (20 to 50 years), there is always a degree of uncertainty in the estimates of peak discharges obtained from a flood frequency study particularly in the medium to large flood range. These uncertainties are a statistical characteristic of the method of flood frequency analysis, and/or the short period of record and are additional to inaccuracies arising from rating curves.

In the absence of recorded peak flood discharge estimates at a stream gauging station close to the point of interest, regional methods of flood frequency analysis are generally followed. A number of regional methods that vary with size of catchment are recommended in Australian Rainfall and Runoff. The uncertainty of design estimates based on regional methods is generally greater than estimates based on recorded flood data and the implications of this uncertainty needs to be assessed in the flood study.

To summarise, flood frequency studies are a relatively rapid means of estimating the peak discharge of flood events with annual exceedance probabilities (AEPs) of interest. Additional studies enable the hydrographs associated with these peak discharges to be estimated. Significant errors can arise through inaccuracies in rating curves and from the use of relatively short periods of record to determine flood discharges in major or extreme events.

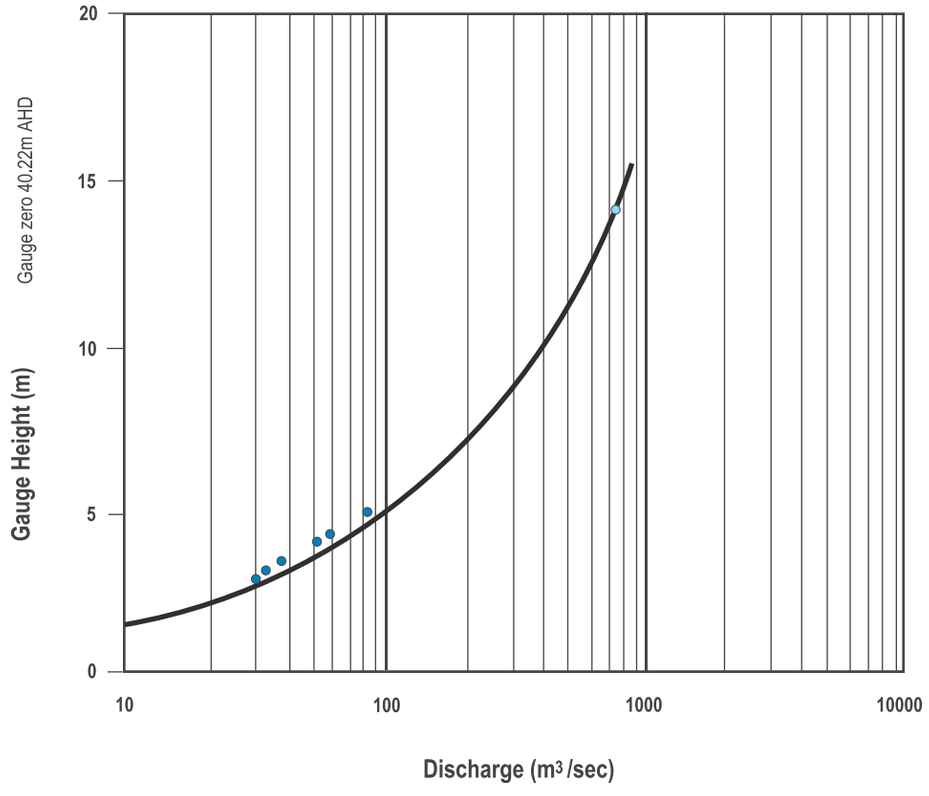


FIGURE F2 Rating Curve for the Richmond River at Kyogle

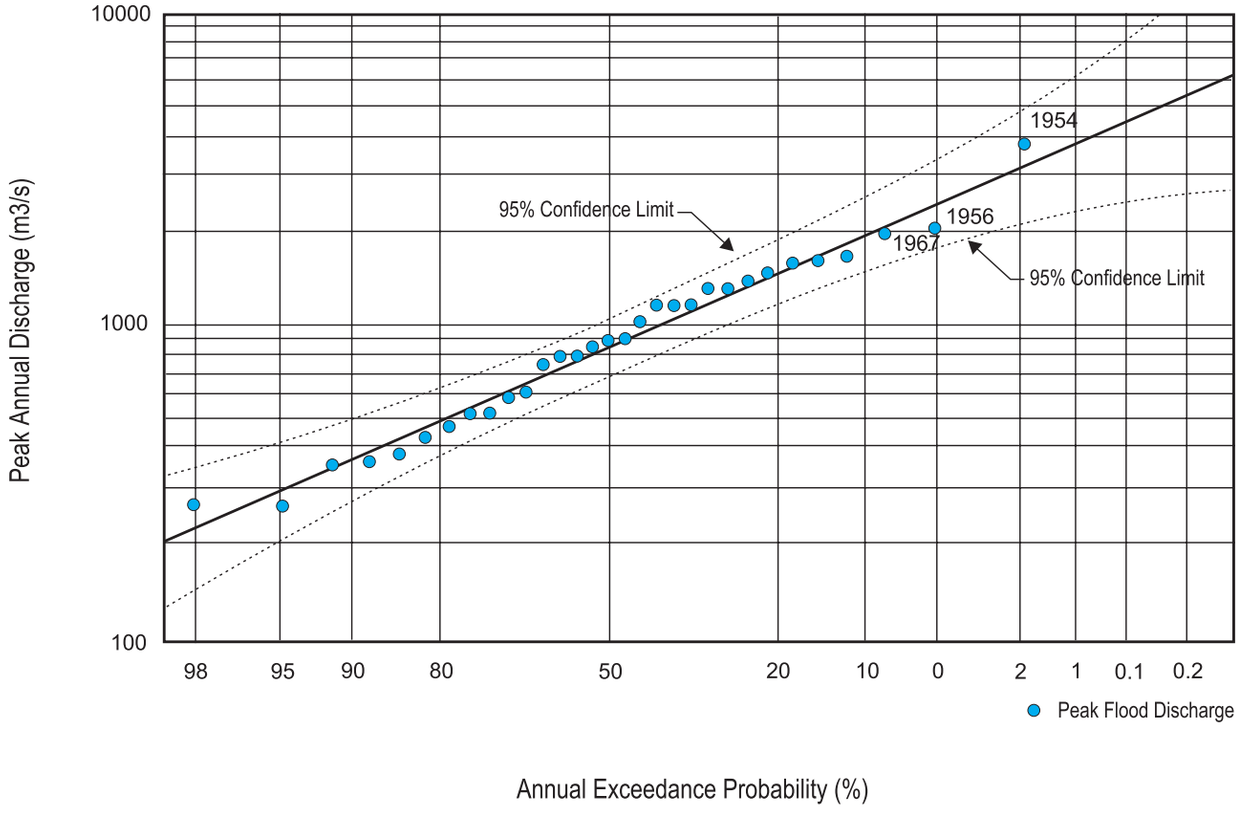


FIGURE F3 - Flood Frequency Curve for the Richmond River at Kyogle

The implications of the uncertainty in design flood estimates needs to be assessed in the flood study (see Section F7).

F4.2 Rainfall Runoff Routing Models

A rainfall runoff routing model is a mathematical representation of the various catchment processes that transform rainfall into runoff. With these models, a rainfall event defined in space and time is used as input data to the model, which then simulates the associated discharge hydrograph at locations of interest in the catchment.

There are generally two methods of applying rainfall runoff routing models. The first involves a deterministic application and employs the use of recorded flood and rainfall event data. This application is generally used in flood forecasting and in calibrating and validating rainfall runoff routing models for use in probabilistic applications. The second application is probabilistic and involves the use of design model parameters and design rainfall (spatially and temporally) to simulate a design flood hydrograph at the catchment outlet or at nominated locations on the catchment. It is used to determine flood hydrographs for different annual exceedance probabilities (AEPs).

The two main catchment processes that affect the size and shape of the discharge hydrograph are rainfall losses and storage routing effects as runoff travels down the catchment. Rainfall runoff models can only represent these processes approximately, and to obtain reliable estimates of discharge hydrographs, it is necessary to calibrate the model parameters to a large flood event for which both rainfall and discharge data have been recorded.

The data requirements for calibrating rainfall runoff routing models are considerably more intensive than for flood frequency analyses. Total discharge hydrographs at the catchment outlet, and data for the corresponding rainfall event defined spatially and temporally across the catchment are required. In the absence of this data, regional methods in the form of regional parameters for the rainfall runoff routing models, are generally followed.

The calibration process consists of adjusting rainfall loss rates and routing parameters to obtain agreement between the recorded and simulated hydrographs. The calibration process is often lengthy and difficult and should be undertaken for a number of large flood events. The rainfall runoff routing model should also be validated against several other recorded flood events to ensure that the model acceptably reproduces recorded results. The calibrated model parameters will vary with the flood event being assessed. Some form of weighting process will be required to estimate a set of model parameters for use in design flood estimation applications. The uncertainty associated with this procedure needs to be recognised and any implications assessed as part of the flood study. Once calibrated the rainfall runoff routing model and adopted parameters can then be used to predict the design discharge hydrographs associated with the design rainfall events of known AEPs.

Design rainfall data throughout NSW is available in the form of intensity-frequency-duration data (spatial) and design temporal patterns (time). With this data it is possible to estimate the time varying intensity of rainfall (in mm/hr) for a given duration of storm (in hours) with a specified AEP for any given location in the state (from Australian Rainfall and Runoff). Design rainfall data are fed into the rainfall runoff model, rainfall losses are abstracted and the associated design discharge hydrograph is simulated.

To summarise, rainfall runoff routing models are a useful tool for simulating design discharge hydrographs and for estimating peak discharges. However, reliable results will only be obtained if the model is calibrated against a number of recorded floods and validated against other floods. It is preferable to use the largest floods for which data are available. Once calibrated rainfall runoff routing models also provide a convenient way of simulating the effects of dams, retarding basins and reservoirs within catchments.

The use of rainfall runoff routing models in estimating design flood hydrographs involves a number of assumptions and a relatively large degree of uncertainty. The implications of this uncertainty need to be assessed by an experienced practitioner.

F4.3 Comparison of Methods

The overall objectives set for the flood study, the size and nature of the catchment being

investigated and the availability of recorded flood and rainfall data on the catchment will determine which method or combination of methods will provide the desired outcomes from the flood study.

In general, rainfall records are longer, far more extensive and more accurate than streamflow records. Hence, rainfall data has a greater degree of statistical reliability than discharge data. Consequently, it is usual to use rainfall based techniques, such as rainfall runoff routing models, to estimate design peak discharges and flood hydrographs for less frequent events. On the other hand, provided recorded flood data are available at a representative stream gauging station, and that the period of record is sufficiently long, a flood frequency analysis generally provides a more accurate estimate of design peak discharges for the more frequent events. As the flood study requires design flood estimates over the full range of flood events, up to and including the PMF, a combination of methods is generally employed to provide estimates of both design peak discharge and flood hydrographs. These procedures are presented in the current version of Australian Rainfall and Runoff.

For the larger catchments, where sufficient data exists to carry out a flood frequency analysis or use a regional flood frequency method, and the use of rainfall runoff routing models is not practicable, recorded flood hydrographs are generally used to estimate design flood hydrographs at the point of interest. This generally involves scaling the ordinates of representative recorded flood hydrographs until the resulting peak discharge, and on occasions the flood volume, is equal to the corresponding estimates from the frequency analysis.

Irrespective of what method or combination of methods is used to estimate design peak discharges or hydrographs, the implications of the uncertainty of the methods and estimates needs to be assessed as part of the flood study. In addition, as the hydrologic data are the key to a reliable hydraulic analysis, it is essential that experienced practitioners undertake the calibration, validation and design application of any numerical methods or models.

F5 Hydraulic Analysis

Having estimated the design discharge hydrograph and the design peak discharges as required for the flood events of interest, up to and including the PMF, variations in water levels, velocities and the extent of flooding in the area under consideration can next be determined. This requires a hydraulic model.

Hydraulic models are of two main types, numerical models and physical models. In numerical models, a computer is used to solve equations representing the flow of water down a river system and to predict water levels and velocities. A physical model is a scaled version of the floodplain being studied. Before describing numerical and physical models, the various factors that affect water levels and velocities are briefly discussed.

F5.1 Water Levels and Velocities

The water level and velocity associated with a discharge of water past a given point on a river system depends upon five factors:

- the available energy driving the flow;
- the loss of energy associated with frictional effects as the flow moves over the bed and banks of the river channel and floodplains;
- the cross-sectional area of flow;
- the depth of flow; and
- impacts due to backwater from downstream channels and structures, and tide levels within lower reaches of the river system or estuary (as discussed in Section C7).

Water flows from one place to another because of a difference in energy levels. In broad terms, the slope of the river channel defines the available energy. The greater the slope, the greater the gravitational energy available to cause water to flow in a downstream direction, and the faster the water flows. Flowing water uses energy to overcome frictional resistance as it moves along the river channel and over the floodplains. Rough surfaces characterised by outcrops of rock, trees, tree roots, fallen logs and tangled and matted vegetation produce much greater frictional resistance than smooth surfaces, such as grass, croplands, and concrete lined channels. Where the frictional resistance is low, water flows faster and shallower. The area and depth of flow also affect water levels and velocities. The larger the area of flow, the smaller the velocity needed

to pass a given discharge; shallower flows are "slowed down" by friction to a greater extent than deeper flows.

It should be noted that in general, the slope of the river channel changes along its length. In addition, the frictional resistance will generally vary across the width of a cross-section and along the reach of interest. Further, the width and shape of cross-section will also change along the length of a river.

Because of these variations, the factors that affect water levels and velocities interact in a complicated way. This interaction is further complicated by the presence of raised road embankments or bridges across flood prone lands, rural and urban development and the presence of any major constrictions along the river system. In the lower reaches of tidal rivers, and in estuaries, the ocean tide level can be of great significance in overall water level estimation.

F5.2 Development of Numerical Models

In a numerical model, the various equations, which relate available energy to friction losses and the area and depth of flow, are solved on a computer. This process provides estimates of the variations over time in water levels, velocities and the extent of flooding.

Numerical models require data concerning the bed slope, frictional resistance and topography of the river channel and floodplains, as well as any special tailwater conditions. These data are obtained as follows. First, the area of interest is studied closely, both from topographic maps, flood photography and from field inspection, to obtain a general understanding of likely flooding behaviour. Next, a number of cross-sections representative of the topography and frictional resistance are selected and are measured by field survey. This enables channel slopes and the depth and areas of flow at these locations to be determined for any water level. Finally, the frictional resistance at the various cross-sections is estimated by a visual inspection of the area, noting the type and nature of bed and bank materials, the presence of trees, scrub, rocks, logs, etc.

All of these data are fed into the model, which is then ready for calibration. If the downstream end of the model is non-tidal, then a rating curve is used to determine the downstream water level. If the downstream end of the model is a tidal river reach or the sea, it is necessary to incorporate the tidal rise and fall of downstream water levels in the model.

F5.3 Calibration and Validation of Numerical Models

The calibration process consists of adjusting appropriate parameters in the model to obtain agreement between recorded and simulated water levels during a major flood. First, a flood suitable for calibration purposes is selected. Next the discharge (peak flow for "steady flow" models, flow hydrograph for "unsteady flow" models) of the flood is estimated. Information on peak flood levels and flood behaviour is sought from long-term residents, newspapers, council records, etc. All of this information is used in the calibration process as a basis for adjusting parameters to achieve agreement between recorded and simulated water levels. Once the model is calibrated, it should be validated against several other recorded flood events to ensure that the model acceptably reproduces recorded results.

There are a number of uncertainties in the calibration and validation process. First, the most recent large flood suitable for calibration purposes may have occurred some years ago and hydraulic conditions may have changed in the interim. The passage of time will have reduced the number of long-term residents still living in the area and may have clouded their memories of the flood. The calibration of hydraulic models requires both detective work and judgement to uncover facts. Inconsistent facts have to be identified and discarded and discrepancies have to be studied and explained. Accordingly, it is essential that experienced practitioners undertake the calibration and validation of numerical models.

Numerical models vary in their degree of complexity and should be chosen to reflect the overall objectives and desired outcomes of the flood study, the nature and extent of flood behaviour being investigated, and the available data for calibration and validation.

The advances in computing power has seen the introduction of more complex numerical models that have both steady and unsteady state applications. These include one dimensional models (1-D), quasi- two-dimensional models (quasi 2-D), two-dimensional models (2-D)

and three-dimensional models (3-D). Further details on the range of models available, their applications and limitations are presented in the current edition of Australian Rainfall and Runoff.

In general, the 1-D and quasi 2-D models require the user to define the flowpaths that are modelled as a one-dimensional system. These flow paths remain fixed during computation. In the quasi 2-D model the one-dimensional flow paths are connected by a series of weir or fluvial links to enable the complex nature of flood behaviour to be modelled. The advantage of the 2-D and 3-D numerical models is that the user does not need to define designated flow paths, however the data requirements, particularly in terms of ground survey and calibration data, are far greater than for 1-D and quasi 2-D models.

Until recently the 1-D and quasi 2-D and 2-D models have been used in combination with each other to provide varying degrees of hydraulic detail. The 1-D or quasi 2-D model is generally used to model the system as a whole (far site) and provide a set of boundary conditions for the 2-D model (near site) which may look at a smaller area of complex flow behaviour in more detail. For example, a quasi 2-D model may be used to model an entire river reach and its floodplain, and a 2-D model may be used to investigate the complex flow behaviour at a bridge, weir or dam site nested within the confines of the quasi 2-D model. However, in recent times with the advances in computing power and more cost effective ground survey, 2-D models are being increasingly used for both near and far site applications. The 2-D models work extremely well in a GIS environment, not only from a user perspective but more particularly from a presentation of results viewpoint.

F5.4 Physical Models

A physical model is three-dimensional, scaled version of the actual river reach under investigation (see Plate 8). The construction of a physical model is very time consuming. Templates that are fabricated to represent surveyed sections are accurately positioned to the model base and a filler material, typically sand topped with weak mortar, are used to provide a solid surface conforming to the topography of the templates.

PLATE 8 - Physical Modelling of Flooding on the Georges River

Physical models have to be calibrated in the same way as numerical models; they require the same calibration data and suffer the same calibration difficulties. Because of the ability of physical models to more accurately simulate water movement in complex flow situations, their prime use is in the modelling of critical physical features where flow is uncertain. The high cost of constructing physical models and their short life preclude their use in every-day flood analyses. More details on the physical models, their applications and limitations are provided in the current edition of Australian Rainfall and Runoff.

F6 Climate Change

A flood study should also address the possible implications of climate change on flooding behaviour as discussed in Section E6. These include:

- increases in sea level. To date, a variety of scenarios exist for the likely increase in sea levels;

- altered weather patterns may intensify storms and so increase the severity of the resulting floods; and
- increased intensity and frequency of extreme events.

The consequences of these increases on flood levels and behaviour should be analysed as part of a flood study either:

- qualitatively based upon the broad range of floods being examined (up to and including the PMF); or
- sensitivity analyses can be examined in relation to rainfall intensity, or downstream water level conditions for key flood events.

This provides a preliminary assessment of the potential impacts of climate change on flooding so this can be considered in the management study. Management options are discussed in Section G9.8.

F7 Accounting For Uncertainty

As outlined in earlier sections, every step in the hydrologic and hydraulic components of a flood study contribute to the uncertainty associated with the estimates of the design levels, velocities and extent of flooding. It is essential that this uncertainty be identified and that the implications, in terms of the flood study objectives and desired outcomes, are quantified. The degree of uncertainty in the design flood estimates will vary depending on the quality and quantity of flood and rainfall data available. In general the greater the available data the greater the confidence in the final design estimates.

Ensuring that experienced practitioners carry out the hydrologic and hydraulic components of the flood study will minimise any systematic errors and enable a satisfactory assessment of the overall uncertainty to be carried out.

Sensitivity analyses in relation to input variables can be used to provide an indication of the degree of risk associated with errors in adopted criteria, coefficients or assumptions made. The results of sensitivity analyses should be considered in management decisions and may influence the decision on the freeboard adopted, as discussed in Section K5.

F8 Information for Primary End Users

The flood study should provide key information for primary end users, including council and the SES, so they can fulfil their role in floodplain risk management based upon the information available until the management study and plan are completed. The required information for each is discussed below.

Information for council should assist in the management of development pending completion of the management study and plan. This should include:

- hydraulic and hazard categorisation for key flood events; and
- flood level information in a suitable format for key flood events.

The use of this information is discussed in Section C9 and Appendices I and J.

Information for the SES should assist in its evacuation and logistics planning. This should include:

- a laymans description of flood behaviour in the study area for the full range of flood events;
- flood level information within the study area relative to the key flood warning gauges for the location for full range of flood events; and
- identification of critical evacuation issues, such as the cutting of key evacuation routes and the development of islands that can ultimately be inundated and the potential critical timing for their loss.

Public infrastructure providers should also consider this information in protecting and upgrading existing facilities and designing future facilities.

F9 References

"Australian Rainfall and Runoff. A Guide to Flood Estimation", Institution of Engineers, Australia, Current Edition.

APPENDIX G FLOODPLAIN RISK MANAGEMENT STUDY PREPARATION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation	
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I	

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)									
Floodplain Risk Management Measures		Flood Planning Levels		Hydraulic & Hazard Categorisation		Flood Damages		Emergency Response Planning for Floods	
Appendix J		Appendix K		Appendix L		Appendix M		Appendix N	

G1 Introduction

A floodplain risk management study is a multi-disciplinary process that is lengthy and detailed. The management study balances a number of differing factors to generate recommendations for an appropriate mix of management measures to deal with the different types of flood risk. The factors considered in the management study include:

- flood behaviour, danger and damage;
- the community costs of flooding;
- future land-use;
- a comprehensive range of flood risk management measures;
- the environmental needs of the river and floodplain areas; and
- environmental and cultural impacts of management measures.

A management study aims to identify all relevant issues, quantify them and weigh them appropriately into an overall management plan by which the community as a whole is better off, though some groups may perceive themselves disadvantaged. Like any social planning process, completing a management study and the subsequent formulation of an appropriate management plan involves discussion and tradeoffs with various groups within the community to gain community acceptance of the management plan dealing with all types of flood risk.

As such, the management study is a major multi-disciplinary process involving high levels of skill in engineering, planning, the sciences (social, environmental, and environmental), economics and emergency management. The steering of management studies requires a significant effort from the floodplain risk management committee.

This appendix discusses:

- the initial considerations for the committee (Section G2);
- the objectives of the management study (Section G3);
- the types of risk to be managed (Section G4);
- key steps in the management study (Section G5) including strategic assessment of new development areas (Section G6) and management option identification and assessment (Section G7);
- the provision of information to primary end users and the public (Section G8);
- specific issues of concern that need to be considered in the management study (Section G9); and
- recommendations from the management study (Section G10).

The management study and the subsequent plan are integrally linked. The study identifies

and assesses issues for input into the decision making process resulting in the management plan. The management plan preparation process is outlined in Appendix H, which should be read in conjunction with this appendix.

G2 Initial Considerations

Identification of the issues, objectives, available studies and data is essential to the effective scoping of the management study. Failure to do so will lead to confusion, wasted effort and associated increased costs.

Therefore, prior to the commencement of a floodplain risk management study the floodplain risk management committee must formulate management study objectives and an associated brief. The issues raised in Sections C2, C3, E2 and F2 should be considered.

It is imperative that the objectives of and issues to be addressed in the management study and subsequent plan be identified and defined at the outset. This enables the full range of issues, including flood problems in existing and potential future development areas, to be effectively considered and the study area to be defined (see Section F2).

Background data and studies, outlined in Appendix E, can provide valuable input into the management study. These may include current flood related development controls which may identify issues and objectives for the management study.

Social, economic, environmental, cultural, and flooding issues need to be considered in assessing management options.

G3 Objectives

The objectives of a floodplain risk management study involve the derivation of an appropriate mix of management measures to effectively manage the full range of flood risk for the specific situation. These will vary with location and the community concerned but will generally include:

- examination of council's local flood risk management policies, strategies and planning instruments to ensure consistency with each other, this manual and the findings of the flood and management studies;
- examination of existing warning systems and community flood readiness in relation to SES disaster planning requirements (refer Section J3 and Appendix N);
- community consultation to provide and gather information, enable participation in the decision making process and gain community acceptance of the management study findings and the subsequent plan;
- determination of true hydraulic and hazard categories based upon the management study and principles outlined in Section G5.2 and Appendix L;
- identification and assessment of floodplain risk management measures for existing development areas aimed at reducing the social, environmental and economic loss of flooding on development and the community, both existing and future, over a full range of flood events;
- identification of potential new development and redevelopment areas within the floodplain for cumulative assessment. This provides the basis for identifying relevant development limits, types, scales and controls and/or works necessary to reduce continuing flood risk in developable areas to an acceptable level (see Section G6). A particular development control is the recommendation of appropriate FPLs, as discussed in Appendix K;
- assessment of the individual and cumulative impacts of proposed management measures for existing and potential future development areas from a social, environmental, land use, flood response and cultural heritage perspective (including minimisation of adverse impacts and maximisation of positive outcomes);
- examination of the potential to enhance the natural environment as part of floodplain risk management measures or through modification to existing measures; and
- identification of modifications required to current policies and planning instruments in light of the results of the investigations.

G4 Flood Risks to be Managed

There are three specific types of flood risks that need to be addressed in the management study:

- the management of flood damage and personal danger to the existing community and properties at risk (the existing risk) to an acceptable level;
- the management of flood damage and personal danger in areas yet to be developed (the future risk) to an acceptable level; and
- the management of personal danger, in particular (with flood damage a lesser consideration), associated with management measures being overwhelmed by a larger flood than used to design works or manage future development, and/or in areas not protected by measures, eg, outside a levee (the continuing risk).

To meet these broad objectives the management study needs to consider and develop an appropriate and integrated mix of measures (discussed in Appendix J) to manage these risks. Costs need to be evaluated and considered in relation to the benefits as discussed in option assessment in Section G7.

Each type of risk is discussed below.

G4.1 Existing Risk

Flood modification measures (structural measures that modify flood behaviour, see Appendix J) are the traditional means of mitigating damage to existing properties at risk to an acceptable level. The feasibility, effectiveness, environmental and social impacts and economics of various flood modification options need to be considered.

Whilst these measures might reduce flood discharges, levels and risk in the area of interest, such measures may increase them elsewhere. The hydrologic and hydraulic models developed in the flood study are used to assess the impact of structural works on flood behaviour.

All flood modification measures have associated environmental, economic and social costs that require evaluation.

When contemplating and evaluating flood modification measures, councils should consider environmental enhancement opportunities available from such works. For example, retarding basins can also serve to improve water quality, reduce the need for costly hard river improvement works and may also incorporate wetland areas.

In addition to flood modification measures, property modification measures, including specific land use controls (for example removal of development and flood proofing) and response modification measures such as flood readiness can also be used to reduce existing risk to a more acceptable level.

DIPNR can provide guidance and advice on technical aspects of management measures including flood modification measures. However, the floodplain risk management committee may need to engage specialist consultants to evaluate the impacts and effectiveness of management options.

G4.2 Future Risk

Property modification measures, such as land use and development controls, are an effective means of ensuring that future development is compatible with flood risk. The council has responsibility for local land use planning decisions and flooding is one of the key issues that needs to be considered in the planning process for flood prone land.

