APPENDIX M FLOOD DAMAGES

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

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. <u>They are, however, a real and essential factor in the overall economic assessment of floodplain risk management measures.</u> 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.

<u>Tangible damages are financial</u> 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.

<u>Intangible damages</u> include the increased levels of emotional stress and mental and physical

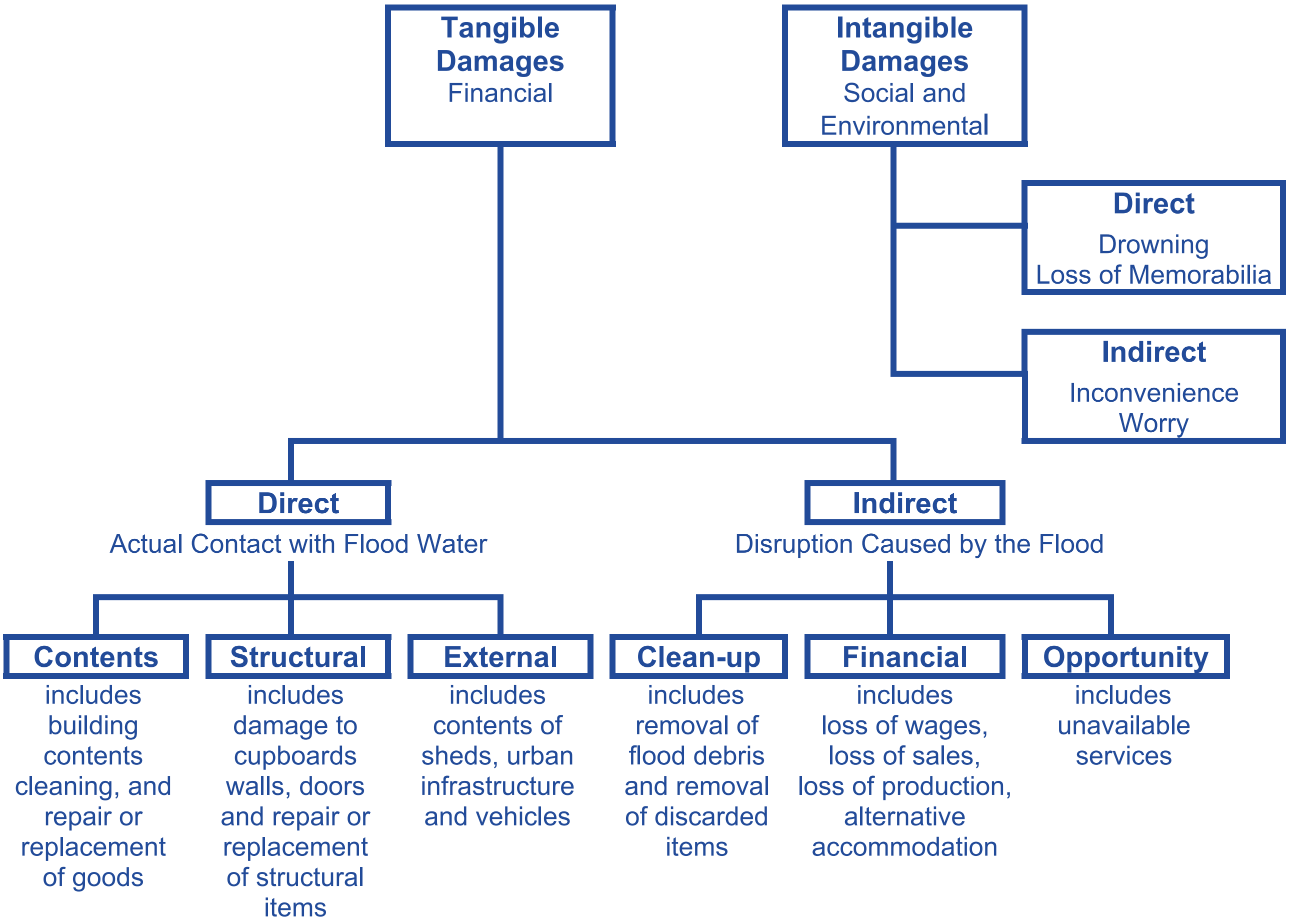

FIGURE M1 - Types of Flood