Thus, the council has the major role to play in flood-related planning considerations. DIPNR can provide technical support and advice with respect to flooding behaviour and planning aspects respectively. Agencies such as the DEC and DPI should be consulted for ecological issues and advice on relevant legislation.

Property modification measures, such as planning measures, are likely to be contentious to the local community as some groups or areas are likely to be disadvantaged whilst others benefit. In these circumstances, the common good of the community as a whole must be the guiding principle. Nonetheless, the committee must ensure that issues of equity, possible trade offs for those disadvantaged and possible extra charges against those advantaged (for example higher rates or a special levy on benefiting properties) are addressed. Again it is important that the deliberations and recommendations of the committee be communicated to the local community by press, radio, etc.

To achieve effective management of future flood risk the management study needs to strategically assess flood risk in future development areas on a cumulative basis as discussed in Sections G6 and G9.1.

G4.3 Continuing Risk

Unless the PMF is adopted as the basis for floodplain risk management measures, which is most unlikely (refer Section K3), a larger flood will occur at some time in the future which will overwhelm these measures. In addition, there will always be properties outside the area "protected" by measures that require assistance in flood times.

Response modification measures (discussed in Appendix J), such as, readiness, response and recovery plans are the most effective means to manage continuing risk. The SES guides the preparation of local flood plans (dealing with flood readiness, response and recovery), with the Local SES Controller having widespread responsibilities and powers (see Appendix N).

The local council has access to many of the resources necessary for response operations (for example manpower, plant and machinery, buildings, etc.). It is essential that a cohesive working relationship is established between SES and council to ensure that both planning and operational aspects of floodplain risk management and flood planning are adequately addressed.

Local flood plans are not management measures that can be formulated and then forgotten. Such plans are aimed at modifying the community's response to the threat and aftermath of a flood. No matter how accurate and timely a flood warning and no matter how well thought out the accompanying defence and evacuation plans, much effort will be wasted unless the community responds effectively.

Thus, there is a very real need to make the community fully flood ready and aware of its responsibilities and to maintain this readiness and awareness by a program of regular re-education of people living in flood prone areas. The more remote in time and experience the community is from the last flood that resulted in significant damage, the more difficult this becomes. Adequate community flood readiness is one of the greatest challenges facing floodplain risk managers. Councils cannot rely on the next major flood to re-educate the community.

The need for effective communication between the council and the community cannot be over-emphasised with regard to flood readiness and response measures (see Appendix J). The use of specialists in this field to prepare a readiness program, on either a local or catchment basis is recommended.

In some areas works may be necessary to improve the ability of the community to respond. Evacuation access and flood warning systems (see Sections J2.5 and J3.4), may need to be upgraded to enable people to be warned effectively and evacuate in a safe manner during flood events.

G5 Key Steps in the Management Study

Key steps in the management process include:

- community consultation, Section G5.1;
- hydraulic and hazard categorisation, Section G5.2;
- strategic assessment of new development areas, Section G6;
- FPL selection, involving both selection of the flood upon which FPLs are based and freeboard, Appendix K;
- flood damage assessment, Appendix M;
- option identification and assessment, discussed in Section G7; and
- appropriate information for primary end users and the public, Section G8.

G5.1 Community Consultation

Effective community consultation is vital to gaining community acceptance of the findings of the floodplain risk management study and subsequent plan.

Effective community consultation requires consideration of the following aspects:

- informing the community of the management study and its purpose;
- assessing the community's level of knowledge, understanding and concern in relation to flood issues and flood readiness;
- obtaining any information members of the community may have in relation

to historic flood levels, behaviour and responses;

- assessing community aspirations in relation to flood problems;
- providing the community with information on alternative management measures and the inherent advantages and disadvantages of these; and
- providing a mechanism for the community to have input into selection of appropriate management option(s).

An appropriate methodology should be developed for the specific study area, community and locality.

In addition, a number of management options, specifically response modification measures (see Section J3) such as flood warning, flood awareness and flood response, rely on community involvement to be effective.

It should be noted that the State Government regards effective community consultation as a basic principle of good floodplain risk management.

G5.2 Hydraulic and Hazard Categorisation

A flood study, Appendix F, provides detailed information on flood behaviour for a range of flood events up to and including the PMF. Typical data from a flood study include peak flood levels and velocities, the progression of flooding over the course of the flood event and the identification of any isolated 'islands', etc.

A management study takes this understanding further by providing information of true hydraulic and hazard categorisation as outlined in Appendix L. This involves breaking the floodplain down into:

- areas of varying hazard level for floods of different severities. Provisional assessment is generally based around flow depths and velocities. Whereas true hazard also accounts for a range of additional physical factors affecting danger to personal safety, as discussed in Appendix L. For example, access and ability to evacuate to safety in times of flood. Two particularly important examples, levees and islands, are discussed in Section G9; and
- areas with different hydraulic functions (which can vary between floods of different magnitudes). These are floodways for flow conveyance, flood storage areas for temporary storage of flood waters during an event and the flood fringe, the remaining area at the edge of the floodplain.

A management study weighs up all of the factors and issues on the basis of merit to determine true hydraulic and hazard categories.

Categorisation provides a better understanding of the variation of flood behaviour and hazard across the floodplain and between different events.

G6 Strategic Assessment of Flood Risk in New Development Areas

Land use planning cannot be effectively undertaken without an understanding of flood risks and the associated consequences. In turn, land use planning controls are an essential element in effectively managing flood risk in new and redevelopment areas.

Therefore the preparation of a management study and subsequent plan involves a realistic appraisal of desired and realisable future land uses. If future land use is not considered and appropriately incorporated in the management plan, the benefits of floodplain risk management measures implemented to address the existing problem may be dissipated and overwhelmed by future development, both with respect to the type of development and its location. It is the responsibility of council to ensure that future planning considerations are fully evaluated and taken into account when undertaking assessments in the management study and in formulating the provisions of a management plan.

The floodplain risk management process provides an opportunity to consider new development areas strategically in a sound framework of knowledge of flood risk to enable effective management of these areas.

Considering these areas requires an assessment of the full range of flood risk so that future land use can be effectively managed to reduce the flood exposure of the future community to an acceptable level.

In addition, new development needs to be assessed cumulatively to ensure it will not significantly impact upon existing development. Impacts of new development on flooding are discussed in Section G6.1.

These investigations are completed as part of the management study to provide councils with guidance on how new and existing areas can reasonably be developed or redeveloped, considering flood risk.

Effective management of flood risk in new development areas needs:

- to identify potential new development areas and future land use needs (discussed in Section E5.1) over a reasonable planning horizon (say 20 years);
- investigations to determine, from a flood risk perspective, whether areas should be developed, and if so, what management options are necessary to support development (see Sections G6.1 to G6.4); and
- investigations to consider the cumulative impacts of new development (see Section G9.1).

This information and associated investigations provide the basis for decisions on appropriate planning measures and controls to manage flood risk to an acceptable level. Controls can be implemented initially through development control plans and policies. However, it is considered essential that development limits and conditions be included in management plans and be incorporated into EPIs (including LEPs), as appropriate, to ensure flood risk is managed strategically rather than through ad hoc decisions.

Once flood-related planning measures have been finalised, it is important to formalise these changes, by rezoning under the EP&A Act, where appropriate. Zonings permitting development should be supported by appropriate flood related development controls to reduce risk to both people and property to an acceptable level.

These aspects are considered in the management study in light of the existing planning controls and the requirements under Section 26 and 27 of the EP&A Act for a public authority to own land which is reserved for a public purpose.

The use of land use planning measures and related controls is discussed in Section J2.1.

G6.1 Impacts of New Development on Flooding

Development can impact upon flood behaviour (levels, flows and flowpaths) and therefore the flood exposure of other properties (and their inhabitants). Impacts can be due to:

- blocking by fill of, or buildings on, floodways;
- removing areas for flood storage within the floodplain, due to filling or levees; and
- increasing the amount of impervious area in a catchment which, without appropriate management, increases the overall volume and peak runoff from the area.

Impacts need to be considered cumulatively to enable effective management of flood risk.

G6.2 Determining Reasonable Flood Related Development Limits

Indicative flood related development limits can be determined based upon an understanding of the flood behaviour and the impacts (discussed above). There are certain areas where development would reasonably be excluded:

- areas where development will have significant adverse impacts on flood behaviour;

  This may be due to blockage of floodways (increasing upstream flood levels or redirecting flows) or filling of a flood storage areas (increasing downstream peak flood flows or redirecting flows).

  Assessment involves consideration of the cumulative impacts of proposed new areas on flooding as discussed in Section G9.1;
- areas where flood hazard is too high and cannot effectively be reduced to acceptable levels by management measures. Emergency management is an important consideration as to whether an area is too hazardous for development due to flooding (eg islands discussed in Section G9.5); and
- areas of important flood dependant ecosystems.

Establishing these areas provides for reasonable flood risk related developable limits.

G6.3 Flood Compatible Development within Development Limits

Within the area where development is considered reasonable from a flood risk perspective, decisions need to be made on controls to support development by reducing flood risk to an acceptable level. This can involve determining:

- the types of development appropriate for the location.

  This relates to the vulnerability of different types of development and the continuing flood risk to which the area is exposed.

  For example, an area considered appropriate for general residential development may not be appropriate for aged care accommodation due to the additional vulnerability of residents. A further example is an area where risk is considered too high for residential development but which may be appropriate for less vulnerable industrial development;

- an appropriate development density.

  The cumulative impacts of overall development on flooding or the ability to effectively manage emergency response from the area, (perhaps due to evacuation issues, see Section G7.1.2) may limit development density. The management study may also consider options to overcome critical limitations, for example, upgrading external access roads to increase capacity or availability during a flood event;

- appropriate measures necessary to support development.

  This involves determining appropriate conditions to ensure future development is not exposed to an unacceptable level of continuing flood risk.

  Conditions (discussed in Section J2.1) may include measures such as filling of development sites and minimum floor levels (FPLs discussed in Appendix K) to reduce the likelihood of flooding or special evacuation requirements involving improvements to evacuation routes; and

- appropriate management plans for critical infrastructure.

  New infrastructure should be available and accessible, as necessary, during significant flood events or be able to be re-established readily after an event. This may require flood related design standards to reduce flood vulnerability in the expected conditions. For example, evacuation routes with better drainage can overcome local stormwater issues that may otherwise inhibit performance.

G6.4 Managing Continuing Risk in New Development Areas

Even with the above controls, flood risk will still remain in new development areas. This continuing risk, and particularly that relating to danger to personal safety, needs to be carefully considered to ensure that this can effectively be managed.

This may require a system of complementary measures such as flood predictions and warnings, and effective external access to facilitate self evacuation of inhabitants (see Sections J2 and J3).

G7 Management Option Identification and Assessment

The formulation of a floodplain risk management plan involves the consideration of various options concerning flood, property and response modification measures (discussed in Appendix J), together with an assessment of their social, economic and environmental consequences. These assessments are undertaken as part of a floodplain risk management study.

Each option, and the finally adopted management plan, will inevitably be a compromise. Its formulation is an exercise in decision making aimed at achieving (or balancing) multiple and often conflicting objectives.

Management measures have both advantages and disadvantages. Whilst a proposed measure, for example, a levee, may alleviate flood damage, it may be detrimental to the environment. This detrimental impact can be in a general sense, for example, loss of habitat, visual intrusion and restriction of ecologically beneficial inundation, or in a particular sense in that it may adversely affect flood levels elsewhere.

To resolve the resulting web of inter-related issues, it is essential that both the issues and desired outcomes be defined and assessed in objective terms. One way of assessing options is described below.

A preliminary list of options is developed considering the non-exhaustive list provided in Appendix J and options identified by the committee and community. It should consider the need to manage the full range of flood risk and therefore provide a balance of options to address all risks.

A preliminary assessment of these options should be completed to narrow down the options. This can be based upon their practicality, feasibility (technical and financial), potential benefits and impacts (on flood behaviour and the environment) for the particular location, and their likely ability to manage all type of flood risk in this instance. The committee can use preliminary assessment to develop a list of management measures for detailed investigation.

In the detailed assessment, initial, broad-scale "single issue best options" are defined for each of the major issues, for example on the basis of "community expectations" alone, or on the basis of "flooding considerations" alone, etc.

Next, the advantages and disadvantages of these options are considered. Positive and negative linkages are identified, problem areas are identified, and the social, economic and environmental implications of these options are assessed. Comparison of the single objective options described above will identify issues of agreement and conflict.

The next step is to define a "preferred plan of management" that meets as many of the objectives established at the commencement of the process as possible. This assessment process can be quite difficult because of the different nature of the underlying issues. For example, one specific issue option may be preferable from a community point of view, but at an increased risk of flooding.

An alternative option may be environmentally preferable, have a lesser risk of flooding, but may be less desirable from the community standpoint. How can these two options be compared ? How are advantages and disadvantages of different natures to be weighed ?

The easiest way of formalising this procedure is to use a matrix method of comparison. This is known as multi-criteria analysis and provides a method of comparing objective and subjective issues. In this system, a matrix is prepared in which the columns consist of the various management options and the rows consist of the various floodplain risk management issues.

Table G1 is an example matrix outlining the range of issues that may be considered. Issues can be categorised into those related to safety of people, social issues, economics, the environment, flood behaviour, feasibility, attitudes, critical infrastructure and compatibility to the management of other hazards or issues. Issues and their weighting and scores will vary with relevance for the location and effectiveness. These should be determined as part of committee and council decision making.

The matrix may be supplemented by an assessment of effectiveness of measures in managing the different flood risks in both existing and future development areas as indicated in Table G2. This reduces the likelihood of certain types of risk not being addressed.

Where possible, the advantages and disadvantages of each option are quantified. This can be done relatively easily in terms of the costs of flood risk management measures and the associated reduction in flood damages. In other areas, such as the environment, community desires, etc., it is difficult to make a quantitative estimate. In these cases, a qualitative estimate of the advantages and disadvantages of the option needs to be made and entered into the matrix, for example ranking outcomes on a scale of 1 to 5.

Weighting may then be applied to options based upon the relative importance of issues to the community. For example, riparian vegetation may be important to the community and therefore this issue is weighted more highly. Alternatively, in areas with little available flood free developable land the need for expansion may receive high weighting.

Once the matrix has been prepared, it provides an easy framework for comparing the various options on an issue by issue basis. The best option for each issue and issues still in doubt can be identified. Ultimately, however, a considered decision has to be made.

The matrix approach cannot make the decision. Making the decision rests initially with the committee and ultimately with the council. However, it does provide a simple framework for organising the data and identifying issues in conflict and 'trade-offs'. It is emphasised that the process followed and its basic assumptions must be fully documented so the reasons for the decisions are clear and accessible to the community.

G7.1 Key Information for Option Assessment

When preparing a management study and plan the committee should consider other relevant studies and plans that set some of the parameters within which management measures must operate. Complementary studies, plans and issues include those relating to land use, the environment (including surface and ground water, vegetation, stream flow, threatened species, acid sulfate soils, and catchment objectives) and cultural issues amongst others, are discussed in Appendix E. These provide essential background information for identifying potential constraints, land use needs and availability, as well as opportunities to enhance the riverine environment. They also allow enable examination of the impact of potential risk management measures.

However, if information is not available or where additional information is necessary, this may need to be derived as part of the management study. In these cases, the study requirements depend upon the specifics of the locality and the existing or potential management measures being considered and should concentrate on the likely impacts of proposed management measures.

These studies may be preliminary in nature, but need to identify and address the relevant issues in enough depth to:

- enable adequate assessment of the likely impacts of options; and
- to determine their feasibility, that is, can the option be built given the constraints.

They may also identify opportunities for environmental enhancement as part of works.

More detailed studies would be required as part of overall assessment, under the EP&A Act, where options are to proceed to implementation.

G7.1.1 Socio-Economic Studies

Measures to reduce flood risk and damage can impose a variety of socio-economic costs on flood-affected communities. For example, the current flooding situation has associated tangible, intangible and social costs. The implementation of risk management measures usually requires money. The cost of risk management measures needs to be weighed against the benefits of a reduction in flood risk and flood damage with consideration of impacts on the social aspects, environment and cultural heritage.

Some risk management measures have quite high social or environmental costs, for example, the relocation or disruption of a community, the clearing of vegetation or reshaping of a waterway to improve hydraulic efficiency and lower flood levels and the construction of levees, etc. Further, the implementation of risk management measures may disadvantage some groups of the community, but benefit others.

To objectively compare issues and management measures, it is necessary to gather a variety of socio-economic data. Accordingly, the following types of studies may be required:

- flood damage assessment (see Appendix M);
- community impact studies; and
- environmental impact assessment.

The social impact of flooding on the community in general and on specific community groups also needs to be assessed. For example:

- do flood prone residents have certain characteristics or disadvantages that will make them less resilient in dealing with the occurrence and aftermath of a flood?
- is flooding a regular occurrence and is the community flood-aware?
- is a flood likely to have a highly disruptive effect on the community or could strategies to address the flood risk disrupt the social fabric of the community?

CATEGORY/ISSUE	Weighting 5 highest, 1 lowest	OPTION - RAW SCORES				OPTION - WEIGHTED SCORES			
		Do Nothing	FPL Levee	Flood Warning & Evacu-ation	Develo-pment Control	Do Nothing	FPL Levee	Flood Warning & Evacu-ation	Develo-pment Control
SAFETY OF PEOPLE:									
reduce hazards in event deriving FPL	4	2.5	4.5	3.5	3.5	10	18	14	14
reduce hazards extreme event	3	2.5	3.5	3.5	3	7.5	10.5	10.5	9
improve evacuation extreme event	4	2.5	3	3.5	2.5	10	12	14	10
SOCIAL:									
increased community growth									
disruption/relocation due to measure									
improvement to property values									
minimise social disruption during flooding									
ECONOMIC:									
life cycle cost of management measures									
reduction in flood damage									
ENVIRONMENTAL:									
Flora/Fauna Impact									
enhance environment									
FLOOD BEHAVIOUR/IMPACTS:									
+ve/-ve impacts of change in hydraulic behaviour									
reduction in number of houses impacted									
FEASIBILITY:									
physical/technical									
financial Council									
potential for State/Federal funding									
ATTITUDE:									
Council									
Community									
COMPATIBILITY:									
other hazards & urban drainage									
environmental management measures									
CRITICAL INFRASTRUCTURE:									
improve availability & function									
TOTAL									

TABLE G1 - Example of a Floodplain Risk Management Option Assessment Matrix

Notes:
1. Issues considered, their weighting and score will vary between committees and location depending upon their effectiveness
2. Example calculations shown (including item weighting and scores). These can be extended to other items and totalled.
3. Weighting is from 1 to 5, with 5 the highest rating. These are derived from council/committee discussions.
4. Options have been rated on a scale of 1 to 5, with 5 the highest score. The Do Nothing option is weighted at 2.5 for each issue as it does not have a cost or benefit to the community. This provides a basis for ranking other options based upon their relative benefit or cost. Options with positive benefits are scored from >2.5 to 5. Options with negative impacts are scored from 0 to < 2.5. Scores are derived from council/committee discussions.

- is the community mobile and is there a high turnover of people in the community?

An economic appraisal of proposed management measures would generally need to be undertaken to ensure that costs are at least balanced by associated benefits. This economic analysis principally deals with tangible costs but needs to include consideration of the following:

- social costs, even though these are difficult to quantify;
- environmental costs, considering the principles of ESD of 'improved valuation, pricing and incentive mechanisms'. This means that valuation of environmental assets and services should be included; and
- equity issues.

OPTION TYPE	EXISTING DEVELOPED AREAS			FUTURE DEVELOPMENT AREAS		
	EXISTING RISK Events up to the Flood used to Design Mitigation Works or to Derive Existing FPLs		CONTINUING RISK Events Rarer than the Flood used to Design Mitigation Works or to Derive Existing FPLs	FUTURE RISK Events up to the Flood used to Derive FPLs for New Development		CONTINUING RISK Events Rarer than the Flood used to Derive FPLs for New Development
	Safety	Damage	Safety	Safety	Damage	Safety
PROPERTY MODIFICATION MEASURES						
Zoning & Development Control				High	High	Low#
Voluntary Purchase	High	High	High			
Voluntary House Raising	Low	Medium	Negative			
Flood Proofing of Buildings	Low	Low				
Access during Flood Events	High		High	High		High
RESPONSE MODIFICATION MEASURES						
Community Flood Awareness & Readiness*	Low*	Low*			Low*	Low*
Flood Predictions & Warnings*	Medium*	Low*	Medium*	Medium*	Low*	Medium*
Emergency Response Planning for Floods*	Medium*		High*	Medium*		High*
FLOOD MODIFICATION MEASURES						
Levees	High	High	Negative	High	High	Negative
Detention/Retarding Basins	Medium	Medium	Negative	Medium	Medium	Negative
Flood Control Dams	Medium	Medium		Medium	Medium	
Bypass Floodways	Medium	Medium		Medium	Medium	
Channel Improvements	Medium	Medium		Medium	Medium	
Enhance Environment						

TABLE G2 – Example of the Ability of Options to Address Different Types of Flood Risk

Notes: Measures considered and their effectiveness will vary dependent upon the individual situation and therefore the ratings in this table should not be used for specific situations.
Blank squares may be not applicable or options have nil affect
High/Medium/Low relate to positive effects. Negative – relates to potential adverse impacts.
* These options all rely on each other to be effective.
# Depends upon consideration of emergency response management issues in strategic planning

The benefits of flooding can be assessed by reduction in flood damages (Appendix M). Three types of costs are:

- direct damages can be estimated from an investigation of the number of buildings flooded, the area flooded, the depth of flooding and the type of land use (for example, residential, commercial, agricultural, etc.);
- indirect damages can be estimated on the basis of the degree of social and community disruption caused by evacuation, clean-up and recovery activities; and
- intangible damages, which include increased levels of ill health, anxiety, depression, etc., are difficult, if not impossible to quantify in meaningful dollar terms. Nevertheless, the dimension of intangible damages, in terms of the likely number of people affected, can be inferred on the basis of flood behaviour, flood severity and the size of the flood prone population.

Management measures produce benefits by reducing these damages.

Whilst direct economic analysis is important it is not unusual to proceed with urban flood mitigation schemes on largely social grounds, that is, on the basis of the reduction in intangible costs and social and community disruption. In fact, on a worldwide basis, it is often the experience that many mitigation schemes are only marginally economic in strict tangible cost-benefit terms.

G7.1.2 Flood Response Studies

As the PMF is unlikely to be adopted for protecting development from flooding, a continuing risk of flooding remains. This is principally a concern for personal safety which generally needs to be managed through emergency response and community education.

Analysing the PMF provides an upper bound of flood behaviour and consequences for emergency response planning. It can identify critical factors, such as key levels for loss of

evacuation routes and inundation of entire areas, so that appropriate emergency response and recovery planning and community education programs can be developed.

Response planning for the consequences of the PMF provides for effective management of smaller events, particularly those rarer than the flood event selected as the basis of the FPL. For example, where the 1% AEP flood is used as the basis for minimum floor levels or protection from a levee, a 0.5% flood event will probably overwhelm these measures. This event, whilst smaller, but significantly more likely than the PMF, will have major consequences to people, property and infrastructure and needs to be accounted for in emergency response planning.

An assessment of the full range of events therefore provides key information for flood response studies. Flood response studies need to consider changes in current flood responses due to an improved understanding of flood behaviour, as discussed above, and the changes likely in these responses due to both proposed floodplain risk management measures and future development. The stakeholders in flood response, including the local council and the SES, need to be consulted.

Evacuation analysis is one possible area for flood response assessment. It is critical that relevant information on evacuation is provided on events up to the PMF in the management study, where necessary. This may include:

- information on the effects on the community of flooding to different heights including road closures, isolation and the need to evacuate, etc.;
- provision of details on evacuation routes including likelihood and location of closures;
- assessment of time available for evacuation, based upon the time for evacuation routes to be closed in the shortest duration design storm event closing the route;
- assessment of rate of rise of water near the time of evacuation route closure;
- estimate of numbers of people/vehicles to be evacuated along routes;
- consideration of the nature of the people to be evacuated; and
- any special evacuation problems.

This information should enable a summary listing of evacuation routes identifying the number of people to be evacuated. The analysis should compare likely available effective warning time with evacuation time and highlight deficits.

The analysis should consider the changes in responses resulting from potential management measures and future development.

G8 Information for Primary End Users

The management study should provide key information for primary end users including council and the SES so they can fulfil their role in floodplain risk management.

Infrastructure providers, including councils, may also find the information useful for planning future, or upgrading existing services and making associated decisions on design standards.

Council can use the following information:

- land use planning recommendations from the management plan should assist council in updating their EPIs and development controls as discussed in Section J2.1; and
- the outcomes of the review of planning certificates discussed in Section G8.1.

Information for the SES should assist in its evacuation and logistics planning. This should include:

- a layman's description of flood behaviour for the full range of flood events;
- flood level information relative to the key flood warning gauges for the full range of flood events;
- identification of critical evacuation issues, such as the cutting of key evacuation routes and the development of islands that can ultimately be inundated and the potential timing for their loss; and
- identification of potential future development areas and their continuing risk management issues.

G8.1 Planning Certificate Information

As part of the completion of the floodplain risk management study an investigation into the most appropriate means to convey information

on planning certificates prepared under Section 149(2) of the EP&A Act (refer Section I7) for the study area should be conducted. It is suggested that council refer its intended approach to its legal advisers for review. The adopted approach is to be included in the management plan.

G9 Specific Issues of Concern

The following section presents an assortment of isolated but important aspects to be considered in management studies and plans that have come to the attention of the DIPNR in previous investigations. These issues are presented here as a partial checklist for the committee's careful consideration.

G9.1 Cumulative Impacts

A common problem for many councils is the cumulative impact of developments that have individually small (or even no impact), but which collectively have significant affects on flood behaviour or impact on local flood plans (readiness, response and recovery plans prepared under the guidance of the SES). The most common examples of this are the:

- blocking of floodways and flow paths by individual developments or levees;
- loss of flood storage due to filling of floodplain areas for individual developments and the consequential rise in flood levels; and
- increase over time in the at-risk population living and working on flood prone land and their impacts on emergency management resources or the capacity of evacuation routes.

Whilst it is true that each development by itself may not lead to a significant increase in flood levels, risk, evacuation needs or potential damage, the increase occasioned by the cumulative effects of a number of such developments is often unacceptable.

This is one of the principal reasons why this manual requires councils to prepare management plans: cumulative effects need to be evaluated before they occur. Evaluation occurs as part of the management study, as discussed in Section G6. Future development types may be included in the plan, if they are acceptable, or if compensating measures are both fully investigated (considering environmental, cultural, social, economic and flooding issues) and implemented to overcome the problems identified. Local EPIs, development control plans and flood related policies need to be revised to reflect the findings of the plan. This relates the plan to the consent process for subsequent individual developments identified as appropriate under the plan.

G9.2 Consequences of Floods Larger Than the Flood Used to Derive the FPL

To effectively address continuing flood risk management studies and plans need to consider the implications and consequences of the full range of flood sizes. This includes frequent floods and floods larger than the flood used to derive the FPL up to and including the PMF event. The emphasis in floods larger than the flood used to derive the FPL is on danger to personal safety and associated emergency risk management. Flood risk management measures that may be appropriate for a certain FPL (typically the 1% AEP flood plus 0.5m freeboard for standard residential development) may be inappropriate for larger floods.

The choice of the FPLs (see Appendix K) is often a difficult compromise between increasing marginal costs of flood or property modification measures and decreasing marginal benefits of protection.

What this means is not the unthinking acceptance of the limited level of protection provided by, say, flood or property modification measures, but the need to develop additional management measures such as response modification measures to mitigate the danger to personal safety associated with overwhelming flood events. Therefore a range of management measures are necessary to manage the full range of flood risk.

The definition of the floodplain and flood prone land is based on the PMF event and not on the more limited flood planning area. In this way, the community will be more receptive to directions to take action in a flood event than if they thought they were completely protected from flooding by development controls or works.

G9.3 Infrastructure Protection

Careful consideration needs to be given to the protection of essential infrastructure, such as

water supply, gas, sewerage, telephones and electric power, during the onset of a flood to ensure the ready restoration of these services in the flood's aftermath. This will both reduce damage to these public assets and facilitate clean-up and recovery in the post-flood period, thereby minimising social disruption to the community.

Protection activities that could be considered include the building of temporary bunds around sewage treatment plants, water treatment plants, electricity sub-stations, etc., and the uncoupling and removal of electric motors from pumps in the sewerage and water supply systems, etc.

Needless to say, if new or upgraded infrastructure facilities are proposed, all endeavours should be made to locate them in flood free areas, render them flood proof, or ensure that services can be easily restored after a flood.

G9.4 Rehabilitation of Areas Degraded by Past Flood Mitigation Works

Rehabilitation of degraded floodplains have significant environmental benefits. Where degraded areas of the floodplain are identified and it is likely they can be attributed to previous works that have excluded necessary flood flows, every effort should be made to incorporate rehabilitation measures into the management study and subsequent plan. Such measures could include allowing natural flows into areas where flow may have been excluded or removal or instigating controlled opening of structures that impede tidal flushing.

When assessing existing flood mitigation works investigations should be undertaken into their modification, reconstruction, modified operation or removal where positive environmental gains can be made without significantly increasing flood risk. For example, in coastal areas where potential flooding during high tides is not an issue, floodgates may remain open, in non-flood times, to allow tidal flushing and preservation or re-establishment of wetland ecosystems. These gates may be designed to automatically close during floods. Such changed operational strategies have already been applied at several locations across the State.

G9.5 Islands

The formation of islands in the floodplain during a flood is a potentially dangerous situation. This is especially so when floods larger than the flood used to derive the FPL totally inundate the island (see Figure G1). People trapped on the island and their rescuers will be placed at undue risk. Thus, the development of land that becomes isolated prior to ultimate inundation needs to be considered with great care.

G9.6 Levees

Levees are a flood modification measure. They are discussed in detail in Appendix J.

Levees are a tried and true flood protection measure as long as they are not overtopped and/or do not fail. However, levees are unlikely to be designed to exclude the PMF and therefore provision must be made for their overtopping or failure. The consequences of levee overtopping must be assessed in some detail and if personal danger and damage levels so require, appropriate measures should be adopted to reduce any catastrophic failure. These measures include response modification measures (such as flood response and readiness plans) to reduce personal danger and property modification measures (such as land use controls in the area behind the levee to reduce flood damage).

Levees may also have significant environmental impacts, through alienation of floodplains and the flooding needed by flood dependant ecosystems from rivers or by the obstruction of fauna passage.

As such, levees must be assessed according to the whole range of environmental planning legislation. A preliminary assessment should be undertaken in the management study to ensure the option is feasible. More detailed assessment is required as part of the investigation and design process, considering the relevant legislation.

G9.7 Hazardous Industries or Hazardous Storage Establishments

Hazardous industry or hazardous storage establishments are defined under State Environmental Planning Policy (SEPP) 33.

In both new and existing cases, management of the potential public health and environmental (medium to long term, post flood) risks associated with escape of materials due to inundation by floodwaters should be considered and formal management measures and procedures adopted in this regard. Where these measures and procedures cannot

adequately address this risk then alternative sites need to be considered. These sites may be within or outside the floodplain, but should be located where these risks can be managed effectively.

G9.8 Climate Change

The management study aims to provide a management plan that is "robust" for a reasonable period of time, ie, if in 20 years time the greenhouse effect is worse than currently anticipated, the adopted management plan should be able to be adapted.

The potential adverse impacts of climate change (see Section E6) on flooding behaviour therefore need to be considered. These include:

- increases in sea level which will increase flooding problems in coastal areas, particularly in intermittently closed ocean lagoons and lakes. These problems would be exacerbated by additional build up of berms at ocean entrances bought about by higher ocean levels. This may lead to the need to consider the following:
  - adopt higher FPLs to maintain the current level of protection or accept a higher level of flood risk ie, more frequent flooding; and
  - develop or update an entrance management plan to manage berm heights where these govern flood levels.

  Sensitivity analyses for the potential range of change in ocean level within the design timeframe should be considered in management studies.
- altered weather patterns may intensify storms and so increase the severity of the resulting floods. Consideration of the associated impacts through sensitivity analyses (see Section F7) may lead to a management study considerations such as:
  - deciding to adopt a higher FPL now aimed at providing a certain level of protection in future; or
  - deciding upon a particular level of flood protection now that will lead to a reduced level of flood protection in future.

An appropriate FPL (see Appendix K) for residential development would still generally be the 1% AEP flood event plus 0.5m freeboard. Freeboard could be expected to account for reasonable change in risk over time and therefore selection of a more conservative FPL may not generally be necessary.

The degree to which climate change is incorporated in a management plan should be decided in the management study after discussion with representatives from DIPNR.

G10 Recommendations from the Study

Recommendations from the study form the basis for a determining a coherent and integrated management plan (see Appendix H) that provides equitable and efficient measures to effectively manage existing, future and continuing flood damage and personal danger and minimises the exposure of the community to flooding.

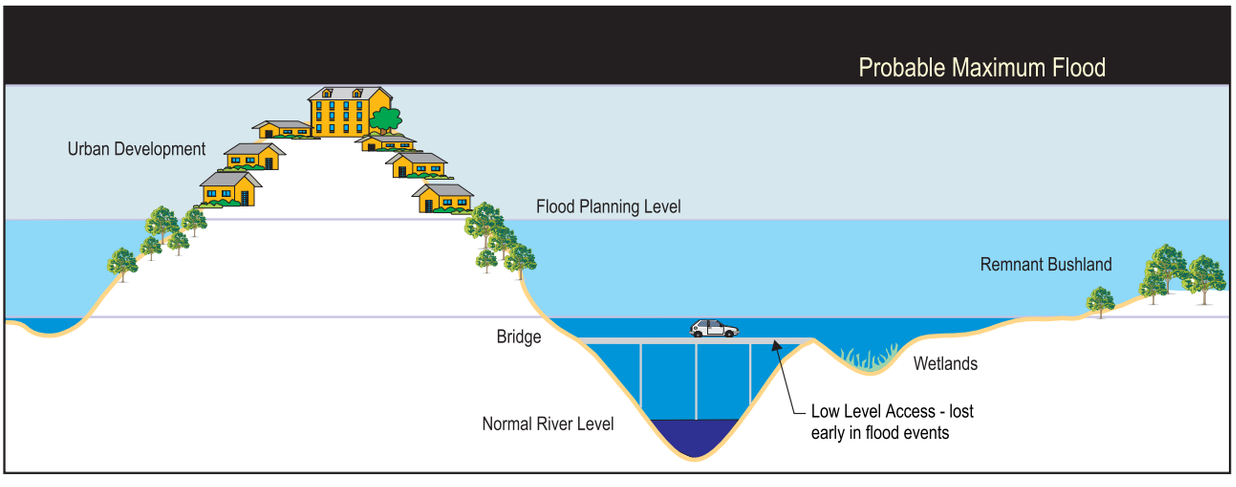


FIGURE G1 - Island which becomes inundated in an Extreme Event (PMF)

APPENDIX H FLOODPLAIN RISK MANAGEMENT PLAN PREPARATION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C										
Floodplain Risk Management Committee Appendix D	→	Data Collection Appendix E	→	Flood Study Preparation Appendix F	→	Floodplain Risk Management Study Preparation Appendix G	→	Floodplain Risk Management Plan Preparation Appendix H	→	Floodplain Risk Management Plan Implementation Appendix I

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)								
Floodplain Risk Management Measures Appendix J		Flood Planning Levels Appendix K		Hydraulic & Hazard Categorisation Appendix L		Flood Damages Appendix M		Emergency Response Planning for Floods Appendix N

H1 Introduction

A floodplain risk management plan is the formalisation of an effective floodplain risk management process. It is based on a comprehensive and detailed evaluation of all factors that affect and are affected by the use of flood prone land. It represents the considered opinion of the local community on how to best manage its flood risk and its flood prone land. It also provides a long-term path for the future development of the community. The management plan may apply to the whole local government area or a specific area of the floodplain. Therefore different management plans may apply in different parts of a local government area.

The floodplain risk management study and plan are integrally linked. The study provides for the assessment of options that form the basis for the considerations and decisions in the management plan. The management study and the plan (usually draft) are often completed in one consultancy. This appendix:

- describes the objectives of the floodplain risk management plan;
- indicates the issues to be considered in plan preparation;
- discusses community involvement in review of the management plan; and
- discusses preparation of the plan and its adoption.

Appendix G details the studies and management option assessments completed as part of the management study leading to the decisions in the plan. Details on plan implementation are discussed in Appendix I.

H2 Objectives

Management plan objectives are to:

- to meet the objectives of the process, outlined in Appendix C, from the findings of the management study.

  The management plan will consist of a coordinated mix of measures that address existing, future and continuing risks. It should describe and discuss the various issues, problems, special features and values of the area, along with specific management measures. It is to include information describing how flood risk in specific areas is to be managed to achieve objectives in both written and diagrammatic form;
- ensure the management plan is fully integrated with the local flood and catchment plans, council's existing corporate, business and strategic plans, existing and proposed planning instruments and meets council's obligations under the LG Act.

  The management plan is linked to other plans, especially the local flood plan. Both the floodplain risk management

and local flood plans share a broad range of flood information, are dynamic rather than static, and activities under one plan have implications for the other. It is emphasised that neither plan can be developed in isolation, and that the optimal result is obtained when both plans are developed and implemented in partnership.

The management plan is also to be integrated with the other planning instruments, policies and strategic, corporate and business plans of council. The proposed inclusions in these planning instruments, policies and plans are to be detailed in the management plan along with an implementation plan.

Recommendations in the management plan should be checked for consistency against council's statutory powers and obligations before adoption;

- ensure that the management plan has the support of the local community.

  Local community support can be gathered by an inclusive process with input into the decision making process. This should be undertaken throughout the preparation of the management study (Section G5.1) and plan (Section H4);

- ensure actions arising out of the management plan are sustainable in social, environmental, environmental, cultural and economic terms and maximise positive and minimise negative impacts.

  The management study provides the basis for the preparation of the management plan. Option assessment considers the broad range of issues discussed in Appendix G. This can assist in establishing the preferred management options and their priority order;

- establish a program for management plan implementation and a mechanism for funding the management plan including priorities, staging, funding, responsibilities, constraints, and monitoring.

  An implementation program is to be included in the management plan. This is to be prioritised based upon how soon the management measures can be implemented, what constraints exist, and how effective the measures are. Measures with little cost that can readily be implemented and which are effective in reducing damage or personal danger should have high priority;

- enable effective management of future land use, by providing the relevant inclusions in the management plan which outline:

  - the limits of development due to hazard and adverse impacts upon other properties;
  - the types and scales of development appropriate within these development limits; and
  - the conditions necessary to support the development types and scales outlined.

  This, along with recommendations of how to implement these changes forms the basis of changes to council's EPIs and development control plans and policies;

- develop or update a local flood risk management policy for the study area.

  The committee should make recommendations to council on its existing or proposed local flood risk management policy. These should reflect the objectives of the management plan and include changes that are necessary to the policy as portions of the management plan are implemented; and

- adopt the management plan.

  The committee would make recommendations to council on the draft management plan. Council would then consider whether to adopt the management plan and in what final form. Alterations to the management plan at this stage should reflect council's decision.

  A management plan is never truly finalised as discussed in Section H5.

H3 Considerations in Plans

The following major elements need to be considered in the preparation of a management plan, where relevant. These elements are derived through the data collection and studies as part of the management process:

- collection of flood related data;
- extent of flood prone land (as defined by the PMF);
- hydraulic categories;
- hazard assessment and categories;
- social description and analysis;
- environmental impacts and opportunities for enhancement;
- land use, existing and potential;
- development types;
- economic analysis;
- management measures (property, flood, and response modification measures);
- land use and related controls;
- FPLs for differing purposes;
- links with agreed catchment objectives;
- links with other plans, particularly the local flood plan;
- provisions of the EP&A Act, LG Act and other relevant legislation and policies;
- protection of Aboriginal sites and places under Section 90 of the NP&W Act;
- performance measures against which the progress and success of the management plan can be measured and reviewed;
- an implementation strategy including consideration of long term issues such as ongoing community education and awareness; and
- monitoring and review.

H4 Community Involvement in Management Plan Review

The community as a whole should be involved in the formulation and implementation of a management plan. Community consultation is a necessary element of the floodplain risk management process (see Figure 2.1).

To conform to the principles of this manual, it is necessary that councils actively involve representatives of the community, particularly owners of flood prone land, in the preparation of the management plan and review of its effectiveness.

Irrespective of any statutory requirements, the management plan should be exhibited and public comment should be sought and taken into account before it is finalised and adopted by council.

It cannot be stressed too strongly that community involvement in all phases of the floodplain risk management process is essential to the development, acceptance and implementation of effective management plans.

In developing management plans, communities should clearly understand that certain areas of land will need to be set aside to facilitate floodplain risk management, for example, as floodways or flood storage areas. These areas can be used for many flood compatible purposes, but should remain capable of fully performing their floodplain management role. Farmland in such areas can usually remain in productive use. In urban areas, such land becomes valuable open space to be used for recreational pursuits and/or environmental enhancement (including wetlands).

It is important to recognise that management plans do not purport to eliminate all flood risk but to ensure that it is effectively managed.

H5 Finalisation of the Management Plan - 'Adopted Management Plans'

A management plan is never truly finished. Social and economic circumstances change and flooding behaviour may be substantially altered by future measures adopted in other areas of the catchment. A management plan represents the 'best' appraisal of existing and likely future circumstances at the time it is 'adopted'. For this reason, we do not speak of 'final' but rather of 'adopted' management plans, that is, plans that have been adopted for the immediate future. Management plans should be reviewed regularly (say every 5 years or after each major flood, or where circumstances change that impact on the relevance of the management plan) to ensure that their provisions remain appropriate.

It is essential that the adopted management plan is complementary to the local flood plan. Existing, future and continuing flood risk cannot be effectively dealt with if this does not occur, or if the SES is left out of the overall management process. Review of either plan should not be undertaken without reference to the other plan and the relevant authority. Changes in the floodplain risk management plan should be reflected in the local flood risk management policy.

APPENDIX I FLOODPLAIN RISK MANAGEMENT PLAN IMPLEMENTATION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C										
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I

TECHNICAL SUPPORT APPENDICES (Those directly supporting this Appendix are highlighted)								
Floodplain Risk Management Measures		Flood Planning Levels		Hydraulic & Hazard Categorisation		Flood Damages		Emergency Response Planning for Floods
Appendix J		Appendix K		Appendix L		Appendix M		Appendix N

I1 Introduction

Management studies and plan provide an informed basis for decision making by the local councils to enable flood risk to be effectively managed to an acceptable and understood level.

However, the completion and adoption of a management plan itself does not manage flood risk. This relies on implementation, which is a critical step in the management process.

Implementation is overseen by a reduced committee (discussed in Appendix D) and undertaken in accordance with a priority for management measures developed in the management plan. This is based upon:

- how soon they can be implemented;
- resourcing required;
- the constraints that exist (including financial and physical);
- how these can be addressed; and
- how effective the measures are.

Therefore, low cost measures that can be readily implemented and are effective in reducing damage or personal danger are likely to have a high priority.

This appendix discusses plan implementation and covers the following specific issues:

- objectives;
- management plan review;
- information provision to the public;
- application of development controls to flood prone land;
- the local flood risk management policy;
- suggested information for planning certificates under Section 149 of the EP&A Act;
- the approvals processes for recommended management works; and
- interaction with the local flood plan developed under the leadership of SES.

Funding for implementing management measures is discussed in Section 2.9.

I2 Objectives

The objective of implementing the management plan is to manage the full range of flood risk through a range of measures and in accordance with the implementation schedule outlined in the management plan.

I3 Management Plan Review

Review of an adopted management plan is discussed in Section 2.7. This should include a review of the implementation plan, particularly where impediments may affect priorities or timing of measures.

I4 Information Provision to the Public

The community needs to be made aware of their risk of flooding and has a right to access information held by public authorities about flooding. The necessary information relates to:

- the affectation of their current property and prospective future property and associated development controls;
- what to do during a flood event; and
- provision of an avenue for further discovery of information and interpretation for the individual property itself.

This can be provided through:

- public education to raise general and specific awareness of flood affectation, as discussed in Section I4.1;
- planning certificates issued by councils under Section 149(2) of the EP&A Act as discussed in Section I7.2. These are required on contracts for land sale and provide information in relation to whether council has policies to restrict development of the property for a range of reasons, including flooding;
- planning certificates issued by councils under Section 149(5) of the EP&A Act or similar documents as discussed in Section I7.3;
- Planning controls including LEPs, DCPs and the local floodplain risk management policy, to provide additional information on development constraints, as discussed in Sections I5 and I8; and
- access to council staff for further discussion.

I4.1 Public Education

Changes in people's response to a flood can reduce flood losses and thus people who use the floodplain need to be ready for floods.

However, education of the public is a difficult task as unless people have actually experienced a flood, they tend to be sceptical when they are informed that there can be floods in their area. Thus, as experienced people move out of the floodplain area they take their knowledge with them and those who replace them add to the increasing number of people who may have little direct experience or awareness of flooding.

The tendency to ignore that an area is flood prone can be aggravated by flood mitigation measures, effective planning controls and floodplain risk management measures. This is particularly the case where levees are built. Levees traditionally engender a false sense of security by implying that all future floods will be excluded from the area. The more successfully these measures reduce the losses in frequent flooding, the fewer the number of people in the community who have experienced a flood. A continuing flood readiness campaign will be necessary to try to ensure the community remains aware of its risk and ready to act.

For those people who are unprepared for a flood, the shock of being flooded can affect their physical as well as their mental health. Indeed, people who have suffered from a flood often find that the social impacts are worse than the financial losses. Further, those who are unprepared suffer more than those who accept that a consequence of deriving benefit from the floodplain is that they may have to cope with one or more floods while they occupy that floodplain.

Public education is therefore an essential element in implementation of a management plan. This is an ongoing task which must be kept alive, for example, through local media, SES activities and, regular advice from council to affected residents. It needs to be targeted to all areas of flood prone land, not just the area below the FPL, and consider the ramifications of the PMF event.

I5 Development Control

Management of development of flood prone land is through a combination of land use restrictions and development controls, as discussed in Sections G6.

These are ideally included within a combination of the relevant EPIs as discussed in Section J2.

A local floodplain risk management policy, as described in Section I6, may also be used to assist in implementing development control. The policy is unlikely to be as obvious as inclusions in LEPs, and DCPs and it deals with issues beyond development control. The development related issues in the policy are relevant for consideration in DCPs.

I6 Local Flood Risk Management Policy

A key outcome of the management plan is the formulation of a local flood risk management policy or update of an existing policy. In essence, such a policy would be a succinct written summary of council's floodplain risk management plan. As such, the policy would serve as a comprehensive introduction to the local community on flooding matters and the management of flooding and its consequences. An important component of the policy would be council's views on the use and development of flood prone land.

The policy, as an integral part of the plan, should be reviewed with the management plan and risk management measures implemented under the plan should be reflected in the policy.

The policy may apply to an area covered by a single management plan or the whole local government area covered by a single or multiple management plans in which general and area specific issues may be addressed.

Policy inclusions are outlined below and should, where appropriate, be included in councils EPIs and DCPs, when these are updated.

I6.1 Local Policy Aims and Objectives

The overall objectives of the policy document should aim, amongst other things:

- to alert the community to the extent and degree of hazard of flood prone land;
- to inform the community of council's policy in relation to the development and use of flood prone land and the existence of the relevant LEPs, DCPs and local approvals policies;
- to reduce flood risk and damage to existing areas of development;
- to ensure that future land use and development is compatible with flood risk;
- to reduce flood risk to future development to an acceptable level through appropriate land use controls. This includes, but is not limited to, definition of FPLs for floodplain development and planning purposes;
- to put in place and complement flood warning procedures and local flood plans for the protection of and/or evacuation of flood prone areas, the relief of evacuees and the recovery of flooded areas;
- to ensure, whenever possible, that buildings and services required for evacuation and emergency needs are sited above the PMF level; and
- to put in place response plans to protect essential infrastructure and services (such as telephones, power, water supply and sewerage) during the onset of a flood and to ensure the speedy restoration of these services in a flood's aftermath.

In general, formulation of a policy should recognise the extent of investment, both public and private, in existing development in flood-prone areas. It should take into account the value of this development when considering alterations and additions to existing development. It should indicate the requirements to be used for new development consistent with the local policy and management plan.

This policy should succinctly present councils considered view on the use and development of flood prone land.

The policy may be developed and updated throughout the floodplain risk management plan and background study preparation process as discussed in Section C9.

I6.2 Contents of Policy

I6.2.1 Introduction

The introduction to the council policy should:

- canvass the NSW Government's Flood Prone Land Policy;
- include a statement of council's aims and objectives;
- indicate the area covered by the policy;
- provide background to development of the policy; and
- indicate the relationship of the policy with other council policies and regulations.

I6.2.2 Definitions

Under this heading it would be advisable to include definitions covering authorities, flood prone land, hydraulic and hazard categories,

risks, development categories, plans, FPLs, ESD, etc. Some can be sourced from the manual glossary.

I6.2.3 Flood Extents & Flood Planning Levels

The policy should indicate, as fully as possible, the extent of flood prone land (as determined by the PMF), and specify the FPLs adopted for planning and control purposes. The extent of flood prone land should be indicated on broad scale maps, together with the various hydraulic and hazard categories for the flood upon which the FPL is based. The policy should include broad details on the basis of adoption of the FPLs for planning purposes and associated risk exposure.

Based on these decisions, standards for the determination of land use categories and the necessary controls, usually detailed in DCPs, can be stated.

I6.2.4 Applications for the Development of Flood Prone Land

This section of the policy should explain the process whereby developers seek council permission for developments on flood prone land. In particular, the various steps and factors that are taken into account in the preparation and submission of a development application for flood prone land should be itemised.

I6.3 Local Development under Part 4 of the EP&A Act

Part 4 of the EP&A Act provides for assessment of "exempt" and "complying" developments. These categories of development could only be introduced through an EPI and the types of development need to be listed. Unless councils have included exempt and complying development in their EPIs and amended SEPP60 to remove them from its operational coverage, they will be covered by SEPP60.

Exempt and complying development and developments requiring consent need consideration in the management plan and local policy, as discussed in Section 3.1.3.

The policy needs to identify the flood related constraints and limitations applying to both exempt and complying developments and detail the conditions that will be set for developments requiring consent.

Indicative constraints, for consideration in the local policy, for specific types of development on flood prone land are indicated below. Additional considerations for development outside those identified as appropriate in the floodplain risk management plan are discussed in Section I6.3.6.

I6.3.1 New Residential Developments

Applications for new residential development in areas below the appropriate FPL should require the applicant to lodge a survey plan showing ground levels (relative to AHD), floor levels and location of existing buildings. This information is essential to allow the application to be considered.

Floor levels of habitable rooms should be specified and should be not less than the relevant FPL. A certificate by a registered surveyor certifying the level of the completed building should be required.

Where, in the opinion of the council, a proposed development could sustain structural damage by flooding, no work should be allowed to commence until the applicant obtains and submits a certificate of structural adequacy from a qualified structural/civil engineer considering the potential flood affectation.

I6.3.2 Existing Residential Developments

Where additions and alterations to existing buildings include habitable rooms, the requirements outlined in Section I6.3.1 should apply, except in particular circumstances where, in the opinion of council, the floor level requirement is impractical or unreasonable.

Where additions and alterations do not involve habitable rooms, applicants should be notified by council of the likelihood of the proposed structure being flooded and should be required to ensure that new structures do not adversely affect the existing flow of floodwaters. The use of flood compatible materials below the FPL should be recommended.

I6.3.3 New and Existing Commercial and Industrial Developments

Where applications for development in flood prone areas are considered, council should require the applicant to lodge a survey plan prepared by a registered surveyor showing ground levels, floor levels (relative to AHD) and location of existing or proposed buildings.

Floor levels should be set at a minimum of the appropriate FPL. This floor level requirement may apply to the whole or part of the structure (providing a location for storage of goods during a flood event). A certificate by a registered surveyor certifying the level of the completed building should be required. The use of flood compatible materials below the FPL should be recommended.

All applications should be accompanied by a certificate from a qualified structural/civil engineer stating that the building will not sustain structural damage from the forces and impact debris associated with floodwaters in the event used to derive the FPL.

Any development consent in relation to applications for new commercial or industrial buildings, alterations to existing buildings or changes of use, should be endorsed by council with advice on matters affecting the land, including flood damage.

In view of the large damages that can be inflicted on commercial and industrial properties, council, by way of a development condition, may require the occupant of such properties to produce detailed on-site response plan to minimise flood damage.

Issues relating to hazardous industries or hazardous storage establishments are discussed in Section G9.7.

I6.3.4 Essential Community Facilities and Critical Services

Special consideration must be given to essential community facilities and critical services, as discussed in Section 3.1.7 and Appendix G. It is essential that requirements for these types of developments are addressed in a local policy.

I6.3.5 Other Developments

Developments such as sporting grounds and open car parks should be considered for flood prone land. Consent for such developments should require certificates from surveyors and engineers as described above.

Developments such as land fill and fencing may require more specialised treatment. It is essential that these issues be addressed in the floodplain risk management process, prior to any inclusion in the local policy.

I6.3.6 Developments Outside those Identified as Appropriate by the Management Plan

Applications for types of developments that are outside those identified as appropriate in the floodplain risk management plan and EPIs fall into two categories, those not originally foreseen, or those that have been rejected, in preparation of the management plan.

The first type may be permissible under a particular zoning in councils EPIs and needs to be treated sensitively. Once council becomes aware of the potential for a new type of development, it should instigate review of the management plan and associated local policy, at the earliest possible stage. This review should consider the cumulative impacts of these types of development on the full range of flood related issues in the management plan. This review may result in changes to the management plan, the local policy and consequently council's EPIs.

The second type, because it is outside those identified as appropriate in the floodplain risk management plan and EPIs, will require rezoning as discussed below.

I6.3.7 Rezoning to Permit Purposes Outside those Identified as Appropriate by the Plan

Consideration of rezoning land to permit purposes outside the development types identified as appropriate in the management plan should be based on additional investigations to address the full range of issues considered in the management plan to an equivalent depth.

From a flood risk management perspective, rezoning applications need to be considered within the strategic framework of the management plan. The development is to be assessed both on a cumulative and individual basis to ensure:

- it will not increase the flood risk experienced by other current floodplain occupants. This includes not altering the danger to personal safety of existing floodplain inhabitants or flood damage to other properties, or adversely affect them in any way (such as elongation of inundation times) during flooding;
- it has to be designed and constructed in such a manner as to ensure that

potential loss of life in an extreme flood event is minimal. The development does not significantly adversely impact upon emergency response management of other sites or areas.

This may involve incorporation of permanent, fail-safe, maintenance free measures into the development to ensure the timely, orderly and safe evacuation of people from that area, should a flood occur. In addition, it should also be demonstrated that the displacement of these people during times of flood will not significantly add to the overall cost and community disruption caused by the flood;

- it has to be undertaken, designed and constructed in such a manner as to hold potential financial losses from flooding at an acceptably low level; and
- it will also not adversely impact on the social, economic, cultural or environmental requirements of the floodplain.

Where the rezoning is considered appropriate and is to be approved or where the findings alter the management plan, it along with the local flood risk management policy and councils EPIs should be reviewed.

I7 Planning Certificates issued under Section 149 of the EP&A Act

Councils issue planning certificates to potential purchasers under Section 149 of the EP&A Act. The function of these certificates is to inform purchasers of planning controls and policies that apply to the subject land. The principles for using these certificates are provided in Section 3.1.4. Their use is discussed below.

Planning certificates are an important source of information for prospective purchasers on whether there are flood related development controls on land.

Section 149 certificates are not seen as a broad community education tool. They have limited circulation as they are generally triggered by property sale, therefore they reach only prospective purchasers and some existing owners. They do not reach the majority of property owners (in a given year) and other occupants of property, who form a large part of the target audience for flood education.

Unfortunately, advice that land is not subject to flood related development controls is often colloquially understood to mean that the land is flood free. Therefore, it is important that flood-related information on planning certificates is clear and unambiguous. Care should be taken to ensure that the information provided is not misunderstood by the general public to mean that the land is flood free when in fact it is only free of constraints to development. Appropriate information can be provided:

- through application of council's local flood risk management policy to all flood prone land, ie, land inundated by the PMF. Under this approach, land up to the FPL for development control may be subject to specific development controls, whilst land between this and the PMF has advice that a flood risk exists even though development controls do not impact on the property;
- through explicit information concerning historical floods or estimated flood levels with various chances of occurrence or FPLs.

To become fully aware of the flood risk prospective purchasers need to rely upon the use of information provided on planning certificates under both Sections 149(2) and 149(5) of the EP&A Act, using either planning certificates or other appropriate means.

Because of the wide range of different flood conditions across the State, there is no standard way of conveying information. As such, councils are encouraged to determine the most appropriate way to convey information for their areas of responsibility (see Section G8.1). This will depend upon the type of flooding, whether from major rivers or local overland flooding, and the extent of flooding (whether widespread or relatively confined).

Councils may consider providing a combined certificate (incorporating information under both Sections 149(2) and 149(5) of the EP&A Act) to prospective property purchasers for the fee charged for the mandatory certificate containing information under only Section 149(2). Alternatively council could, if it has the necessary ground and floor level survey information, provide a flood report indicating flood levels in relation to land and building floor levels for a separate fee. Either approach would enable prospective property purchasers to be

provided with the available flooding information relevant to the land.

I7.1 Initial Subjective Assessment

In certain circumstances, particularly in relation to local overland flooding, definitive flood level data may not be available to enable determination of properties that should be covered by development controls and therefore covered under Section 149 of the EP&A Act. In such cases, as a first step, an initial subjective assessment should be made to determine the properties likely to be at risk. The methodology used to undertake this assessment should be documented and based upon historical information and reasonable assumptions given the catchment and channel size and terrain.

This assessment should only be used in the first instance and be updated as studies are undertaken to provide a better assessment of flood extents as part of the preparation of a management plan for the area.

I7.2 Typical Examples of Information Provided on Planning Certificates under Section 149(2)

One means of enabling prospective purchasers to become fully informed is for councils to adopt a local flood risk management policy which relates to all flood prone land. This would enable councils to provide advice on planning certificates under Section 149(2) as to whether the property:

- is flood affected to the extent that council applies development controls such as minimum floor levels (for properties within the area affected by the FPL); or
- whilst not affected by flood related development controls (areas above the FPL), could be flooded in rarer events than that adopted as the basis of the FPL.

Examples of information provided under Section 149(2) of the EP&A Act in relation to flood risk are as follows:

- A property above the FPL

  "Council considers the land in question to be above the flood planning level and therefore its local flood risk management policy does not impose flood related development controls. However, the property may be subject to flooding in very rare flood events. Information relating to this flood risk may be obtained from Council."

- A property below the FPL

  "Council considers the land in question to be below the flood planning level and therefore subject to flood related development controls. Information relating to this flood risk may be obtained from Council.

  Restrictions on development in relation to flooding apply to this land as set out in Council's local flood risk management policy, which is available for inspection at Council."

This enables prospective purchasers to become aware of the location of prospective purchases within the floodplain, and provide them with the indication that additional information does exist and where this information can be sourced.

I7.3 Typical Examples of Information Provided on Planning Certificates under Section 149(5)

Examples of information provided on planning certificates under Section 149(5) of the EP&A Act in relation to flood risk are as follows:

- Where information on various design floods is known

  "The information available to Council indicates that the estimated 1 in 100 and 1 in 20 year average recurrence interval flood levels are 5.7m AHD and 5.0m AHD respectively. The probable maximum flood level is 8.3m AHD."

- Where only historical information is known

  "Flooding to a level of 6.9m AHD, as determined by debris marks, occurred in the storm event of November 1996. However, no information is available on the average chance of a storm of this magnitude happening in any given year at this stage."

I7.4 Additional information that could be provided on Certificates under s149(5)

Councils may consider they need an additional statement when specific information on flood levels is provided under Section 149(5):

"Council does not have sufficient accurate ground level information to indicate the extent of the land that may be affected by flooding. A registered surveyor may be able to assist in determining flood extents on the site and flood levels relative to building floor levels."

I8 Approvals for Recommended Management Works

Prior to undertaking any works recommended in the floodplain risk management plan all necessary approvals are to be obtained. Development consent (under Part 4 of the EP&A Act) may be required and council's planning staff should be consulted to determine the level of environmental assessment required. Otherwise environmental assessment in accordance with Part 5 of the EP&A Act must be undertaken and appropriate approvals gained.

Controlled work, as defined in the Water Act or Water Management Act, which also require development consent are considered integrated development and are to be dealt with under Sections 91 to 93B of the EP&A Act. Other integrated development assessment provisions may also apply.

In addition, it may be necessary to consider the provisions of the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth) and Threatened Species Conservation Act 1995 (NSW), Fisheries Management Act 1994 (NSW), and Native Vegetation Conservation Act 1997 (NSW), as they relate to environmental impact assessment.

Other legislation and policies may also need to be considered.

I9 Interaction with the Local Flood Plan

Implementation of management measures can impact on the emergency management planning for floods documented in the local flood plan (discussed in Appendix N).

Changes in flood behaviour, or flood warning systems, or critical levels for evacuation can impact upon flood response and associated planning.

Therefore, it is important that the SES be informed of any such changes, as and when they occur, so adjustments, as necessary, can be made to the local flood plan.

APPENDIX J FLOODPLAIN RISK MANAGEMENT OPTIONS

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I

J1 Introduction

There are basically three ways of managing flood risk to reduce flood losses:

- by modifying existing properties (for example. house raising) and/or by imposing controls on property and infrastructure development (Property Modification);
- by modifying the response of the population at risk to better cope with a flood event (Response Modification) (for example improving community flood readiness); and
- by modifying the behaviour of the flood itself (Flood Modification) (for example construction of a levee to exclude floodwaters from an area).

Property modification measures, such as effective land use controls, are essential if the growth in future flood damage is to be contained. Response modification measures, such as flood education programs, are the most effective means of dealing with the continuing flood risk (the risk that remains from flood events after other management measures are in place). Flood modification measures, such as levees, are a common and proven means of reducing damage to existing properties under threat from flooding. However, they are usually costly and have the greatest potential to affect the ecology of the floodplain. As such they are restricted to use in addressing existing flood risk.

A floodplain risk management plan needs to consider all three types of management measures and adopt an integrated and effective mix, which is appropriate to the specific circumstances of the flood prone community. Particular attention should be given to measures that have a dual purpose of reducing flood risk and enhancing or restoring the natural environment.

This appendix describes the various types of floodplain risk management measures, including some of their advantages and potential disadvantages. Section J5, discusses issues in common to all measures.

For convenience, the various measures have been described in isolation. However, a fundamental principle of good floodplain risk management is that risk management measures should not be considered either individually or in isolation. They must be considered collectively from within the all-embracing framework of a floodplain risk management study that allows their interactions, their suitability and effectiveness and their social, environmental and economic impacts to be assessed on a community-wide basis.

J2 Property Modification Measures

Property modification measures refer to modifications to existing development and/or development controls on property and community infrastructure for future development. These measures include:

- land use planning including zonings and development controls;
- voluntary purchase of high hazard properties;
- voluntary house raising;
- flood proofing of buildings; and
- flood access.

These are aimed at steering inappropriate development away from areas with a high potential for damage and ensuring that potential

damage to developments likely to be affected by flooding is limited to acceptable levels by means of minimum floor levels, flood proofing requirements, etc.

J2.1 Land Use Planning

Land use planning limits and controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately.

Effective consideration of future development involves a strategic assessment of flood risk to future development areas to guide councils, in wisely and rationally controlling development to reduce the risk exposure of new development to an acceptable level, as discussed in Section G6.

Strategic assessment of flood risk, as described, can steer inappropriate development away from areas with a high hazard and/or with the potential to have significant impacts upon flood behaviour in other areas. It can also reduce potential damage to developments likely to be affected by flooding to acceptable levels by means of minimum fill and floor levels and flood proofing requirements, etc.

Land use planning measures and controls are discussed in Sections J2.1.1 and J2.1.2. Application to individual properties is discussed in Section J2.1.3. The development of a local floodplain risk management policy is discussed in Section I6.

J2.1.1 Zoning

Land use controls are an essential part of managing flood risk. Adjustments to zonings to adequately consider flood risk normally occur after the completion of the floodplain risk management plan. Appropriate land use control measures are strongly recommended if the rate of growth of future flood damage is to be limited. To achieve an objective compromise on these issues, it is essential that planning measures be formulated under the auspices of a floodplain risk management committee. This allows all issues to be aired and resolved within the context of an overall management plan, set within a clearly understood strategic time frame. This leads to recommendations on the division of flood prone land into appropriate land use zones, an effective and long term means of limiting danger to personal safety and flood damage to future developments.

Councils should therefore give due consideration to selecting appropriate zones and related provisions when flood prone land is being rezoned. Moreover, any flood related zonings identified in the floodplain risk management plan should be incorporated into an LEP or DCP.

However, the New South Wales Government's Flood Prone Land Policy does not support the use of zoning to unjustifiably restrict development simply because land is flood prone. Zoning of flood prone land should be based on an objective assessment of land suitability and capability, flood risk, environmental and other factors.

In many cases it is possible to develop flood prone land sympathetically to the natural characteristics of the land without resulting in undue risk to life and property. The flood risk assessment should include consideration of factors discussed above.

J2.1.2 Development Controls

As indicated above appropriate zoning provides control on future land uses considering the flood risk.

In the areas where development is considered acceptable, development controls are the appropriate means of implementing detailed aspects of council's floodplain risk management plan, particularly when addressing future flood risk.

However as indicated above, the suitability and effectiveness of development controls in managing risk needs to be considered within a strategic management framework as part of the management study. The aspects that need to be addressed in detail in the management study with associated recommendations in the management plan should include:

(a) Access to the Site During Flood Events

This issue needs to be addressed in the assessment of suitability of or the capacity of the site for development, as part of the management study, and later in sub-division and building design. It relies on the ability to predict flooding and warn residents of the need to evacuate during a flood event. Local topography and flood behaviour must be considered in developing requirements and controls. A requirement might be that

vehicular access is available from some or all of the floodplain until the flood waters reach a particular level, and that pedestrian access is available until the flood waters reach some other particular level. Often the benchmark level to be considered is the most likely to trigger the need for evacuation. Experience has shown that often this level is as water starts entering the house.

(b) Fill or Excavation in the Floodplain

Fill or excavation in the floodplain is likely to change the flow pattern of a flood. Limits may be placed on the location, level and quantity of fill or excavation. The determination of these limits must take into account the cumulative effect of a number of small excavation or filling projects across the whole floodplain. It should be noted however that excavation and filling are not comparable, as excavation is more likely to affect small floods, whereas filling has more impacts on larger floods.

(c) Freeboard

The purpose of freeboard is to provide reasonable certainty that the reduced level of risk exposure selected by deciding upon a particular event to provide flood protection for is actually provided given the range of factors discussed in Section K5.

(d) Floor levels

It is common practice to set minimum floor levels, particularly for habitable rooms in residential buildings. Minimum floor levels can reduce the frequency and extent of flood damage. These are generally based upon a selected FPL.

(e) Differences between Land Uses

Different land uses may require different flood related development controls due to specific problems relevant to the development type. This aspect is considered in determining the appropriate types of development for specific portions of the floodplain in the management study.

(f) Services

Services might be disrupted at the infrastructure plants (water treatment, sewerage treatment, power generation and communication exchanges) or along the distribution networks. To reduce the disruption caused by infrastructure services being interrupted by floodwaters, conditions for the location and flood proofing of power, potable water, sewerage, drainage and communication services are appropriate.

(g) Impact on Flood Behaviour

The impact of activities such as the development of existing sub-divisions, future subdivisions, land clearing, land fill or other changes to ground levels on flood behaviour need to be addressed. The cumulative impact of a number of similar proposals needs to be assessed in the preparation of a floodplain risk management plan.

(h) Structural Soundness When Flooded

Flood waters can impact upon the structural soundness of buildings in a number of ways relating to flow velocities and depths and associated debris loads. Structural soundness of buildings can be tested by the resultant impacts, including buoyancy. Development conditions in flood affected areas should be considered in relation to certification of the soundness of structures for the local hydraulic conditions.

(i) Building Materials

Some building materials are less susceptible to damage by flood waters, or are easier to clean up after a flood. Acceptable or unacceptable materials might be identified in development controls.

Compatibility of materials that, if adversely affected, would reduce the stability of flood exposed structures would be recommended.

(j) Fencing

Fences, whether solid or open, can impact upon flood behaviour by altering flowpaths. This impact will depend upon the type of fence and its location relative to the flowpath. Where a significant impact is expected in an area, controls should be considered in relation to type of fencing permitted, or to limit its location or height.

J2.1.3 Aspects Dealt with in Individual Development Applications

For those types of development that have been identified as appropriate in the floodplain risk management plan for the area under consideration, the merit approach, as reflected

in specific development controls, should be used to ensure that individual developments are compatible with detailed provisions of the plan. Aspects to be addressed include:

- preferred location on the site;
- the compatibility of any proposed flood mitigation works within the overall floodplain risk management plan;
- whether the minimum floor levels in the proposed development are in accordance with the FPL;
- the suitability of proposed building materials;
- whether minor structures, such as fences, are likely to affect or be affected by flood flows; and
- limiting the runoff from the development to pre-development or 'natural' levels.

If building extensions are of a major nature and could lead to a significant increase in likely flood damage, or obstruction to flood flow, they should be subject to more stringent conditions. Detailed comments on major and minor extensions are provided in Section 3.1.3.

J2.2 Voluntary Purchase

In certain high hazard areas of the floodplain it may be impractical or uneconomic to mitigate flooding to existing properties at risk. In such circumstances it may be appropriate to cease occupation of such properties in order to free both residents and potential rescuers from the danger and cost of future floods. This is achieved by the purchase of the properties and their removal or demolition as part of an adopted floodplain risk management plan.

Under such circumstances, property should be purchased at an equitable price and only where voluntarily offered. Such areas should ultimately be rezoned to a flood compatible use.

J2.3 Voluntary House Raising

Voluntary house raising has long been a traditional response to flooding in New South Wales, as demonstrated by the number of raised houses in frequently flooded urban areas such as Lismore and Fairfield.

Home owners generally have very strong sentimental and emotional attachments to their dwellings, which often also represent a large capital investment.

Avoidance of flood damage by house raising achieves the following three important objectives:

- a reduction in personal loss;
- a reduction in danger to personal safety and in the costs of servicing isolated people who remain in their homes to protect possessions; and
- a reduction in stress and post-flood trauma.

In general, voluntary house raising is a suitable management measure only for low hazard areas of the floodplain. In high hazard areas, either physical means of protection, for example, levees, or voluntary purchase measures are required.

Where voluntary house raising in a specific area is identified in an adopted floodplain risk management plan as a means of protecting a significant number of houses at serious risk of flooding, it becomes a formal management measure and, as such, is eligible for Government financial assistance. The provision of funding is dependent upon the relative priority of these works on a statewide basis. If voluntary house raising is the only means of damage reduction available to individual properties at low risk, house raising can be undertaken by the individual owner.

Not all houses are suitable for raising. Houses of single or double brick construction or slab-on-ground construction are generally either impossible or too expensive to raise, however the decision on this latter issue is very site specific. Houses best suited to raising are timber framed and clad with non-masonry materials.

While raising a house may achieve the objectives described previously, care must be exercised in implementing this measure by considering the implications of a slightly higher than design flood. The new construction may be isolated for long periods during floods, necessitating an increased load on emergency services, should they be required. The isolated house would also need to be capable of "self support" during flooding. This requires, for example, adequate food, water and possibly power supplies. Thus it is essential that both the benefits of and

problems associated with voluntary house raising are considered in the floodplain risk management planning process.

J2.4 Flood Proofing of Buildings

Flood proofing refers to the design and construction of buildings with appropriate water resistant materials such that flood damage to the building itself (structural damage), and possibly its contents, is minimised should the building be inundated.

At best, flood proofing is an adjunct to other management measures. Because of this, the recommendation to adopt flood proofing as a formal management measure can only be made on an objective basis from within the strategic framework of a floodplain risk management plan. Whilst flood proofing can minimise structural and possibly content damages to flood-affected buildings, the occupiers of flood-affected buildings still suffer the social and economic disruption of flooding.

Thus, councils cannot simply allow development of flood prone land as long as buildings are "flood proofed". Rather, the social and economic consequence of flooding needs to be assessed for both the "non-flood proofed" and "flood proofed" situations. If the consequences of flooding with flood proofing in place are still unacceptable, other management measures need to be sought such as levees (for existing development) or alternative locations or development controls (for new development).

To prevent or minimise structural damage from flooding, developments should be designed to withstand inundation, debris and buoyancy forces.

PLATE 9 - Flood Proofed by Raised Floor Level

PLATE 10 - Flood Proofing with Habitable Areas on Upper Floors

Particular methods of construction and certain types of materials are better able to withstand inundation than others. For example, plasterboard and chipboard, both materials commonly used for the internal wall linings and cupboard fittings of a house, can be badly damaged on inundation and may have to be replaced. In contrast, double brick construction can withstand inundation and may only require a hose and scrub down when the flood subsides.

In commercial buildings the adopted floor level is also affected by economics and commercial risk-taking considerations. This can result in a superficially attractive decision by a commercial enterprise on the assumption that it can build the cost of flood losses into its operating costs in exchange for the savings in capital costs associated with not having to raise floors above flood level.

However, the expectation of losses is often forgotten with potentially disastrous consequences on the financial stability of the enterprise when damages or losses subsequently occur.

PLATE 11 - Flood Proofing of Commercial Development

Councils have a duty of care in approving such developments to ensure proper evaluation has been carried out and in determining appropriate development conditions. They may require the proponent to submit detailed advice of measures proposed to avoid or cater for flood losses.

Irrespective of the proponent's desires, the overriding consideration should be that the proposed development will not adversely affect flood behaviour or increase the potential for danger to personal safety or property, whether public or private. The proper course is to determine levels of acceptable risk for specific areas from within the overall framework of the floodplain risk management plan. Decisions must not be made on an individual and ad hoc basis.

J2.5 Flood Access

Flood access can be partly dealt with as a development control. However, it also needs to be addressed on a broader scale than the layout of new sub-divisions. In some areas, particularly along the coastal rivers where floods rise and fall in hours (rather than the weeks which may be characteristic of western flowing floodwaters), complete isolation during a flood may be acceptable. It needs to be remembered, however, that this only applies to smaller floods as larger floods which involve overfloor flooding invariably involve evacuation.

In the more usual situation, in which complete isolation during a flood is not acceptable, an access route which is closed in small or large floods may be acceptable, if there is an alternative route available. The alternative route may have significantly lower traffic capacity, but should allow large vehicles through. Hence it should not have extremely steep gradients, tight bends or bridges with load limits.

Land use planners and engineers need to be aware of the compromises which exist in most designs. To use roadways as the overflow path when flows exceed the capacity of the local runoff system is acceptable, so long as the same roads are not intended to be active traffic corridors during major flood events.

Access during flood events is not only by roads. In dealing with existing areas of development consideration should be given to where boats can be launched or berthed in quiet floodwaters. Planning should consider where helicopters can safely land and what rail services are likely to be available or unavailable in flood time. Such forms of assisted evacuation should not be relied on as a means of facilitating new development where alternative land is available.

The need to be able to shut down critical facilities, such as pump stations, by physical presence at the site, or by remote control is also a flood access issue.

PLATE 12 - Flood Proofing with Fill

J3 Response Modification Measures

Flood response measures encompass various means of modifying the response of the population to the flood threat. Such measures include plans for:

- flood warning and effective warning time;
- the protection and/or evacuation of an area;
- the relief of evacuees; and
- the recovery of the area once the flood subsides.

Planning for these measures are incorporated in the local flood plan for the area, which is prepared under the guidance of the SES (see Appendix N). The local flood plan is complementary to the floodplain risk management plan.

The importance of flood response modification measures has become apparent in recent years, as confirmed in the significant floods at Nyngan 1990, Coffs Harbour 1996, and Wollongong 1998. It is impractical in most cases to use the PMF to derive the FPL. Therefore all flood and property modification measures will ultimately be overwhelmed at some time by a flood larger than the event they provide protection against. The development and implementation of effective flood response within the community is a means of reducing the damage associated with this risk.

Response modification measures, such as flood warning and evacuation procedures, can be of substantial benefit in their own right. Flood warning and evacuation plans can be very cost effective. In fact, they may, in some cases, be the only economically justifiable risk management measures.

J3.1 Flood Education

The key step towards modifying the community's response to a flood event is to ensure that the community is fully aware that floods are likely to interfere with normal activities in the floodplain. This must be done purposefully because awareness of flooding and readiness for its consequences cannot be assumed.

Flood readiness can be enhanced by various simple education strategies such as:

- advice about flooding to residents from time to time;
- articles in local newspapers;
- flood information leaflets on flooding in specific areas;
- displays of flood photographs and newspaper articles in the council chambers or in shopping centres;
- videos of historic floods in the area;
- erecting signs or street markers showing flood levels from previous significant flood events, or the FPL for residential floors;
- signposting of evacuation routes;
- school projects on floods and floodplain management; and
- flood commemorations.

Experience has shown that the major factor determining the degree of flood readiness of a community is usually the frequency of moderate to large floods in the recent history of the area. The more recent the flooding, the greater the community flood awareness and readiness is likely to be.

However, unless the recent experience of a community has been of larger floods, there are likely to be two common and potentially dangerous misunderstandings:

- those used to managing smaller floods need to be aware that occasionally a very large flood will require substantially different and quicker actions; and
- those not normally affected by floods will not be aware that a major flood could seriously affect them. Residents protected by levees, living in houses set with elevated floor levels, or on land not subject to flood related development controls (ie above the FPL), are prime examples of common sources of misunderstanding.

Even when residents have a high level of flood awareness, there will always be people moving into an area who have not experienced flooding even in the areas from which they originated. It should be assumed that some people are likely to be unaware of basic flood readiness activities and of the flood risk and the nature of flooding in their location. Awareness raising activities must be devised to ensure that newcomers become aware and the long term residents do not forget. These activities must be repeated regularly to maintain consciousness of the risk.

Sustaining an appropriate level of flood readiness is not easy. It involves a continuous effort by Council in cooperation with the SES (more details are set out in Appendix N). The cost of such efforts should be regarded as the 'maintenance cost' of a flood warning and evacuation scheme.

As part of the preparation of a floodplain risk management study, advice should be provided on the most appropriate means of establishing and maintaining an appropriate level of community flood readiness.

J3.2 Flood Information Leaflets

Flood information leaflets can be prepared to convey an indication of the range of flood risk that residents in different areas are exposed

to. This can be approached on a number of different levels, each of which has the aim of informing people of:

- whether the area where they live is exposed to a risk of flooding. General historical flood information or photos could also be provided;
- what range of risk they are exposed to;
- the need to be flood ready indicating what they should do in planning for a future flood event. This could include an explanation on flood warnings and what the resident should do in regard to warnings of different levels of flooding, as appropriate;
- location of appropriate evacuation centres where applicable; and
- contact details for provision of further information.

Where the decision is made to use leaflets as part of the management plan, these should be individually prepared for areas of the floodplain which have a common flood threat. Thus separate leaflets might be prepared for Central Kempsey, North Lismore, rural floodplain upstream from Nowra, etc and are available from SES. An example prepared by the SES is provided in Figure N2.

Councils, may, if they desire, using Geographic Information Systems (GIS) and linked databases and a range of flood information provide leaflets addressed and targeted to individual occupiers which provide an indication of specific risk levels for individual properties.

J3.3 Community Readiness

Community awareness of floods needs to be used to create community readiness for floods.

Effective local flood plans need to be developed and the community must be made and remain aware of the role of each individual in mitigating flood impacts. This individual role could be through stocking up before flood waters cause isolation, avoiding unsafe routes once flooding has begun, protecting personal goods and possessions or evacuating their houses.

Flood readiness includes the ability of flood affected people to control and minimise their potential losses from flood threat by appropriate preparatory and evacuation measures. Readiness involves deciding, or at least considering, what goods and possessions to move and how and where to put or take them.

Irrespective of the available warning time, there is widespread variation in flood awareness and resulting response capability, both from community to community and from household to household in New South Wales. This has been demonstrated in surveys of people's responses during floods. In the Georges River floods of August 1986, for which there was next to no effective warning time, two man-hours of effort by a flood aware household reduced damages by an amount some $3,000 to $4,000 per household greater than that achieved by a flood unaware household. Flood affected residents in Forbes typically evacuate all their goods and possessions with little fuss and bother, even down to removing internal doors. These residents have ample warning time (2 to 3 days) and can be flooded frequently (3 times in 1990). When regularly flooded, people become well prepared for a flood. It must be noted that such readiness declines quickly the longer the time since the last flood occurred.

It is important that preparation should not be solely for the more common and/or less severe floods. The community needs also to be prepared for the flood that is quite outside the experience of anyone in the floodplain. There eventually will be a flood which overwhelms the access routes usually used at flood time, overtops levees which have not been overtopped before and which inundate areas, both rural and urban, that have not previously been affected. The key message is that for these rare floods, different action must be taken.

The first step in creating readiness is always creating awareness. Other steps will follow which may be specific to particular areas. These may include the development of warning services, local flood plans and planning for the recovery from flooding.

J3.4 Flood Prediction and Warning

The Bureau of Meteorology (BoM) has a system of weather data collection that allows flood levels to be predicted in non-flash flooding catchments. It may take some time for the BoM predictions to be heard by the community, over the radio or television or otherwise.

The SES has responsibility to issue flood warnings. The SES adds local information to the broad scale advice prepared by BoM, and turns the predictions of flood levels at specified gauges into warnings about the consequences of predicted flooding, such as, closing of roads or water entering properties or otherwise affecting human interests and activities. Further information on this process is at Appendix N.

J3.5 Local Flood Plans

The SES in association with other agencies and the community, through the Local Emergency Management Committee, leads in the development of detailed local flood plans for areas with significant flood problems. These plans describe the various measures to be undertaken before, during and after a flood, including warning, evacuation, resupply and other procedures. Appendix N discusses these plans and their application to the general community.

The floodplain risk management committee needs to ensure that the floodplain risk management measures adopted in the floodplain risk management plan are compatible with the local flood plan.

J3.6 Recovery Planning

The floodplain risk management plan needs to recognise that after the flood:

- council and other authorities will need to restore or clean up their assets;
- individuals will be engaged in some clean-up activities;
- council will be expected to provide some assistance, even if only in carting material to the tip;
- authorities such as Department of Community Services may provide some welfare services;
- meetings to share flood experiences and subsequent problems could include trauma counselling to help people realise they are not alone in the floodplain; and
- the period after the flood is an opportunity to collect data that will help to better deal with the next flood event. This information should include:
  - water information (levels, rates of rise and fall, velocities, areas inundated);
  - details of damage;
  - information which did or did not become available when needed during the flood; and
  - actions which were taken during the flood.

J4 Flood Modification Measures

The purpose of flood modification measures is to modify the behaviour of the flood itself by reducing flood levels or velocities or by excluding floodwaters from areas under threat. It is essential that these measures are assessed, first, on an overall catchment basis, and second, from within the strategic framework of an overall floodplain risk management plan. If assessed individually or in isolation, there is the possibility that future land-use developments may reduce, if not eliminate, present mitigating effects. For example, retarding basins must be assessed on a systems basis that incorporates the impact of future development.

As a result of the possible impacts of flood modification measures, any proposal for such works must be subject to strict and detailed environmental assessment in accordance with the EP&A Act and associated conservation protection legislation.

J4.1 Flood Mitigation Dams

Flood mitigation dams reduce downstream flood discharges. As the flood wave passes through the dam, the dam is progressively filled to the point of overflow, trapping a portion of the floodwaters. The full dam then provides temporary storage for floodwaters subsequently passing through it.

The mitigating effects of a large dam on a major flood is often surprisingly small for the following reasons:

- the volume of water in a major flood may be much greater than the storage capacity of even a large dam;
- the dam may be nearly full at the start of a flood; and
- floods may result from rainfall in parts of the catchment that are not commanded by dams.

With regard to the final point, it may be uneconomic to construct dams on all tributaries of a river system and it is generally rare to find

a suitable dam site that commands a significant number of tributaries.

Consequently the benefits of flood mitigation dams are generally limited to mitigating the effects of a flood generated in only one portion of the catchment.

For flood mitigation dams to be effective, it is essential that adequate air space be retained to store water when a flood occurs. While compromises are possible, this generally limits and possibly precludes their use for other purposes, such as town water supply or irrigation.

J4.2 Retarding Basins

A retarding basin is a small dam that provides temporary storage for floodwaters. Retarding basins are being increasingly used as a means of controlling the peak discharge from newly urbanised areas. Some of these basins are becoming quite large, and in fact, they are more properly regarded as small dams and have to be designed as such.

A retarding basin behaves in the same way as a flood mitigation dam, but on a much smaller scale. In urban areas, retarding basins are most suitable for small streams that respond quickly to rapidly rising flooding.

Retarding basins have a number of inherent disadvantages that should be carefully evaluated for each particular situation, for example:

- they require a substantial area to achieve the necessary storage;
- where they involve multi-purpose uses, safety aspects during flooding need to be addressed;
- long duration or multi-peak storms (when the basin is filled in the first peak) can increase the likelihood of overtopping (when no alternative is available), or embankment breaching or failure ('dam-break'), and the resulting personal danger and damage; and
- they provide little attenuating effect when overtopping occurs.

Consequently, it is important that retarding basins are properly designed (including consideration of alternative storm patterns), constructed and maintained. Risk is reduced by complementary works (bywash spillways) or specific land use planning measures (downstream flowpaths). The NSW Dam Safety Committee can assist with guidelines regarding basins.

It is noted that with appropriately designed outlet works, retarding basins act as sediment traps thereby improving urban water quality by reducing the concentration of settleable solids.

J4.3 Levees

Levees are frequently the most economically attractive measure to protect existing development in flood prone areas. The height or crest level of a levee is determined by a variety of factors that include:

- the economics of the situation (including the nature of development requiring protection);
- the physical limitations of the site;
- the level to which floods can rise relative to the ground levels in the area (important in safety considerations); and
- the visual impact of the levee.

A levee may rarely be called upon to achieve its design requirements. If it fails at this time because of poor design, improper construction or poor maintenance, the money spent on its construction has largely been wasted. Even if design, construction and maintenance is exemplary, all levees will ultimately be overtopped by an 'overwhelming' flood (unless designed for the PMF event). It is not a question of if overtopping will occur, but of when and what the consequences will be. Hence, the importance of plans that address the defence and evacuation of areas protected by levees cannot be overstated (ie. continuing flood risk).

In using levees for flood risk management, in either urban or rural situations, the following precautions need to be noted:

- the likelihood and consequences of catastrophic damage and unacceptable personal danger levels when the levee is overtopped, (when the levees at Nyngan were breached, in 1990, the cost of the resulting damage and disruption was some $65 million in today's terms);
- appropriate design of the levee and provision of spillways to avoid

uncontrolled high velocity flows or even failure when the levee is overtopped;

- proper maintenance of the levee crest level, grass cover and spillways and the avoidance of damage from traffic or animals;
- development control measures for development protected by the levee;
- provision is necessary for local overland flooding from within the levee into the main stream. This may require a pumping system and storage basin within the levee;
- emergency response plans for levee overtopping and evacuation. The need for such plans is particularly important where escape routes can be severed, as in a ring levee situation where the protected area can fill fairly rapidly once overtopping commences;

PLATE 13 - Ring Levee Protection

- analysis of flow conditions that may develop when overtopping occurs and the flood continues to rise. In some situations high hazard conditions can develop in protected areas and unless appropriate restrictions are applied, development and personal safety could be at risk;
- the need for infrastructure management plans to reduce damage to essential services and facilitate rapid recommissioning following flooding is essential;
- on-going community education to ensure that the population is aware of the risk of overtopping, is informed about emergency response plans and does not lapse into the common belief that levees 'provide protection against all floods'; and
- levees may prevent the flow of water to valuable environmental areas, such as wetlands, and the consequences of this need to be considered especially for threatened species and the ecological community as a whole.

Some of the foregoing precautions do not apply when the PMF is adopted as the design event for levees. In such cases, important factors to consider include the maintenance of the levee and the provision of adequate freeboard against wave action and subsidence, and local overland flooding.

As with many development proposals in flood prone areas, both urban and rural, levees have the potential to increase flood levels elsewhere on the floodplain. Consequently, this aspect needs to be addressed in the formulation of any levee proposal.

As indicated above, levees may have the effect of restricting floodwater access to parts of the floodplain. The ecological impacts (or costs) of this exclusion need to be included in the assessment of levees as a management option. Additionally, some agricultural activities may be dependent on the excluded portion of the floodplain receiving flood waters to provide a periodic soaking or to reinstate soil fertility.

Despite the foregoing problems, levees are a common and important management measure for existing flood risks. However, at best they are a partial solution and should be supplemented by comprehensive flood planning and readiness measures.

J4.4 Bypass Floodways

Bypass floodways redirect a portion of the floodwaters away from areas under threat from flooding, and so reduce flood levels along the channel downstream of the diversion.

Opportunities for the construction of bypass floodways may be limited by the topography of the area, environmental considerations and the availability of land. Bypass floodways may exacerbate downstream flood problems and, as they direct flows away from natural paths, may impact on channel form both upstream and downstream of the site of the works. Despite these shortcomings, bypass floodways can, on occasions, provide a useful risk management option.

J4.5 Channel Modifications

The hydraulic capacity of a river channel to discharge floodwater can be increased by widening, deepening or re-aligning the channel and by clearing the channel banks and bed of obstructions to flow. The effectiveness of channel modifications depends upon the characteristics of the river channel and the river valley.

In urban situations, channel modifications can provide the community with other positive benefits. In the main, these involve enhanced visual aesthetics by landscaping and the provision of recreation facilities, such as linear parks.

Channel modifications are likely to be most effective (including reducing the need for other structural works) on steeper smaller streams with overgrown banks and narrow floodplains. Channel modifications are unlikely to have a significant effect in flooding situations where there are extensive areas of overbank flooding or where flooding effects are dominated by increased tide levels.

As a management measure, channel modifications have a number of potential disadvantages. For instance:

- like bypass floodways they facilitate the transfer of floodwaters downstream and can accentuate downstream flooding problems;
- the potential impacts of such works on channel bed and bank stability both upstream and downstream of the site;
- the high cost of maintenance;
- the destruction of riverine habitat; and
- the visual impact of replacing naturally varying channel sections with a section of more uniform geometry.

The use of concrete lined channels to replace natural streams is particularly undesirable from an environmental stand point and should be avoided where possible.

Where modifications to natural streams are proposed these should be designed considering guidelines for the rehabilitation and restoration of streams as available through organisations such as the Co-operative Research Centre for Catchment Hydrology.

J4.6 Floodgates

Floodgates may be used to control flow down a bypass floodway, or to prevent flow along a small creek or drain or other waterway.

When used to control flow down a bypass floodway the opening of the floodgates is generally designed to keep the flow in the mainstream until bank full conditions are about to be reached. The gate is then opened to reduce the problems that would occur if there were somewhat uncontrolled overbank flow from the mainstream. The Tuckombil Canal Fabridam near Woodburn and the Belmore River floodgates near Kempsey are two examples of this type of structure. Floodgates are also a common feature on spillways of many major dams.

There are many locations where floodgates are used to keep flood waters from backing up a drain or creek. These gates may be designed to be normally open and closed when there is a flood; alternatively, they may be normally closed and open only when the water level behind the gate is higher than the water level in the mainstream.

Floodgates may be designed to open or close automatically, or may require someone to open or close the gate at flood time.

The protection of some low-lying urban areas or farmland is usually the key function of floodgates. This benefit must be compared with a range of other adverse environmental impacts of floodgates such as:

- changes in aquatic ecology;
- exposure of acid sulfate soils;
- changes in water quality;
- drying out of wetlands and change in functionality;
- potentially altered hydrological regime resulting in changed vegetation species composition; and
- restriction of fish passage and loss of nursery habitat.

Changes in operation of flood gates, particularly those whose principal purpose was to exclude tidal inundation and backwater flooding, can assist in reducing or rehabilitating these problems. In areas of known acid sulfate soil problems allowing for controlled tidal flushing

during non-flood periods can decrease the level of acidity released into an estuary to a more acceptable level. In addition, controlled opening of floodgates can direct additional water to wetlands. This can be accomplished by maintaining some or all gates in an open position during non-flood times and having procedures to have gates closed during flood periods. Closure of gates can be automatic with maintenance checks ensuring automatic closure of gates has occurred during flood periods.

Maintenance of floodgates is important to ensure that they do close or open satisfactorily when the flood comes and remain closed or open as required during non-flood times.

J5 Issues Common to all Measures

J5.1 Asset Management

Considerable public funds are spent on flood modification works. As such, they are a significant council asset. If they fail, the resulting damage is likely to be very high. Moreover, much of this damage will also be met from the public purse (about 90% of the total cost of Nyngan's flood damage was paid for one way or another by the 'public').

Thus councils have a responsibility to inspect and maintain floodplain risk management structures to ensure they are in a state of continual readiness.

An asset maintenance plan should be part of the overall floodplain risk management plan. Schedules of inspections and remedial works should be specified. An ongoing record system should keep track of past, current and proposed assets and their maintenance.

J5.2 Environmental Protection and Enhancement

Flooding is not merely a source of danger and loss to human occupation of the floodplain. A wide range of natural processes (soil fertility, habitat, and biota) depend on natural flooding cycles for ongoing viability. Therefore, an underlying principle within the Flood Prone Land Policy is that every effort must be made where possible, to enhance the existing environmental situation and to have minimal adverse environmental impact to the natural flooding cycles of the floodplain through the construction of flood modification measures.

Flooding is an important natural process that replenishes the floodplain with water and allows the large scale cycling of nutrients and biota. Inundation of the floodplain boosts invertebrate production, supports breeding activity in waterbirds and fish, initiates growth and regeneration of riverine forest and woodland vegetation and creates extensive areas for colonisation by aquatic plants.

Flood mitigation works can affect life sustainable flood cycles to important floodplain habitats, restrict the movement of fish into and out of important breeding and nursery areas and reduce the production and dispersal of biota food sources. They may also impact on the condition of floodplain soils by restricting sediment, nutrient and water inputs. They may also impact on groundwater levels by affecting groundwater recharge during floods. It is important to avoid these potential impacts on the floodplain and to recognise the benefits of flooding to the environment.

Rehabilitation of degraded floodplain habitats affected by past interference to natural flood cycles can produce significant environmental benefits including increased biodiversity, return of the natural hydrological regime to an area, increased habitat for native terrestrial and aquatic flora and fauna and restoration of important fish breeding and nursery areas. Opportunities for rehabilitation and restoration of floodplain environments should be investigated and considered where possible.

The issues above are not exhaustive in their coverage. Identification of these issues on a local and catchment basis is one of the important issues to be addressed by the floodplain risk management committee (see Appendix D).

J5.3 Acid Sulfate Soils

Acid sulfate soils, when disturbed, pose a significant threat to the environment with their exposure leading to the production of highly acidic runoff and groundwater. These acidic waters allow leaching of aluminium and iron resulting in high levels of dissolved metals in solution. They may also create significant local structural problems with corrosion of steel and concrete, potentially affecting structures such as floodplain risk management works, culverts, bridges and pipework.

Acid sulfate soils are sediments which contain sulfidic mineral pyrite. These sediments may

become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. These soils are most likely to be encountered in low lying areas of coastal floodplains. DIPNR has prepared a series of 1:25,000 scale risk maps for acid sulfate soils identifying actual and potential occurrences. However, acid sulfate soils may also occur out of normal context where material containing sulfidic sediments has been transported from another site for disposal and/or fill purposes and exposed to air.

Councils have a responsibility to address the issues of acid sulfate soils in their floodplain risk management plan, where applicable, and should ensure that appropriate steps are taken to avoid both their physical disturbance and any changes to natural water table levels. Where known acid sulfate soil problems are linked to prior flood risk management works suitable operation procedures and amelioration works should be identified in the floodplain risk management plan to enable environmental restoration and enhancement, wherever possible, without affecting the level of flood protection provided.

APPENDIX K FLOOD PLANNING LEVELS

K1 Introduction

Flood planning levels (FPLs) are an important tool in the management of flood risk. They are derived from a combination of a flood event, an historic flood or flood of certain AEP (discussed in Section K4), and a freeboard (see Section K5).

FPLs do not, however, ensure that development is located in areas where it will not have significant adverse impacts on flooding nor do they address personal danger issues. These issues need to be considered strategically in studies and managed through appropriate land use restrictions in EPIs, and emergency response planning, as discussed in Section G6. Figure K1 illustrates an iterative process for considering flood behaviour and land use attributes in determining areas and conditions for development, including selecting FPLs.

This appendix discusses the purpose of FPLs (Section K2), FPL selection and factors that influence this (Sections K3 to K5), and the duty of care of decision makers (Section K6).

K2 Purpose of FPLs

Historical practice in NSW has generally seen the adoption of a single FPL for development control. This tended to focus on the 1% AEP event and resulted in the popular perception that this event defined the limit of flooding. This perception precluded assessment of risk levels associated with rarer floods that may be more critical for a particular location.

This is one reason the Government's policy requires consideration of the full range of flood risk in setting FPLs for purposes including:

- development control measures to aid in managing future flood risk; and
- design levels for mitigation works to manage existing flood risk.

K3 Selecting FPLs

A floodplain risk management study involves determining appropriate land uses and densities and selecting both the flood events and freeboards upon which FPLs for different purposes are based.

Therefore decisions on FPLs are based upon a detailed understanding of flood behaviour across the full range of floods, their likelihood of occurrence and the associated consequences in terms of danger to personal safety and social, economic, environmental and cultural issues.

FPLs for new residential development will generally be based upon the 1% AEP flood. While there is potential to vary this, it should only occur where it can be clearly demonstrated that the situation is exceptional. The factors contributing to such an assessment are illustrated in Figure K2 and discussed in Section K4.

As decisions on FPLs are generally based around floods of a certain AEP, Figure K3 showing the relationship between AEP and the chance that an event occurring in a given period of years and Table K1 showing probabilities of experiencing various AEP floods over 70 years, provide valuable background information.

Table K1 highlights that a 2% AEP flood has a 75% chance of occurring once and a 41% chance of occurring twice in 70 years. The possibility of getting two large floods in a relatively short period is highlighted by around 1% AEP floods in Kempsey in 1949 and 1950 and in Lismore in 1954 and 1974.

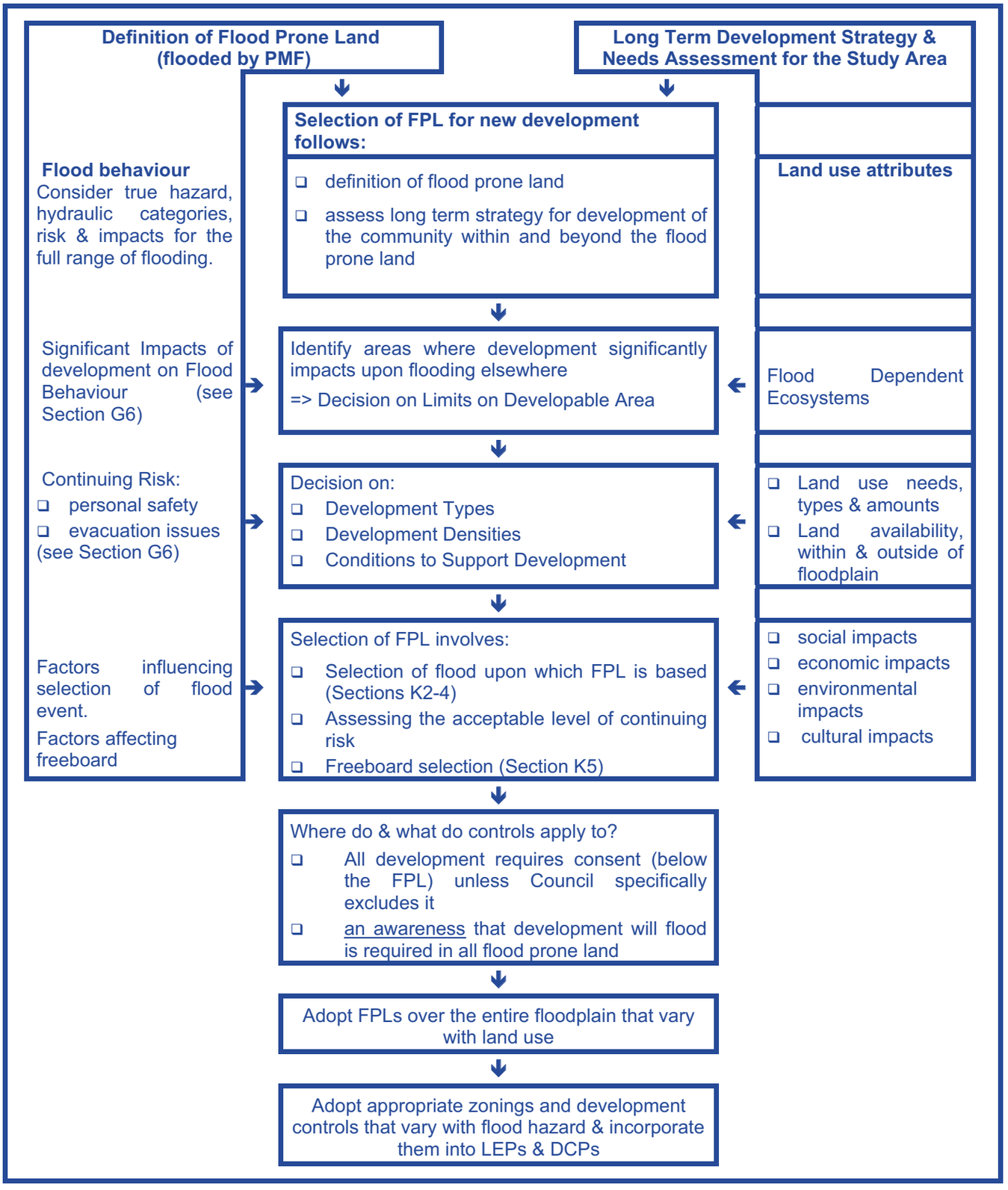


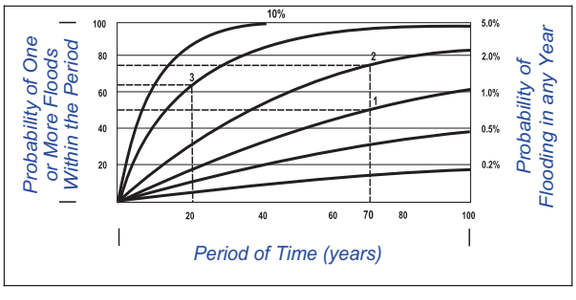
FIGURE K1 - The Process for Considering Flood Behaviour & Land Use Attributes to Derive Land Use Limits & Controls, including FPLs

FIGURE K2 - Important Factors in Selecting FPLs

K3.1 FPLs for Development Control

Future flood risk can be managed strategically through a combination of:

- appropriate zonings and controls to ensure that development is restricted to areas where it will not significantly impact on flood behaviour in the flood event used to derive the FPL, and that development type, scale and controls result in manageable continuing risk (discussed in Section G6);



EXAMPLES:

1. *Given a 1% AEP flood, probability of occurrence of this or a greater event over a 70 year period would be 50%.*
2. *Given a 2% AEP flood, probability of occurrence of this or a greater event over a 70 year period would be 75%.*
3. *Given a 5% AEP flood, probability of occurrence of this or a greater event over a 20 year period would be 65%.*

FIGURE K3 - Probability of Experiencing a Number of Floods in a Period of Time

Size of Flood (Chance of occurrence in any year) ARI/(AEP)	Probability of Experiencing the Given Flood in a Period of 70 Years	
	At least once (%)	At least twice (%)
1 in 10 (10%)	99.9	99.3
1 in 20 (5%)	97.0	86.4
1 in 50 (2%)	75.3	40.8
1 in 100 (1%)	50.3	15.6
1 in 200 (0.5%)	29.5	4.9

TABLE K1 - Probabilities of Experiencing a Given Size Flood Once or More in a Lifetime
(predicted by statistical theory for random events)

- adopting FPLs for new development (minimum fill and floor levels) to reduce the likelihood of properties and buildings flooding and associated damages to an acceptable level; and
- effective management of personal safety in rare events (discussed in Section G6.4).

Therefore development controls, including FPLs for future development, aim to reduce the likelihood that properties and buildings flood and reduce the exposure of people to dangerous flood situations.

As it is generally not feasible nor socially, environmentally nor economically desirable to safeguard development against the PMF, a continuing risk from rare flood remains. The selection of a flood event upon which a FPL is based is therefore essentially a matter of balancing:

- the social, economic, environmental and cultural costs of restricting land use in flood prone areas; against
- the social, economic, environmental and cultural benefits of a reduction in the frequency, inconvenience, damage and danger to people caused by flooding.

The relevance of these issues varies with location in the floodplain and between different types of development. What may be appropriate for one land use may be inappropriate for another land use, or for the same land use elsewhere with a different flood risk exposure. The latter should be addressed by appropriate land use restrictions.

In general, the FPL (minimum floor level) for standard residential development would be the 1% AEP flood event plus a freeboard (typically 0.5m) with minimum fill levels at the 1% AEP flood level.

Higher FPLs may be necessary for aged care facilities and other types of developments with particular evacuation or emergency response issues (discussed in Section L6). Consideration should also be given to using the PMF as the FPL when siting and developing emergency response facilities such as police stations, hospitals, SES headquarters, and critical infrastructure, such as major telephone exchanges, if possible.

The decision on appropriate FPLs for commercial and industrial developments relates more to economic benefits versus costs as discussed in Section K4.4. Therefore, there is greater potential for FPLs for these developments to be based on event more common that the 1% AEP flood.

However, danger to personal safety for personnel, clients, etc still requires careful consideration, particularly where more frequent events are used as the basis for FPLs.

K3.2 FPLs for Mitigation Works

An FPL for a mitigation work to protect existing development from flooding, such as a levee, needs to consider the range of issues outlined in Section K3.1, the issues discussed below, and additional issues relating to freeboard (see Section K5).

The FPL for mitigation works may be different from the FPL for future development due to a range of factors which vary with location. These include the economics of the works, financial and technical feasibility, potential environmental impacts, physical limitations of the site, community concerns, potential impacts elsewhere in the floodplain and the height floods can rise to relative to ground levels in the area.

In tidal areas, some towns have levees with crest levels providing protection for 2% to 10% AEP events, whilst FPLs for development controls behind levees is based upon the 1% AEP flood.

In contrast, in some areas of inland NSW, it is physically and economically possible to construct levees to exclude floods approaching the PMF. In these cases, flood related development controls within the area protected by the levee may only need to relate to local overland flooding issues within the levee. However, when a levee excludes the PMF, care needs to be taken in planning on the basis of zero continuing risk as there is a degree of uncertainty regarding the absolute accuracy of PMF estimates (Appendix F).

In most circumstances, overtopping or failure of works including levees can result in catastrophic damage and undue danger to personal safety. An asset management plan with fail-safe maintenance program is essential for all levees together with sound local flood plans to address the inevitable overtopping provided for in most levee designs.

Unless a levee is designed to exclude the PMF, considerable care must be taken to inform residents that it will be overtopped at some time in the future and to clearly explain to residents the purpose of and need for a local flood plan to address levee overtopping or failure. Without this understanding the community may have a false sense of security which may increase danger to personal safety.

K4 Factors Influencing FPLs

FPLs are made up of the selection of an appropriate flood event and an associated freeboard. Whilst an appropriate FPL for new residential development is generally based upon the 1% AEP flood, there are a range of factors, indicated in Figure K2, which are assessed in selecting the flood event upon which the FPL is based, as discussed below. There is also a range of factors that affect the selection of freeboard, generally 0.5m for residential development (discussed in Section K5).

K4.1 Risk to Life

Risk to life issues relate to the consequences of the full range of floods including the flood used to derive the FPL and rarer floods.

Selection of the flood event upon which the FPL is based and associated development controls, such as minimum fill and floor levels, need to ensure that risk to life is effectively managed for the full range of floods. A flood larger than that used to derive the FPL will result in increased risk to life and property as:

- water enters buildings or overtops levees built at the FPL and may result in the need for evacuation;
- high hazard or flow conditions may develop in areas where floodwaters simply pond in the flood event used to derive the FPL; and
- significant access problems may develop. This is not a serious issue in a floodplain with continuously rising roads leading out of it. However, any flood which cuts access and isolates parts of a community can cause serious additional danger to personal safety. This is a particular problem where there is a large flood range between the flood used to derive the FPL and the PMF.

These issues need consideration in the development of specific areas of land, the type and scale of such developments (discussed in Section G6), and in selecting FPLs for mitigation works and development control. These considerations need to address the cumulative impacts of future development (Section G9.1), particularly for emergency planning and response.

K4.2 Flood Behaviour

Flood behaviour is more likely to impact upon areas for development or the location of mitigation works rather than a final decision on FPLs.

The cumulative impacts of the full extent of development (fill, buildings and fences) which could occur as a result of selecting a particular flood as the basis for the FPL needs strategic assessment along with the potential impact of flooding on development (Section G6).

Mitigation works to reduce flood risk for existing development may also impact upon flood levels elsewhere in the floodplain. These impacts need consideration in assessment of mitigation options (Section G7).

K4.3 Social Issues

Social issues that need consideration include availability and demand for land, existing extent of development, current FPLs and risk exposure, land values and social equity and flood duration. All may impact upon decision on FPLs.

K4.3.1 Land Availability and Needs

The demands for and availability of land within and outside the floodplain, for different types of development within a reasonable planning horizon may impact upon decisions to develop particular areas and the type of development desirable in these areas.

Demand and availability of land would ideally be known prior to the management study. If not, a preliminary assessment of these should be undertaken prior to or as part of the study.

This provides the information for the management study to consider the:

- cumulative impacts of development of identified areas on flood behaviour;
- variation in flood hazard exposure of available land and its management;
- type of development appropriate in particular areas;
- conditions to support development; and
- continuing risk in potential development areas after controls are in place.

These issues are discussed in Section G6.

K4.3.2 Existing Level of Development

New development and relatively undeveloped areas provide more flexibility in decision making than developed areas.

Greenfield sites in particular, provide an excellent opportunity to set appropriate development limits (Section G6.2) and conditions (Section G6.3) including FPLs, to reduce continuing risk to an acceptable level.

However, as land is developed, the options for changing its use and management are greatly reduced. This is due to the significant investment, both public and private, in existing development and associated infrastructure, such as buildings, roads, drainage, water supply, sewerage and electricity. The scale of existing investment is frequently such that the development cannot reasonably be abandoned, even if it is does have a high potential for flood damage.

K4.3.3 Current FPLs for Planning Purposes

The current FPL used for planning purposes has generally been set by a previous decision

of council which may be based upon previous studies or historical precedent. It should therefore be an important consideration when determining FPLs for new development in the management study.

The study may find that what was believed to be the 1% AEP is now a 1.25% (1 in 80 year ARI) flood event. There may be a desire to increase the FPL based upon the revised 1% AEP flood event. However, there may only be marginal benefit in damage reduction and risk exposure in adopting a higher FPL for new development. Instead a slightly higher flood exposure may be considered acceptable.

K4.3.4 Land Values and Social Equity

Land values are influenced by the proximity of the land to natural features such as watercourses, employment and community facilities.

Most of the community is aware that overbank flows from watercourses happen from time to time and land values incorporate this awareness. Some people have the perception that specific estimates of the likelihood of flooding have a much greater impact on land values than the general community awareness of flooding does. Therefore as FPLs are based on specific estimates of the likelihood of flooding, decisions about FPLs must recognise the associated social equity issues.

This is particularly relevant if the decision about FPLs limits the type of development that may occur at a site. This decision is part of the strategic planning considerations (see Section G6) in the management study and should precede or coincide with the decision on FPLs for future development.

K4.3.5 Duration of Flooding

Duration of flooding is another important social consideration. Flood peaks in many areas of western NSW may last for a significant time (sometimes weeks) isolating and perhaps inundating significant areas of townships.

The ability of townships to function with some semblance of normality during a flood event needs consideration. This is one reason for construction of levees around many such townships. Considering duration may result in a decision to adopt a higher FPL than required on economic grounds.

K4.4 Economic Factors

The economic factors in selecting FPLs for mitigation works and development controls are different, as discussed below.

K4.4.1 Future Development

A key consideration in new development cases is the ability of people to financially recover from severe flood events. This is an area where residents generally have less flexibility than businesses.

This consideration has led to standard residential development in NSW having a FPL based upon the 1% AEP flood with freeboard (typically 0.5m), a practice that is expected to continue.

Considering a reduction in the FPL for new residential development below this level is not a simple balance between different levels of flood damage and development costs. It has significant social equity implications as damages will be borne by future residents whilst any cost savings related to lower fill levels are made by developers of the land.

The greater flexibility of business in managing risk and recovering financially from flooding, means that FPLs for industrial and commercial development may be based upon a more frequent flood event. An acceptable level of risk may become a business decision for the owner or occupier. This allows for trade-offs between council's responsibility to present and future owners and occupiers and the latter's natural preference to accept the risk and potential damages as a business cost to lower initial set up costs. Figure K4 is an example of pure economic cost versus benefit for determining a flood as a basis of the FPL.

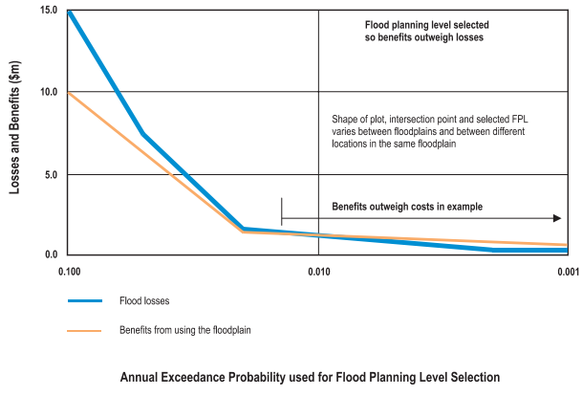


FIGURE K4 - Flood Losses Compared to Benefits with Selection of Various FPLs

However, it is strongly stressed that at the business level, these costs are often overlooked in the long-term, usually with severe financial consequences to the viability of the operation post flooding. The social equity issue of who pays and who benefits remains, particularly where the developers of the land (who benefit) and the long term occupants (who pay) are different. In addition, personal safety still needs to be addressed for these developments for the full range of flood events.

Therefore selecting a reasonable flood event upon which to base the FPL for business development remains an important consideration for councils in their management studies.

K4.4.2 Mitigation Works

The economics of selecting the flood upon which the FPL for protection works is based relates to the benefit of works in reducing flood damages to private property and community infrastructure relative to the estimated life cycle cost of the mitigation works. Different FPLs for protection works will have different reductions in flood damages and costs of works and therefore benefit, as the level of service to the community will change.

K4.5 Environmental Issues

It may be possible to choose a FPL to meet multiple objectives. For example, areas immediately adjacent to the watercourse (riparian zone) may also have a high conservation value and be below the proposed FPL. By ensuring this land is not developed inappropriately, valuable habitat areas may also be conserved. However, land use limits (see Section G6.2) are a more appropriate tool for this purpose.

K4.6 Cultural Issues

FPLs are unlikely to result in significant impacts on cultural issues. These are more likely to be effected by location of protection works or new development areas. However, the FPL of a protection work, such as a levee may impact on the views from a cultural site. Where this is a key issue for the site it may need consideration in balance with flood risk management objectives.

K5 Freeboard

Freeboard is incorporated into FPLs. It is the difference between the flood event upon which the FPL is based and the FPL itself.

The purpose of freeboard is to provide reasonable certainty that the reduced risk exposure provided by selection of a particular flood as the basis of a FPL is actually provided given the following factors:

- uncertainties in the estimates of flood levels. These can arise from a relatively short database of past floods and past storm surges in coastal waters, together with uncertainties and simplifications in the models used to predict flood discharges and flood levels;
- differences in water levels across the floodplain because of 'local factors'. These factors are not able to be determined in floodplain modelling, which assumes a static water level;
- increases in water level as a result of wave action are also not determined in floodplain modelling. Wave action can be of two types. Wind-induced waves across fetches of open water and waves induced by boats and vehicles moving through flooded areas. For example, wave action may be important in the wide floodplains of the western rivers as a wind fetch 2 kilometres long could readily generate waves up to 0.5m high;
- changes in rainfall patterns and ocean water levels as a result of climate change, as discussed in Section E6; and
- the cumulative effect of subsequent infill development of existing zoned land.

In effect, freeboard acts as a factor of safety which should never be relied on to manage risk in events larger than the flood used to derive the FPL. In the majority of circumstances a freeboard of 0.5m would be acceptable for new residential development controls. However, freeboard may be different for:

- different land uses. Although, the adoption of a different flood event for deriving a FPL with the same freeboard would provide a more realistic indication of risk exposure;
- in different parts of the floodplain. Factors influencing freeboard, as indicated above, may vary with location; and
- mitigation works of different types relative to development controls.

  Mitigation works may be exposed to additional risk due to their nature and

construction than new development, resulting in them needing more freeboard.

For instance earthen levees also need to consider the following issues:

- post construction settlement, which effectively reduces the long term level of the levee;
- surface erosion due to vehicle, animal or pedestrian crossing can result in surface erosion reducing its level;
- the potential for significant surface shrinkage cracking and associated additional risk of failure where good grass cover and an appropriate moisture content cannot be maintained; and
- the performance of earthen levees, when they overtop is characterised by relatively quick vertical erosion resulting in an embankment breach. This can allow more water in quickly which can result in relatively fast rising flooding and difficult evacuation.

These can all add to general freeboard requirements meaning that a larger freeboard is used for earthen levees than for development control purposes or for a levee constructed of concrete.

K6 Duty of Care

Community leaders are always asked to make decisions about where to allow behaviour that is associated with some risk, because there are many benefits from allowing that behaviour. The use of motor vehicles is an obvious example and the use of the floodplain is another. The risk of incurring damage or losses in flood time increases in those parts of the floodplain more susceptible to flooding. Reducing the use of the floodplain can lower the flood damage bill. However, the benefits from using the floodplain for rural or urban or recreational purposes are also reduced. Those that use the floodplain and those who allow the use, must recognise that whatever FPL has been adopted there is still some risk and they need to accept responsibility for being careful. Each needs to be conscious that flood events bigger than the FPL can occur and it is a matter of when, not if, they will occur.

As with other planning decisions, councils have a duty of care in advising property owners, occupiers and developers on the extent and level of flooding and in making decisions with regard to an appropriate FPL. Because of the importance of such decisions, councils should document and carefully explain the basis of selecting a FPL.

APPENDIX L HYDRAULIC AND HAZARD CATEGORISATION

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I

L1 Introduction

The personal danger and physical property damage caused by a flood varies both in time and place across the floodplain. Floodwaters flow swift and deep at some locations, whilst in other places they are shallow and slow moving. The variation of degree of hazard and flood behaviour across the floodplain over the full range of potential floods needs to be understood by flood prone landholders and by floodplain managers.

To achieve effective and responsible floodplain risk management, it is necessary to divide the floodplain into areas that reflect, first, the impact of development activity on flood behaviour and second, the impact of flooding on development and people. Division of flood prone land on these two bases is referred to as 'hydraulic categories' and 'hazard categories' respectively.

In this manual, hydraulic and hazard categories are used to determine appropriate types of land development in flood-prone areas. As such, the determination of these categories is an essential element in the formulation of a floodplain risk management plan.

This manual recognises three hydraulic categories of flood prone land (floodway, flood storage and flood fringe) and two hydraulic categories (low hazard and high hazard). Division of the floodplain on the basis of these two effects produces the following six categories of flood-prone land:

1. Low Hazard - Flood Fringe
2. Low Hazard - Flood Storage
3. Low Hazard - Floodway
4. High Hazard - Flood Fringe
5. High Hazard - Flood Storage
6. High Hazard - Floodway

This appendix describes the various hydraulic and hazard categories, discusses significant factors which affect these categories and provides guidelines for their determination.

L2 Purpose of the Categories

At the outset, it should be realised that hydraulic and hazard categories are tools to assist in the preparation of an appropriate floodplain risk management plan (a strategic planning document). They are not to be used for the assessment of development proposals on an isolated or individual basis. Such ad hoc analysis cannot take into account the cumulative impact of gradual on-going development over time, a key issue to be addressed in a floodplain risk management plan. Rather, hydraulic and hazard categories are to be used for assessing the suitability of future types of land use and development in the formulation of floodplain risk management plans.

Both hydraulic and hazard categories need to be determined in the floodplain risk management study for inclusion in the adopted floodplain risk management plan.

L3 Hydraulic Categories

For the purpose of this manual there are three hydraulic categories of flood prone land:

- floodways;
- flood storage; and
- flood fringe.

Floodways are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of

flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

Flood storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood fringe is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

In determining appropriate hydraulic categories, it is important that the cumulative impact of progressive development be evaluated, particularly with respect to floodway and flood storage areas. Whilst the impact of individual developments may be small, the cumulative effect of the ultimate development of the area can be significant and may result in unacceptable increases in flood levels and flood velocities elsewhere in the floodplain.

L4 Determination of Hydraulic Categories

In all but the simplest flow situations, the results of a flood study will be required to determine hydraulic categories. A flood study involves a detailed hydraulic analysis of flood behaviour for a range of flood severities up to the PMF, and generally involves the use of numerical or physical models (see Appendix F). A flood study provides details of peak depths and velocities across the floodplain, the pattern and timing of flooding, etc.

It is impossible to provide explicitly quantitative criteria for defining floodways and flood storage areas, as the significance of such areas is site specific. The following guidelines, although general, are given to assist in the delineation of flooding and flood storage areas:

Floodways are areas conveying a significant proportion of the flood flow and where partial blocking will adversely affect flood behaviour to a significant and unacceptable extent. It is essential that this be investigated across the full range of potential floods as the definition of the floodway is one of the critical steps in the floodplain risk management process.

Flood storage areas - those areas outside floodways which, if completely filled with solid material, would cause peak flood levels to increase anywhere by more than 0.1 m and/or would cause the peak discharge anywhere downstream to increase by more than 10%.

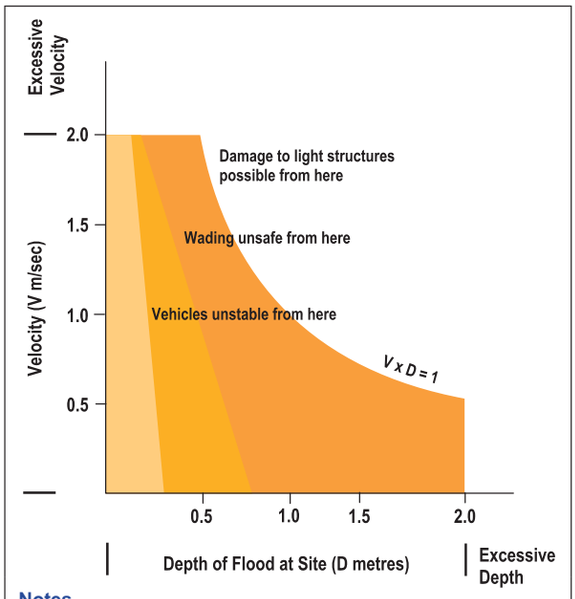
Areas being tested by the above criteria should be treated as contiguous entities, having regard for topography and location within the overall flood-prone area. They must not be separated or considered in a piecemeal fashion.

L5 Determination of Hazard Categories

Hazard categories are broken down into high and low hazard for each hydraulic category. These can be defined as:

- high hazard possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading to safety; potential for significant structural damage to buildings.
- low hazard should it be necessary, truck could evacuate people and their possessions; able-bodied adults would have little difficulty in wading to safety.

A comprehensive analysis of flood hazard to establish risk can only be made from within the strategic framework of a floodplain risk management plan. The plan requires the detailed results of a flood study and an assessment of all the factors in Section L6, such as flood warning, flood awareness, flood readiness, possible evacuation problems, etc. The process involves firstly evaluation of hazard level from pure hydraulic principles, and then refining the hydraulic hazard category in light of other relevant factors affecting the safety of individuals. Figures L1 and L2 have been prepared to allow initial hazard categorisation on hydraulic considerations alone. Figure L1 shows approximate relationships between the depth and velocity of floodwaters and resulting hazard. This information has been used to define the provisional low and high hazard categories of Figure L2.

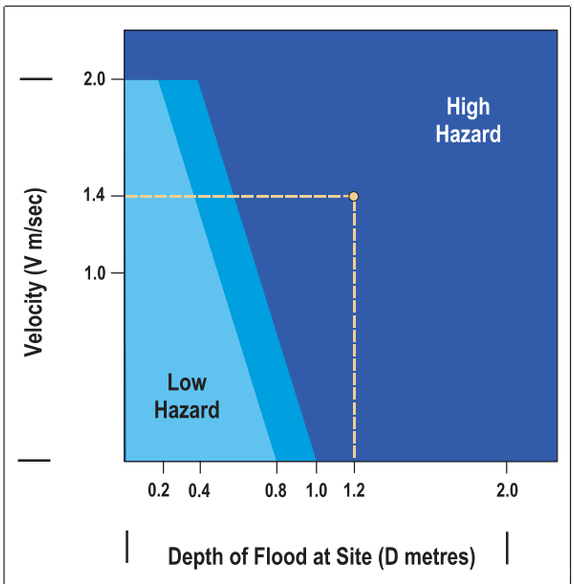


Notes

1. At velocities in excess of 2.0 m/s, the stability of foundations and poles can be affected by scour. Also, grass and earth surfaces begin to scour and can become rough and unstable
2. The velocity of floodwaters passing between buildings can produce a hazard, which may not be apparent if only the average velocity is considered. For instance, the velocity of floodwaters in a model test has risen from an average of 1 m/sec to 3 m/sec between houses.
3. Vehicle instability is initially by buoyancy.
4. At floodwater depths in excess of 2.0 meters and even at low velocities, there can be damage to light-framed buildings from water pressure, flotation and debris impact.

Derived from laboratory testing and flood conditions which caused damage.

FIGURE L1 - Velocity & Depth Relationships



Notes

The degree of hazard may be either -

- reduced by establishment of an effective flood evacuation procedure.
- increased if evacuation difficulties exist.

In the transition zone highlight by the median colour, the degree of hazard is dependant on site conditions and the nature of the proposed development.

Example:

If the depth of flood water is **1.2 m**
and the velocity of floodwater is **1.4 m/sec**
then the provisional hazard is **high**

FIGURE L2 - Provisional Hydraulic Hazard Categories

These categories are provisional because they do not reflect the effects of other factors that influence hazard. In effect, the two diagrams provide a starting point for the determination of hazard categories. When the other factors that affect hazard are identified and qualified, the provisional hazard categories of Figure L2 should be revised if necessary to develop true hazard categories.

For instance, the impacts associated with a particular hazard category, in an existing developed area, may be reduced if an effective local flood plan is developed, implemented and maintained under the guidance of the SES.

However, even plans with effective in-built maintenance mechanisms (such as local flood plans prepared under the guidance of the SES) cannot be guaranteed to overcome flood risk nor do they change the degree of hazard itself, ie. if they do not work effectively the level of hazard is unchanged. Maintenance of local flood plans and floodplain risk management plans is necessary to ensure that they remain appropriate in the light of future changes within the catchment and in management policies, procedures or practices.

It should be noted that evacuation measures proposed in private or site specific flood plans (see Section N7) for individual developments, outside the development types considered appropriate in the management plan, is not an appropriate measure to rectify adverse impacts, to manage the consequences of inappropriate decisions or to override the management plan. Therefore private or site specific flood plans should not form the basis for development consent.

It may be necessary to increase the hydraulic hazard classification derived from Figures L1 and L2, from low to high, if there are substantial difficulties associated with the evacuation of people and their possessions. In assessing these aspects, it is necessary to consider the difficulty of the conditions that could be expected if an extreme flood occurred.

Figure L2 is presented as a tool to assist in the development of hazard categories in floodplain risk management plans. It is not appropriate to use Figure L2 to determine the hazard implications of individual developments. Flood hazard, like flood hydraulics, needs to be assessed on an integrated and strategic basis across the entire flood prone area, not on an isolated basis associated with individual developments.

To use Figure L2, it is necessary to know the average depth and velocity of floodwaters at various places in a flood prone area. The depth of floodwaters is the difference between the flood level and the ground level. The velocity of floodwaters is obtained from the results of a flood study, or pending the completion of such studies, from an assessment of available flood information or data.

As part of the floodplain risk management study, it may be appropriate for council to prepare 'hazard maps', which define areas of low and high hazard across the flood prone area for the potential range of floods. Detailed maps may also be prepared for floods associated with the FPLs and the PMF, with less detailed maps for other floods as required. Such maps can be used to assess the consequences of the hazard for existing and future development areas on flood prone land.

L6 Factors Which Determine the Flood Hazard

Provisional flood hazard categorisation based around initial hydraulic evaluations does not consider a range of other factors that influence flood hazard. Therefore provisional hazard categorisation should be used with the following factors, (which are discussed in detail below) to determine true hazard categories:

- size of flood;
- effective warning time;
- flood readiness;
- rate of rise of floodwaters;
- depth and velocity of floodwaters;
- duration of flooding;
- evacuation problems;
- effective flood access; and
- type of development.

Other factors, such as the complexity of the stream network and the inter-relationship of flows between streams will need to be considered, as appropriate.

L6.1 Size of the Flood

The size of a flood and the damage it causes varies from one event to another. Small floods generally cause minor damage and community disruption. Mid range floods can cause significant disruption and damage. Large floods, although rare, can cause massive damage and disruption. Unfortunately, it is impossible to predict in advance when flooding will occur. Also, there is no guarantee that, if a major flood has occurred recently, another perhaps larger flood will not occur in a relatively short period of time (see Table A1).

L6.2 Effective Warning Time

The effective warning time, or actual time available for people to undertake appropriate actions (such as raise pumps, lift or transport belongings and/or evacuate) is always less than the total warning time available to the emergency services. This is because of the time needed, firstly, to alert people to the imminence of flooding (by radio, loud-hailer, television, word of mouth or other means), and secondly, to have them begin effective property protection and evacuation procedures.

The consequences of flooding can be reduced if adequate time is available and is well utilised. However, even if people are fully evacuated along with transportation of possessions, a flood will generally still cause significant damage to the structural fabric of buildings, to stock and crops, to urban infrastructure and still wreak substantial community disruption. People are temporarily displaced from their homes and workplaces, flood-affected buildings need to be cleaned and restored, and transported possessions have to be returned. The whole process costs time and money and endangers lives and affects health.

Total available warning time is determined largely by catchment characteristics. The larger the catchment and the slower the rate of rise of floodwaters, the longer the available warning time. Some towns on the large western rivers of NSW have warning times measured in weeks. In contrast, warning times for coastal rivers and coastal areas in New South Wales are often

less than 6 hours. In small steep catchments, there is often no available warning time, as the catchments respond too quickly. In some cases, little or no advice may be available as to the expected height of floodwaters (especially for small catchments or river reaches affected by ocean tides).

In large catchments, flood warnings can be based on rates of rise and peak water levels at upstream gauges. In smaller, quicker responding catchments, flood warnings need to be based on rainfall measurements. These days, automatic monitoring equipment is available to measure water levels and rainfalls. In the smallest catchments, warnings need to be based on predictions of likely rainfall made before the rainfall occurs.

L6.3 Flood Readiness

Flood readiness greatly influences the time taken by flood-affected people to respond in an effective fashion to flood warnings. In communities with a high degree of flood readiness, the response to flood warnings is prompt, efficient and effective. The formulation and implementation of plans for the evacuation of people and transportation of possessions promote flood readiness. The community as a whole knows what to do on receipt of a flood warning, people as individuals know how to respond, residents and property owners have developed personal evacuation plans and can implement them effectively on receipt of a flood warning. Flood readiness is discussed in Section J3.

The SES is responsible for leading the development of local flood plans for flood prone areas of New South Wales. There is a section of each local flood plan that deals with flood readiness and sets out how promotion will be achieved (see Appendix N for details).

L6.4 Rate of Rise of Floodwaters

The rate of rise of floodwaters affects the consequences of the flood. Situations in which floodwaters rise rapidly are potentially far more dangerous and cause more damage than situations in which flood levels increase slowly.

Typically, the rate of rise of floodwaters is more rapid in small, steep catchments than in their larger, flatter counterparts. The enormous catchments of the western rivers of NSW have very slow rates of rise. At Bourke, for example, the rate of rise of floodwaters is typically less than 0.1 metre per day and it may take up to several weeks for flood levels to peak. In contrast, the rate of rise of floodwaters in coastal rivers is far more rapid, and can be greater than 0.5 metres an hour.

L6.5 Depth and Velocity of Floodwaters

The threat to personal safety and to gross structural damage (ie. houses being washed away) caused by floods, depends largely upon the speed and depth of floodwaters. These, in turn, are dependent upon both the size of the flood and the hydraulic characteristics of the river and its floodplain.

The ability to safely wade or drive through floodwaters is very dependent on depth and velocity. The greater these factors become, the greater the danger to people, animals and vehicles being swept away. Consequently, depth and velocity are important considerations in formulating evacuation procedures for developed areas and in considering new development in flood-affected areas. In assessing the safety of wading, a number of factors other than depth and velocity need to be taken into account: is the ground surface even; are depressions, potholes, fences or major stormwater drains present, etc.?

As the depth of floodwater increases, caravans and buildings of light construction will begin to float. In these circumstances the buildings can be severely damaged when they settle unevenly in receding floodwaters. If the flood velocity is significant, buildings can be totally destroyed and cars and caravans can be swept away. In certain areas, the build up of debris and the impact of floating logs can cause significant structural damage to buildings and bridges.

The rate of flood water movement and the height that a flood will reach are related to the three dimensional shape of the catchment. An important factor that tends to increase the depth of flooding, and hence the overall degree of flood damage, is the presence of obstructions to the movement of floodwaters.

Such obstructions include buildings, embankments and bridges, areas built up by land-fill, and the blocking effect of inappropriate trees, shrubs, fences and debris. The increase

in flood levels depends upon the velocity of the floodwaters and the degree to which they are obstructed. However, appropriate trees and shrubs have long term ecological benefits that must be taken into consideration when assessing the flood impacts.

L6.6 Duration of Flooding

The duration of flooding or length of time a community, town or single dwelling (for example, a farmhouse) is cut off by floodwaters can have a significant impact on the costs and disruption associated with flooding. For example:

- an extended period of isolation in stressful situations can exacerbate post-event anxiety and trauma-related disorders;
- shortages of water and food may occur thereby placing high demands on limited emergency services; and
- medical emergencies may occur with treatment delayed or at worst prevented.

The duration of flooding generally correlates with the rate of rise of floodwater, typically, being longer in larger, flatter catchments and shorter in the smaller, steeper ones.

L6.7 Evacuation Problems

The levels of damage and disruption caused by a flood are also influenced by the difficulty of evacuating flood-affected people and property. Evacuation, may be difficult because of:

- the number of people requiring assistance;
- the depth and velocity floodwaters;
- wading problems, which can be exacerbated by uneven ground, fences, debris, localised high velocities, etc.;
- mobility of people – children, the aged, disabled people and the ill are less able to evacuate through floodwaters than healthy adults;
- the distance to flood-free ground;
- the inability to contact emergency services;
- bottlenecks, ie., the large number of people and great volume of goods that have to be moved over roads which cannot cope with the increased volume of traffic;
- the time of day and existing weather conditions (dark, rain, wind, etc.); and
- the lack of suitable evacuation equipment such as boats, heavy trucks, helicopters, etc.

Consideration of the impact on evacuation strategies of increased occupation of the floodplain is one of the key tests of cumulative impact in preparing management plans.

L6.8 Effective Flood Access

The availability of effective access routes from flood prone areas and developments can directly influence personal danger and potential damage reduction measures. Effective access means an exit route that remains trafficable for sufficient time to evacuate people and possessions, or any other appropriate boat-based or air-based means of evacuation. Specific problems can occur with cul-de-sac residential developments on rising land where the access road runs downhill from the properties, as the floodwaters rise, road access is cut off.

Access is generally divided into two categories, pedestrian and vehicular. The provision of road access that is trafficable in all weathers will assist in reducing the flood hazard and enhance the effectiveness of emergency services. Pedestrian access is far less effective due to problems with moving the aged, children and disabled.

It is essential that the consideration of access routes extend beyond the FPL. For example, in potentially hazardous developments (such as isolated high spots of land and canal subdivisions which can become inundated in floods larger than the event used to derive the FPL), provision should at least be made for access routes in extreme flood events. Access routes do not have to be above the PMF level but be at a level of flood protection that, in combination with effective warning time, development type and flood duration, provides adequate time for evacuation and reduces risk to acceptable levels. Without such access, the risk to personal safety of the entrapped and their rescuers may be unacceptable.

Further, care should be taken to evaluate the suitability of proposed evacuation routes and measures under a rare flood event, possibly the probable maximum flood (PMF) event.

Arrangements and evacuation routes, which may be suitable for flood events up to a flood used for determining the FPL, may become unsafe or inoperable for rare floods.

A potentially hazardous situation develops when rising floodwaters isolate an area of land, leaving it as an island in a sea of floodwater, prior to ultimate inundation.

Thus, while the filling of a flood prone block of land may render the property itself 'flood free' for the flood event on which the FPL is based, the property may become isolated if the access road is flooded, ie, in effect the filled land becomes an island. This isolation can cause significant additional danger to personal safety due to the potential for these islands to be completely inundated in rarer floods (see Figure G1).

Rescue by boat, helicopter or large vehicle may be necessary, so putting the rescuers lives at risk. Whilst such a situation may not develop for 'normal' floods, a check should be made to see whether or not rare flood events cause islands to develop, or even worse, to be later submerged.

L6.9 Type of Development

The degree of hazard to be managed is also a function of the type of development and resident mobility. This may alter the type of development considered appropriate in new development areas and change management strategies in existing development areas.

The following factors can affect the initial hydraulic assessment of hazard:

- the existence of special evacuation needs;
- level of occupant awareness;
- isolated residential development;
- hazardous industries or hazardous storage establishments;
- potential for damage and danger to personal safety; and
- development over watercourses.

L6.9.1 Special Evacuation Needs

General evacuation problems are discussed in Section L6.7. This section relates to the requirement to consider the specific evacuation needs from particular types of development such as aged, disabled and childcare facilities, mobile homes and caravan parks, isolated houses, schools, hospitals, and community centres.

An increase in the hydraulic hazard category for these development types is often necessary due to the requirement for:

- additional and different resources to evacuate; and
- additional effective warning time.

This may well mean that these development types are precluded from an area of the floodplain satisfactory for normal residential development.

PLATE 14 - Caravan Damage
(Photo courtesy "News & Sunday Mail")

L6.9.2 Level of Occupant Awareness

Caravan and mobile home parks, motels, hostels and hotels can all involve occupants (both short and long term) who are not conversant with flood risk management strategies for the development. The management (manager, operator or licensee) is responsible for providing advice on what to do during a flood, enabling occupants to act appropriately.

For existing establishments this may require the preparation, maintenance and promotion of a flood emergency response plan for the site. The plan should rely on resources under control of the management and occupants, rather than on external parties, such as the SES or council. Occupants should be advised of the flood emergency response plan and their responsibilities in a flood event. Copies of the plan should be available to occupants and provided to the SES for their information and reference in the local flood plan, if SES consider

this appropriate. Preparation of these plans for existing developments should be encouraged because of their potential to reduce flood risk (to both property and personal safety).

It must be noted that flood emergency response plans, where they do work effectively, reduce the flood risk (both the property and personal safety) but not the hydraulic hazard category in specific events.

Due to the transient nature and special needs of occupants, such plans should not be used as the basis of development consent for new developments of this type.

L6.9.3 Isolated Residential Development

Generally in lowering the density of development the evacuation assistance required is also reduced due to the lower number of people at risk. However, in the instance of rural residential developments proposed a reasonable distance inside the floodplain, the location generates special evacuation needs, due to the length and uncertainty of the evacuation route. Rural residential developments are often proposed as a low density alternative where normal residential developments are considered inappropriate due to flood impacts or other development constraints, such as servicing by infrastructure. However, where these are proposed with poor evacuation routes, the combined hazard level will often mean that they are inappropriate.

PLATE 15 - Isolated House

L6.9.4 Hazardous Industries or Hazardous Storage Establishments

Where a site within the floodplain involves an existing hazardous industry or hazardous storage establishment as defined in SEPP33, the potential affect of flooding of these materials can affect the hydraulic hazard category. If, due to escape of materials resulting from, or damage by, floodwater the potential is there for:

- a public health risk; or
- medium to long term (after the flood event has ended) environmental damage;

which results in an increased risk during floods. This increased risk can be reduced by having mechanisms and written procedures in the local flood plan to manage them.

It is important to encourage proper management of hazardous materials. Written procedures and appropriate mechanisms to manage this risk should be required or the materials should be re-located to a place they can be effectively managed, either within or outside the floodplain.

L6.9.5 Potential for Danger to Personal Safety and Damage

Certain types of development have a higher potential for damage in flood events than others and may present a danger to personal safety. There may be damage to structures themselves or associated damage to other structures in downstream areas (even in the low hydraulic hazard areas). These types of developments include mobile home and caravan parks. Caravans not removed, and mobile homes not tied down can result in downstream damage and danger to personal safety due to their mobility.

These factors, together with risk minimisation strategies, should be considered when determining the hazard category for these types of sites. This should be considered along with other associated factors, as indicated above, in hazard determination for these sites and in risk minimisation strategies.

L6.9.6 Development over Watercourses

Careful consideration needs to be made of proposed developments over watercourses. These developments should be assessed in terms of their potential impacts on hydraulic hazard, both within and external to the site, in events up to and including the probable maximum flood. Particular care should be taken in relation to increased danger to personal safety and impact on external resources for flood evacuation (such as the SES and council).

Existing developments should have properly prepared and maintained flood emergency response plans to assist in risk minimisation. These plans should rely, wherever possible, on the resources of the individual occupants and not on external evacuation resources. Occupants need to be made aware of the plans. The responsibility for preparation and maintenance of these plans (including regular reminders) lies with the managing agents or body corporate for the site. Copies of these plans should be provided to the SES for their information.

As indicated above, flood emergency response plans cannot be relied upon to be effective in all flood events and therefore cannot be considered to reduce the hydraulic hazard. At best they reduce flood risk in events where they operate effectively. As such, flood emergency response plans should not form the basis of development consent.

APPENDIX M FLOOD DAMAGES

FLOODPLAIN RISK MANAGEMENT PROCESS Appendix C											
Floodplain Risk Management Committee	→	Data Collection	→	Flood Study Preparation	→	Floodplain Risk Management Study Preparation	→	Floodplain Risk Management Plan Preparation	→	Floodplain Risk Management Plan Implementation
Appendix D		Appendix E		Appendix F		Appendix G		Appendix H		Appendix I

M1 Introduction

This appendix introduces various categories of flood damage and briefly describes the ways in which flood damage is measured and estimated. The importance of local councils collecting flood damage data after a flood event is discussed and council's responsibilities in this area are outlined. The necessity to consider flood damages in the long term strategic planning of future land use decisions is also discussed. Much of this material is taken or developed from the publication by the AWRC.

While this appendix concentrates on the human environment of the floodplain that may be damaged by flooding, there is also the need to consider the environmental costs and benefits of flooding and floodplain risk management measures. This is because whilst floods usually cause damage to human activity they are beneficial to the flood dependant ecosystems of the floodplain. As with intangible damages (discussed below), the environmental costs and benefits may be difficult to quantify. They are, however, a real and essential factor in the overall economic assessment of floodplain risk management measures. The estimation of environmental costs and benefits require expertise beyond that traditionally associated with floodplain risk management.

M1.1 How Much Flood Damage Is There?

The estimated average annual cost of flooding in Australia is some $400 million per year, of which New South Wales incurs some $140 to $150 million (see Appendix A).

The data used to derive these figures (AWRC, 1992) are uncertain, especially data concerning the cost of local overland flood damage (probably highly under-estimated), damage to rural enterprises (farms) and rural infrastructure (roads, railways, etc.) and flood damages to the ecology of an area. To improve floodplain risk management, and more importantly, to allow the effectiveness of management measures to be assessed, more reliable flood damage data are needed at all government levels. Local councils are in the best position to gather this data.

PLATE 16 - Household Damage Due to Inundation
(Photo courtesy "News & Sunday Mail")

M2 Flood Damage Categories

There are numerous categories or types of flood damage. Figure M1 shows various damage types commonly used in technical studies and their inter-relationships.

M2.1 Tangible and Intangible Damages

The most basic division of flood damages is into tangible and intangible damage categories.

Tangible damages are financial in nature and can be readily measured in monetary terms. They include the damage or loss caused by floodwaters wetting goods and possessions (direct damages) and the loss of wages and extra outlays incurred during clean-up operations and in the post-flood recovery period (indirect damages). Direct and indirect damages are discussed in Section M2.2.

Intangible damages include the increased levels of emotional stress and mental and physical

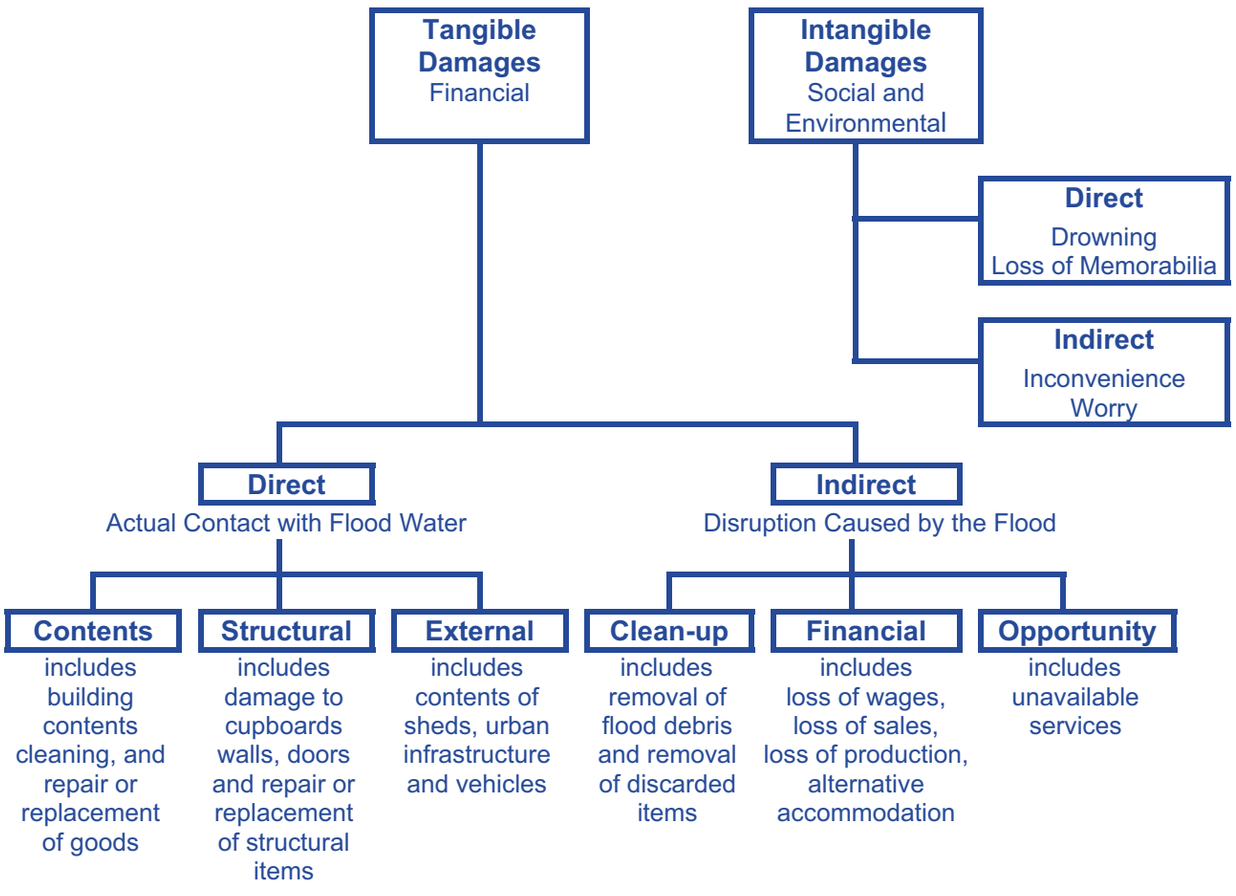


FIGURE M1 - Types of Flood Damage

illness caused by the flood episode. A flood is a traumatic experience for many victims. There is the sense of personal loss and despondency caused by the destruction of memorabilia (family photographs and documents) or loss of pets. There is the stress caused by additional and at times quite large financial outlays to replace flood damaged possessions. A flood can be a terrifying experience for young children and many suffer nightmares for a considerable time after the event. There is the stress caused by families having to function in a different way; children may have to live in temporary accommodation or they may have to attend different schools. *Helping Children Cope with Disaster* is a brochure prepared by the American Red Cross and the Federal Emergency Management Agency to address the problem.

It is difficult, if not impossible, to quantify intangible damages in financial terms. Intangible damages are real and represent a significant cost to flood affected persons, a cost that can be quite long lived. Most floodplain risk management studies acknowledge intangible damages but do not attempt to quantify them. However, it may be possible to approximately dimension the problem, by, for example, estimating how many flood-affected people may require additional medical treatment for depression or the ecological cost of the loss of a local environmental feature. Intangible damages are discussed further in Section M2.3.

M2.2 Direct and Indirect Damages

The two basic categories of tangible damages are direct and indirect damages.

Direct damages are caused by floodwaters wetting goods and possessions, thereby either damaging them irreparably or reducing their value. Some items might be capable of repair, whilst other items will be damaged beyond repair. In the first case, the direct damage is equal to the cost of repairs plus the loss in value of the repaired item. In the second case, the direct damage is equal to the pre-flood value of the item or its replacement cost.

Indirect damages are the additional financial losses caused by the flood. These can include the extra cost of food and accommodation for

evacuees (ie. the additional cost above normal costs in a non-flood situation). It also includes any loss of wages by employees, the loss of actual and prospective production or sales by flood-affected commercial and industrial establishments, and opportunity cost to the public caused by the closure or limited operation of public facilities.

M2.2.1 Direct Damage Categories

The direct damage to a property is commonly divided into three categories:

- contents damage;
- structural damage; and
- external damage.

Contents damage refers to damage to the contents of buildings, eg, in the case of residential properties, damage to carpets, furniture, etc.

Structural damage refers to damage to the structural fabric of buildings, eg, damage to foundations, walls, floors, doors and windows, etc. Note that structural damage also includes damage to built-in fittings. (Because they are not removable, these items are regarded as part of the structure of a building).

External damage includes damage to all items external to buildings. A common and significant form of external damage is damage to parked motor vehicles.

M2.2.2 Indirect Damage Categories

Indirect damage can be conveniently divided into three categories, clean up costs, financial costs and opportunity costs.

Clean up costs can be treated as an indirect cost (as in this appendix) or as a third category of tangible damages. Much of the cost of clean up operations arises from the time spent by people in this activity. They are either foregoing wages or other more satisfying activities when participating in clean up operations.

Financial costs refer to all other actual expenses suffered by people and businesses in the flooded area, either directly or indirectly. These include loss of wages, sales, and production and alternative accommodation.

Opportunity costs refer to the absence or reduced levels of service provided by public authorities and facilities, such as school closures, limited telephone facilities. Opportunity costs are imposed on the general public, including those owning properties outside the floodplain.

M2.2.3 Sector Costs

Tangible flood damage costs, both direct and indirect, can be classified into different land use sectors, such as residential, commercial, industrial, public institution, public utility, recreational, primary production and others. Typically, in most urban flood damage studies, only three or four sectors are recognised, these are residential, commercial, industrial (or commercial/industrial combined) and public properties. Rural studies, however, require a broader range of issues to be covered.

M2.3 Emotional, Mental & Physical Health Costs

A flood imposes a range of intangible damages on flood victims. These include the emotional, mental and physical ill health of the victims. Although it is impossible to fully measure these costs in financial terms, they are discussed in some detail here in view of their significance to victims and to the post-flood recovery of the community.

M2.3.1 Behaviour of Flood Victims

Typically, the emotional behaviour of many flood victims is in keeping with the 'disaster syndrome' identified by Wallace (1953, 1956), which comprises four phases, shock, suggestibility, euphoria, and frustration.

The shock phase occurs immediately after a flood. Victims report feelings of incredulity and disbelief that such a thing (the flood) could happen to them.

Next comes the suggestibility phase, in which some people are grateful for help and responsive to suggestions and directions.

This is followed by the euphoria phase, whereby some flood victims may be optimistic and happy. They have had an adventure, they feel part of the community and contribute to the clean-up operations.

This is subsequently followed by the frustration phase, during which some victims, as individuals, become aware of their losses and future difficulties. In this final phase those victims tend to become depressed, resentful and blame

authorities and others for their plight. Marital and family difficulties are often reported during the frustration phase.

These four phases were observed after the Brisbane floods of 1974 (Cameron McNamara, 1977; Chamberlain, et al, 1981). These four phases were also reported during and after the Nyngan flood of 1990.

- The shock phase took place on the night of the flood when people were evacuated to raised buildings in Nyngan.
- The suggestibility phase ran from evacuation, the next day by helicopter and bus, through the period of temporary accommodation in Dubbo and elsewhere.
- The euphoria phase commenced during the period of temporary accommodation and during clean-up operations, which were assisted greatly by an enormous volunteer effort.
- The frustration phase occurred over several months after people had returned to their homes and the volunteers and other helpers were finishing up.

M2.3.2 Emotional, Mental & Physical Health Costs

The emotional costs of flooding can be quite long-lived. In April/May 1975, some 15 months after the 1974 Brisbane flood, a follow-up survey of flood victims found that about 25% still had not recovered from the emotional trauma of the event (Chamberlain, et al, 1981). Factors that contributed to non-recovery included the severity of flooding, the degree of the resulting financial hardship, age and socio-economic status. Elderly people on low incomes whose houses were deeply flooded were the most ill affected.

Accordingly, a major flood imposes a range of emotional costs on flood victims, many of them quite severe. Moreover, the emotional strain may linger for up to several years after the event.

Flood aware communities can be expected to suffer less social and financial disruption than communities with a low level of flood awareness. Thus, the emotional stress of flooding should also be less in flood aware communities. A recent survey of flood prone residents in Forbes supports this conclusion (Water Studies Pty Ltd, 1992). Most surveyed residents were married couples with young families. Their flood losses were small, but household disruption was great - all had packed and unpacked and moved in and out of their houses three times during floods in 1990. Nevertheless, when surveyed after the third flood, their spirit was good and their enthusiasm undampened.

It should be noted that whilst major floods in Australia are spectacular events and are often dangerous, they are generally accompanied by surprisingly little loss of life**.** Twelve (12) people died in the 1974 Brisbane floods (some 30,000 people had their homes inundated by floodwaters). Fourteen (14) people lost their lives in the 1955 Hunter River floods (the homes of 18,000 people were flooded). Loss of life during floods is generally due to accidents and misadventure (typically electrocution) rather than through people being 'swept away'. However, the disastrous 1852 flood down the Murrumbidgee River swept away the town of Gundagai, drowned 89 people out of a population of 250, and resulted in the town being shifted to higher ground.

Evidence for the effects of floods on the mental and physical health of flood victims is inconsistent. While the effects of a flood may be expected to be detrimental to the health of flood victims, the question is in what way and to what degree. Smith et al (1980) and Handmer and Smith (1983) have reviewed the effects of flood hazard on health. It was found that the 1974 flood in Lismore had no overall effect on the number of hospital admissions or the number of deaths, but that there was a variation in the pattern of admissions to hospital. After the flood a higher percentage of people were admitted for mental disorders. Abrahams et al (1976) examined the effects of the 1974 Brisbane flood on the health of flood victims. There was no increase in mortality in the post-flood period, but the number of visits to general practitioners, hospital and specialists ".... were all significantly increased for flooded persons in the year following the flood". Complaints were more psychological than physical in nature, and included irritability, nervous tension and depression.

Thus, it can be concluded and may even be expected, that a major flood will tend to result in an increased incidence of psychological

disturbances in flood victims. The trigger for these illnesses would appear to be the emotional strain resulting from the financial and social costs caused by the flood.

The question of the effects of floods on physical health appears more tenuous. In a study of the health effects of the 1968 Bristol floods in England, Bennet (1970) found that there was a significant increase in the physical ill health of flood victims, a 50% increase in the deaths of flood victims and a marked rise in deaths from cancer. Careful statistical analysis of health data is required to validly separate out the effects of flooding on health.

Apart from physical injury during evacuation and clean-up operations, floods and flooding, *per se*, appears to have no direct effect on physical health. However, floods can be expected to be detrimental to physical health to the extent that disease is stress-related, especially for sufferers pre-disposed to stress-related diseases.

M3 Actual and Potential Damages

There are a further two categories of flood damage that are generally applied to tangible damages, namely actual and potential damages.

Actual damages are the damages caused by an actual flood. Potential damages are the maximum damages that could eventuate should such a flood occur. In assessing potential damages, it is assumed that no actions are taken by the flood affected population during the flood event to reduce damage, such as lifting or shifting items to flood free locations, and moving motor vehicles.

Typically, Damage Reduction Factors are used to convert potential damage estimates to actual damage estimates. Two important parameters affecting Damage Reduction Factors are the length of the effective flood warning period and the flood awareness and readiness of the affected population. The longer the effective warning period, the more time available for evacuating goods and possessions. The more flood aware and ready the population, the more effective these measures will be.

M4 Collection of Flood Damage Data

A flood provides an opportunity to gather data concerning actual flood behaviour and flood damage. Surveys of actual flood damage should be undertaken as soon as practical after a flood has occurred. The data can be used to confirm the effectiveness or otherwise of management measures already in place. They also provide essential information for future flood studies and floodplain risk management plans.

M4.1 Local Council Responsibilities

The responsibilities of local councils are outlined in Section 3.1. Section 3.1.8 highlights that councils are in an excellent position to coordinate the collection of local data to assist in future flood investigations.

Collection of relevant basic flood damage data is neither a lengthy or costly procedure. It can involve the use of council personnel, or consultants or contractors, to document flood depths and simple property characteristics. Technicians, staff from the survey section, or junior engineers are all appropriate for this task. Valuers, estimators or loss assessors can be used to extend the raw data and put dollar values to the actual flood losses.

There are two basic steps associated with an actual flood damage survey. The first step involves identifying, where practicable, every property and/or every building which was inundated by flood waters and recording the depth of inundation or the level to which flood waters rose. The second step involves recording in detail, the extent of damage, for some or all of the buildings and properties.

The two basic steps may be conducted together, within days of the flood reaching its peak, or the second step may be conducted some weeks after flood waters have receded, but while memories are still fresh.

Some data on buildings in the flooded areas may be readily obtained from council records within 24 hours of a flood, and used in discussions with the owners or occupiers of flooded premises. The data collection in the field involves council representatives visiting flooded properties and recording details, after discussion with owners or occupants if possible.

If the second step, more detailed data collection is conducted a few weeks after the first field data collection, some analysis of the initial data may be useful before the second survey. This

analysis may allow targeting of particular data in the second step. Data such as:

- what items were damaged;
- where the items which suffered water damage were located;
- where water came from; and
- what level the water got to;

should be recorded systematically so that valuers can convert the raw data into costs in dollars.

The collection of flood data after an actual flood is very cost-effective in improving floodplain risk management. Councils have a responsibility to their ratepayers and the community, to seize data collection opportunities so that the information can be used to assist in floodplain risk management across the council area and throughout the state or inter-state. Information from flood damage surveys in other states of Australia is used to assist in floodplain risk management decisions in NSW.

M4.2 Difficulties in Collecting Data

Actual damage surveys are made difficult by the fact that, at the time of the survey, many flood affected occupants are still dazed by the flood episode and confused as to the contents of rooms. Further, many items may have already been discarded during the clean-up process. These items have to be identified and their value established, sight-unseen. In these circumstances survey forms need to contain a detailed list of items likely to occur in each room. The person conducting the survey then leads the occupant through this list to ascertain the pre-flood contents of the room and an indication of their value.

M4.3 Lessons Learnt from Urban Flood Damage Studies

In some cases floor or flood levels are estimated by inspection, rather than actual measurements of floor levels and marks left by actual floods. Although some costs seem to be saved by estimating floor or flood levels, rather than accurately measuring the levels, the apparent savings are frequently lost because the community does not accept the resulting conclusions. Tying floor and flood levels to known benchmarks is strongly recommended, unless the costs are prohibitive.

In many flood damage surveys, a sample of representative properties is first identified and then damages to these properties are determined, either by questionnaire or through personal inspection by a trained valuer. In questionnaire surveys, property owners estimate their own damages. A mix of a small number of property inspections by an experienced valuer and a wider coverage of questionnaires to property owners who have experienced a recent flood is generally desirable.

Experience with potential and actual flood surveys indicates that:

1. Any questionnaire should be kept simple, with many required responses being a tick in a box ☑. Sample questionnaires are available from DIPNR.

   The questionnaire should also be worded carefully to avoid loss of data in the distinction that is sometimes drawn between storm damage and flood damage. Reference to a storm event may ensure that all damage is reported in the survey.

2. Flood awareness and readiness are probably the most important factors in damage reduction. An aware and ready person will reduce losses far more in 1 or 2 man-hours of activity than a non-aware person will in 6 to 8 man-hours (Water Studies, 1986, 1988). This has significant ramifications for education programs (see Appendix J).

3. In flood-aware towns where residents have at least 12 to 24 hours warning, many inhabitants have damage reduction measures down to a fine art. Typically, flood prone residents at Forbes evacuate everything moveable from their homes, including carpets, furniture, doors and in one case the kitchen stove, which was electric with plug-in connector (see Water Studies Pty Ltd, 1992 for details).

4. People living in country towns generally appear to be more resourceful and better adapted to dealing with a flood and its aftermath than city dwellers.

M4.4 Urban Flood Damage Data

Basic flood damage data to be collected from urban areas (irrespective of whether the damage is caused by local overland or

mainstream flooding) relate to the number and type of flooded properties and depths of flooding within buildings and across grounds. Standard forms are available from DIPNR to assist in this process. No estimates of flood damage or flood loss per se are required.

Each urban property that is partially or fully covered by floodwaters needs to be included in the survey, irrespective of whether or not buildings are flooded above floor level.

Note that some data need to be assessed subjectively usually on a comparative basis, such as building size. A quick inspection of house sizes will provide broad guidelines for 'small', 'medium' and 'large' dwellings. Similarly, house style will provide a reasonable guide to building age. A detailed questionnaire to assist in the second step of the data collection is available from DIPNR.

M4.5 Rural Flood Data

Basic flood damage data to be collected from rural areas relate to crop and stock losses on a farm-by-farm basis. Standard forms are available from DIPNR. These losses also include agistment costs and fodder and feed costs. Coordination between the local council and state authorities is necessary to collect data on rural infrastructure damage.

In the case of rural flood damage, the farmer is asked to estimate the value of his losses. Rural flood surveys may take longer than urban surveys because of the larger areas involved.

M5 Estimation of Flood Damage Costs

The flood damage data collected, when combined with data collected under similar situations and circumstances elsewhere, is generally used to estimate the cost of flooding for a specific urban or rural area.

To compare the benefit and effectiveness of proposed mitigation measures, it is necessary to:

- first estimate flood damage which would be caused by different sized floods which might occur now;
- secondly estimate the reduced flood damage which would be caused by those floods after specific mitigation measures were implemented; and
- estimate potential damage costs for proposed new development areas considering likely development conditions.

M5.1 Potential Damage

Flood damage studies are frequently necessary for areas that have no recent records of damage in an actual flood. Potential damages should be measured, in areas that have not been subject to a recent flood and associated damage survey and in areas that have been flooded.

In a potential damage survey, a sample of representative properties is first identified and then damages to these properties are determined, either by questionnaire or through personal inspection by a trained valuer. This is different from some actual damage questionnaire surveys, in which property owners estimate their own damages.

Damage reduction factors are used to convert potential damage estimates to actual damage estimates.

Potential damage surveys are typically undertaken in non-flood times. In such a survey, the valuer estimates damage on an item-by-item basis for each room of the building. This is typically done for three or four possible flood depths (typically about 0.05m, 0.5m, 1.0m and 2.0m above floor level). The damage estimates are made on the basis that nothing is shifted should a flood occur. Needless to say, detailed survey forms are required to record these data. Because of the absence of flooding and the presence of all goods and chattels, it is relatively straightforward for a trained valuer to estimate potential damage.

M5.2 Stage-Damage Curves

Actual and potential flood damage data can be presented as stage-damage curves for different property types. Such curves relate contents damage to depth of flooding above floor level. These curves are generally derived on the basis of numerous damage studies undertaken throughout Australia (Water Studies, 1986). Stage-damage curves can be derived for residential, industrial, commercial, rural and public properties.

M5.3 Computer Models and Property Counts

To determine the flood damage over a specific urban area it is necessary to know the number of flooded properties, the type of flooded properties and the depth of flooding above floor level. The number of flooded properties can be determined from flood studies, flood maps, aerial photographs or from a street by street inspection.

It is generally very difficult to discriminate property types from aerial photographs. A knowledge of flood levels and floor levels throughout the flooded area will enable flood depths over the floor to be calculated for each building. Floor level data may be obtained either from council plans or by measuring floor height above ground level, with ground levels estimated from contour maps. The appropriate stage-damage curve allows the damage to be estimated for each property. A computer model or a spreadsheet is typically used to combine all these data and estimate the flood damage for different flood levels up to and including the probable maximum flood (PMF). Similar procedures are used to estimate flood damage costs for rural areas.

M5.4 Accuracy and Reliability

To obtain consistent and reliable estimates of flood damage requires care and experience. Even so, such estimates are necessarily approximate. For properties of the same type, there is typically a widespread variation in damage from property to property. Stage-damage curves reflect average damages. Thus, when using stage-damage curves to assess damage in an unsurveyed property, the estimate is necessarily approximate. However, if the sample of surveyed properties has been chosen correctly, the total damage estimate for all flooded properties will be much more reliable. Further inaccuracies creep into damage estimates from uncertainties in flood, ground and floor levels. Again, if the estimation procedures are correctly chosen, there should be no gross bias in the total damage estimate. To ensure that these uncertainties are minimised the damage assessment should be carried out by an experienced practitioner.

M6 Average Annual Damage

Over a long period of time, a flood liable community will be subject to a succession of floods. In many years, no floods may occur or the floods may be too small to cause damage. In some years, the floods will be large enough to cause damage, but the damage will generally be small because the floods are small to medium sized. On rare occasions, major floods will occur which cause great damage, such as the Nyngan flood of April 1990 that had an estimated average recurrence interval of 200 years and caused some $65 million in damage.

The average annual damage (AAD) is equal to the total damage caused by all floods over a long period of time divided by the number of years in that period. (It is assumed that the development situation is constant over the analysis period).

AAD is a convenient yardstick to compare the economic benefits of various proposed mitigation measures. For example, consider two structural measures, a proposed house raising scheme and a proposed levee, that reduce the current AAD by $0.5 M per year and $1.5 M per year. The levee is clearly more effective in reducing flood damages, it generates greater benefits than the proposed house raising scheme, but it also costs more to construct and maintain. Also, there may be different environmental and social costs associated with both schemes. All of these cost factors have to be weighed up and evaluated in determining the relative economics of possible mitigation measures. Suffice it to say that the AAD provides a consistent means of evaluating the physical economic benefits of different mitigation measures. It should not be forgotten that unless the environmental impacts of the various measures under consideration are also included in the assessment, then the end result of the assessment will not truly reflect the costs and benefits of the proposal.

How is AAD determined ? We do not know the actual sequence of floods that will occur at a particular flood liable community. However, we do know that *on average*, the 20 year average recurrence interval (ARI) event will occur once every twenty years (an annual exceedance probability (AEP) of 5%), the 50 year event will occur *on average* once every 50 years (an

AEP of 2%), etc. Further, by examining a range of floods, we can estimate the potential and actual damages caused by floods of different severities, as described in Section M4. The variation of flood damage with the annual likelihood of occurrence of the flood (AEP) can then be plotted, as shown in Figure M2. Figure M2, indicates that in this particular situation flood damage only commences at the 10% AEP flood event and the more extreme the flood, ie. the lower the AEP, the greater the flood damage. The AAD for the situation depicted in Figure M2 is equal to the area under the damage - annual likelihood of occurrence curve.

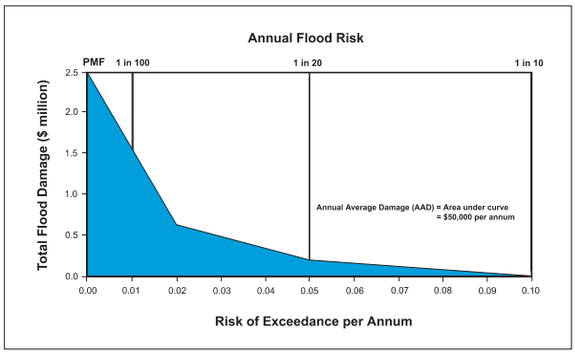


FIGURE M2 - Flood Damage Variation with AEP

The AAD for floods up to the 5% AEP flood is determined from the area under the damage curve (Figure M2) to the right of this point. This equates to $5,000 (½ x $200,000 x 0.05), ie. floods up to the 5% AEP event contribute $5,000 to the AAD. The total area under the damage curve (Figure M2) for all events up to and including the PMF is $50,000, this is the total AAD.

M7 Future Flood Damages

It is important that the question of flood damages related to future developments on flood prone land, urban or rural, is also considered in the formulation of a floodplain risk management plan.

This type of investigation should consider future land use scenarios, projected lot sizes, occupancy rates and estimated flood impacts. Flood level information from the flood study and the stage damage curves (from damage studies for existing development) can be used to assess the viability of the range of land use proposals under consideration and provide a sound basis for the long-term, strategic management of the flood prone land.

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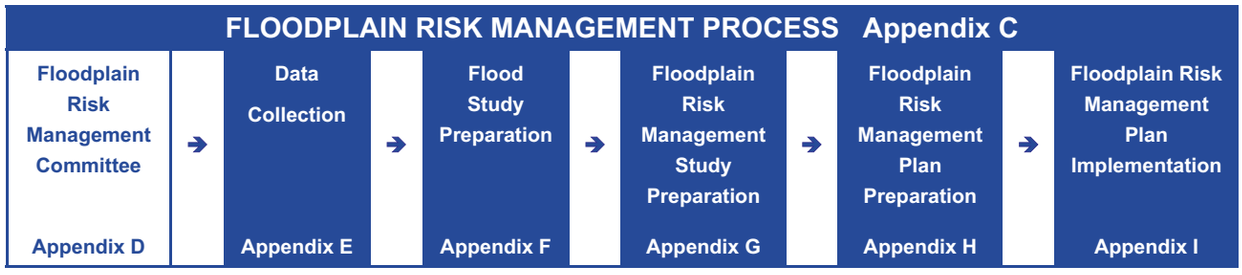
APPENDIX N EMERGENCY RESPONSE PLANNING FOR FLOODS



N1 Introduction

Flood planning refers here to the preparation of formal community-based plans of action in accordance with NSW emergency management legislation to deal with the threat, onset and aftermath of flooding. The plans, called local flood plans, themselves are 'records of intended proceedings' for the management of floods. Properly produced and utilised, they will help the related agencies with tasks to perform during flood events to meet their responsibilities. They will also be useful in informing and educating flood liable communities about the problems they must face. In doing these things they will help people to avoid or mitigate property losses and to stay safe when flooding occurs.

The matter of private or site specific flood plans prepared for individual developments, businesses or households, is covered in Section N7.

Of all the floodplain risk management measures, it is only community-wide flood planning which addresses the continuing risk remaining after works are implemented. Continuing risk relates to floods larger than the flood event used to determine the FPL for new development, or the protection level provided to the existing township by previous development controls or protection measures (such as a levee). It involves planning to evacuate a town faced by potential levee overtopping or flooding from events rarer than the flood event used to derive the FPL. Local flood plans may be supported by works in the floodplain risk management plan to improve the manageability of continuing risk. These may include flood warning systems and improved evacuation access as discussed in Appendix J.

Many of the actions detailed in local flood plans will also contribute to the ability of communities that are protected by structural measures to deal with the problems which flooding poses. This is because communities can be affected by flooding even though inundation may not occur within protection works, such as levees. An example is that travel outside a town might be disrupted, and the provision to the town's people of information on roads which may become closed by flood waters (or are already cut) is a matter which can be planned for.

N2 The Role of the State Emergency Service

The SES plays the central role in the development of local flood plans in New South Wales. This is because one of the functions of the SES is to act as the combat agency for dealing with floods which includes the establishment of flood warning systems, and the evacuation and welfare of affected communities. These responsibilities are defined in the State Emergency and Rescue Management Act (1989), the NSW State Disaster Plan (DISPLAN).

Importantly, the State Emergency Service Act (1989) reinforces the flood combat agency function by specifying that the Director General (DG) of the SES has the authority to 'undertake such planning and make such preparations as (the DG) sees fit'. The DG SES can call on other emergency service organisations and government departments to assist in the preparation of local flood plans and in the management of floods when they occur. As far as flood planning is concerned, this means that the SES takes the lead in the preparation of local flood plans. It must, however, ensure that other agencies are incorporated in the planning process.

N3 Levels of SES Planning

In 1990, the SES began the preparation of a series of plans covering arrangements for the management of floods in all flood liable areas of the State. These plans are intended to cover all levels of flooding, from those creating only minor nuisance to those potentially necessitating large-scale evacuations and/or causing substantial disruption to community activity. They are also intended to cover all relevant flood threats, whether the inundation of land emanates from rivers, creeks, lakes or the sea, or even from cases of dam failure where that is known to be possible as a result of structural or spillway deficiencies having been identified.

Despite the range of potential sources of flooding, the principal flood threat in New South Wales is riverine and the plans reflect the dominance of the problems caused by overbank flooding from streams. Similarly, the intelligence that supports the plans is primarily about the effects of flooding in areas around gauges on the state's major rivers.

Three levels of flood plan have been produced. There is a State Flood Plan, a Division Flood Plan (for each SES Divisions) and a local flood plan (for each local area with a significant flood problem). Most local flood plans have been prepared on a council area basis but some have been produced for combinations of two or three council areas or for parts of council areas.

N3.1 The NSW State Flood Plan

The New South Wales State Flood Plan:

- defines the flood threat in the state;
- outlines the legislative basis for the management of floods and floodplains;
- describes the management systems which apply to flood mitigation, preparedness, response and recovery arrangements; and
- sets out the responsibilities of agencies with regard to these functions.

The management systems described relate to the:

- mitigation of flooding by the careful management of development on floodplains;
- development by the SES of a flood intelligence system for flood prone areas throughout the state;
- development of a state-wide series of SES Division Flood Plans and Local Flood Plans covering all potential types and severities of flood threat;
- education of members of communities about the dangers of flooding and what can be done about it;
- provision of flood warnings and the development of improved flood warning systems and services;
- mobilisation of SES and other appropriate resources for the conduct of flood response operations;
- mobilisation of the emergency management structure in support of SES controlled flood operations; and
- application of recovery functions, including SES assistance with recovery.

N3.2 Division Flood Plans

Division Flood Plans outline, for each division:

- the purpose and authority of the plan;
- the nature of the flood threat and its consequences;
- the council areas for which local flood plans are required;
- responsibilities of the SES Divisional Controller, other officers, agencies and organisations at Division and District level;

Division flood plans also describe arrangements for:

- maintenance of the plan;
- support for SES units in carrying out public education relating to flooding;
- control of operations;
- liaison with other participants;
- plan activation and notification to other agencies, organisations and officers;
- establishment of communications between the SES Division Headquarters, SES Units, SES State Headquarters and other agencies with responsibilities during periods of flooding;
- transmitting warnings and SES flood bulletins containing information about the effects of rising and falling floods to units, media outlets and, where appropriate, downstream Divisions;

- provision of out-of-area support for areas expecting or experiencing flooding;
- management of evacuation across council and Division boundaries; and
- the conduct of Division-level debriefs.

SES Division Controllers are responsible for the management of flood operations within their respective divisions. This includes the allocation of personnel and other resources from one area to another within a division. Each Division Controller is assisted by a corps of volunteers operating from a Division Headquarters.

N3.3 Local Flood Plans

Local flood plans outline, for each local area:

- the purposes and authority of the plan;
- the nature of the flood threat and its consequences; and
- the responsibilities of the SES Local Controller, other officers, agencies and organisations at local level.

Local flood plans also describe arrangements for:

- cross-border assistance to the area and from it to neighbouring areas;
- maintenance of the plan;
- SES participation in floodplain risk management initiatives;
- development of flood intelligence;
- development of flood warning systems;
- strategies for public education about flooding;
- SES training for flood readiness;
- maintaining the condition and readiness of SES equipment and SES local and unit headquarters;
- control of operations;
- location of operation centres;
- liaison between participants;
- establishment of communications between the SES local headquarters and the relevant SES Division Headquarters, SES field teams and agencies operating at local level;
- plan activation and notification to other agencies, organisations and officers;
- obtaining intelligence during times of flooding;
- transmitting warnings and SES flood bulletins containing information to the community about the effects of rising and falling floods;
- control of roads;
- flood rescue;
- evacuations;
- registration of evacuees;
- protection of essential facilities from flood waters;
- logistics support;
- resupply of isolated communities;
- management of domestic pets and companion animals;
- assisting stranded travellers;
- the issuing of “all clear” messages;
- welfare of evacuees or displaced persons;
- coordination of recovery operations; and
- conduct of debriefs.

Annexes describe the flood threat and the areas affected by flooding, list the gauges and gauging systems monitored by the SES and detail any special operational provisions or arrangements. For example, warning delivery, evacuation for towns or caravan parks, dam-failure flood response, resupply operations, or for decentralised operations when localities are cut off by flooding.

Some of the elements of local flood plans are likely to be relatively simple in content and need to be described only briefly (for example conditions for plan review, liaison arrangements and communications systems used). These elements can often also be treated in a relatively generic manner because they differ little from community to community. Others, however, may need more detailed treatment or treatment which differs substantially between communities. It is difficult to be prescriptive on this matter, but the following may guide the development of arrangements for key functions that relate to the provision of assistance to members of the community when flooding is imminent or occurring.

- Warning: the plan should define the warning task for a series of levels (for example minor, moderate and major floods) by identifying the clientele, anticipating their information needs and specifying how warning information and advice will be provided to different groups of clients in floods of differing severity. The integration of flood forecasting (for example by the Bureau of Meteorology) and warning activities should also be addressed.
- Evacuation: the planning process should identify the areas that may need to be evacuated at different flood levels and define the mechanics of likely evacuation operations. Depending on the potential scale of the evacuation task and the complexity of the environment from which evacuation may be required, this will involve consideration of such things as:
  - numbers of doorknockers required to deliver warnings;
  - the capacity of evacuation routes and the problems of bottlenecking and low-point inundation;
  - the time available to complete the evacuation before inundation occurs or evacuation routes are lost;
  - the transport resources which will be needed; and
  - the identification of reception (evacuation) centre sites.

  In some communities, it will be appropriate to divide the area to be evacuated into operational sectors and to plan the mechanics of the operation separately for each sector.
- Resupply: the areas which might, because of isolation, require resupply should be identified and the means by which resupply would be effected should be noted.

The activities relating to these functions and several other functions that must be carried out during times of flooding, must be supported by flood intelligence that indicates the impacts of flooding at different gauge heights in areas liable to inundation. The SES maintains records of flood intelligence by collecting data on affects through reconnaissance and from members of the community during times of flooding. Council records and information gathered during the compilation of flood studies and floodplain risk management studies, are also important sources of flood intelligence. Records of the effects of flooding at different levels will increasingly be maintained in Geographical Information System formats in the future.

The interaction of the Floodplain Risk Management Process and the Flood Planning Process are shown on Figure N1.

N4 The SES Local Controller

The local controller is the SES representative most involved in flood planning and flood management at the local government level. Local Controllers are responsible to their respective Division Controllers for the control of floods within their council areas and for the co-ordination of the activities of supporting agencies. They are required, therefore, to take a broad view of the flood management responsibility and the lists of their responsibilities in individual local flood plans illustrate the breadth of their operational task. Besides the operational responsibilities, the Local Controller must undertake other activities including:

- ensuring that the SES is represented on any local floodplain risk management committee and contributes to the development of effective floodplain risk management plans;
- working with local councils (and, in situations where dam failure is possible the owner to the dam) to promote awareness of the flood threat in the community; and
- coordinating the development of the local flood plan and ensuring that the plan is integrated with the local disaster plan (DISPLAN). The necessary co-ordination can best be achieved by membership of the local emergency management committee.

With very few exceptions, each local controller is assisted by a corps of volunteers operating from a local headquarters.

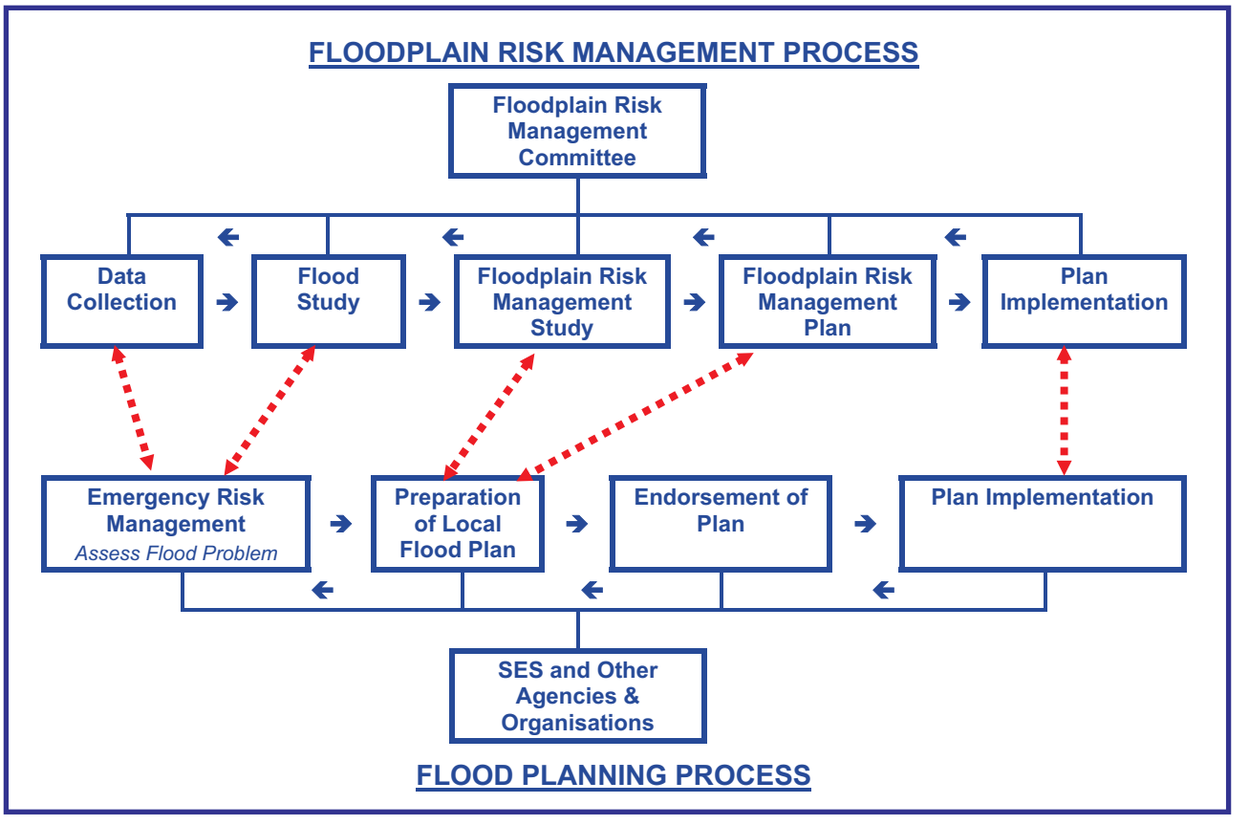


FIGURE N1 – Interaction of the Floodplain Risk Management and Flood Planning Processes

N5 *Ensuring Quality in the Planning Process at a Local Level*

Effective local flood planning requires the co-ordinated efforts of:

- the SES;
- the local council;
- state agencies;
- commonwealth agencies;
- volunteer organisations; and
- the local community (including people whose properties are flood affected and those who might be indirectly affected).

All of these interests and the types of expertise they encompass should be incorporated in the actual planning process so that responsibilities can be negotiated and agreed, a range of views tapped on the solution of particular flood management problems, and broad ownership of the plan fostered. When the draft plan has been prepared, it will be the subject of endorsement by the local emergency management committee of the relevant council area or areas before the final document is distributed to all agencies with roles to play in it and released into the public domain.

After endorsement and distribution, the plan should be reviewed regularly:

- after significant flood events or plan exercises;
- when new information about the threat becomes available (for example, after completion of a management study);
- when there are significant environmental changes (such as the building of a levee or the raising of important roads); and
- when there are changes in key flood management personnel.

If there are no substantial changes of these sorts after several years, the plan should be reviewed in any case to ensure that the arrangements continue to reflect sound practice and to maintain agency familiarity with the document. After review, the revised plan will be re-submitted to the Local Emergency Management Committee for endorsement and copies distributed again to all relevant agencies. The planning process must be iterative and continuous if the plan is to maintain its freshness and utility as a management tool.

N6 Using the Local Flood Plan as an Educational Tool

The existence of flood plans can be used to remind people in flood affected areas that the flood threat exists and to debunk well-known myths. These include the notion that very severe floods of the past will never be equalled in scale in the future and the belief that management devices such as levees, diversion channels and retention basins will render future floods harmless.

The wider community on whose behalf the flood plan is written needs to be familiar with the flood risk and the existence of the plan.

A plan on its own is too general to be used alone as an educational tool. For this reason the SES also produces locally customised FloodSafe Guides for flood prone communities or specific flood risk areas. In addition the SES conducts media campaigns and works with councils of local government areas to run public activities to increase community awareness. Figure N2 provides an example of a FloodSafe Guide. The main objectives of community flood education are:

- familiarising communities with the flood threat or reminding them about it;
- informing people about the arrangements which have been devised for managing it; and
- indicating to them how they can help protect themselves and their property from the effects of flooding.

The local flood plan and FloodSafe Guides should be publicly available in libraries and council information centres. They can be publicised via local media outlets and in commemorations of past flood episodes. Wide availability will help reinforce other methods of raising public awareness such as the establishment of fixed flood markers, the playing of community service announcements about flooding on radio and television and the periodic mounting of photographic displays or school projects with flood themes.

N7 Private Flood Plans

Private or site specific planning refers to the preparation of arrangements aimed at dealing with the impact of flooding on a particular business or household. The SES supports the idea of owners and occupiers of premises in areas of flood risk having a plan for what they should do to prepare for and respond to flooding. To this end, the SES promotes this practice in community and business education activities and continues to develop information to guide the community when they choose to prepare a private flood plan.

N7.1 Limitations of Private Flood Plans

Any form of response planning, but private planning in particular, is unreliable as a long term risk mitigation measure. This is because all plans must be prepared using assumptions about conditions (environmental and organisational) that are expected to apply in the future and which may prove to be wrong or at least very different to the actual event.

Floods are highly variable in frequency and severity and this influences two critical planning assumptions, available flood warning time and likely consequences. If, in an actual flood, there is a significant variation between assumptions and reality, even a well written plan may fail unless intelligent on-the-day adaptation is implemented.

Implementation of a plan depends explicitly on a thorough understanding of the risk and of the roles and responsibilities of participants. To experienced emergency managers these are areas well known for there uncertainty and the SES trains and practices continually to minimise their impact. Businesses and households will have a much lower capacity to undertake the necessary training and practice and so the plans they own will be much more prone to failure.

N7.2 Private Plans as a Development Consent Condition

In a naive attempt to provide some sort of protection to council when it approves a DA in a flood risk area, some councils are imposing development consent conditions requiring site specific plans. Some consent conditions require the applicant to seek SES endorsement of their plan. Taking into account the preceding discussion about limitations of private plans, the SES is opposed to this approach and some specific points related to this policy are set out below:

- Conditioned private flood plans will only be prepared to secure the development

consent, not because of a genuine commitment to taking some personal responsibility for risk management. Unless a plan is owned, understood, and practised by the owner/occupier, it will almost certainly be forgotten and fail to be effective;

- There is no workable process for quality control of private plans and the SES, having no resources available to service such a huge task across NSW, has no choice other than to refuse requests by an applicant for the SES to review their plan;
- The SES is aware of a case where a private plan has been submitted to a LEMC in an attempt to circumvent the SES policy. The legal status of endorsement of a private flood plan by an LEMC, against the policy of the legal combat agency for flood (the SES) has not been tested; and
- Councils should be aware that the issue of private flood plans as a consent condition has been tested in the NSW Land and Environment Court and the policy of the SES has been recognised as valid.

N8 Summary

Flood planning is an important element of the wider floodplain risk management process. It is also more than simply the production of a plan. The planning process enables solutions to the emergency risk management problems which floods pose to be generated before flooding occurs - by which time many potential solutions, if not previously considered, may not be able to be instituted. Planning also helps weld together the agencies which have responsibilities for flood risk management and the local flood plan itself can be used to increase the community's comprehension of the threat and what can be done to manage it.

FIGURE N2 - Example FloodSafe Guide – Page 1

FIGURE N2 - Example FloodSafe Guide – Page 2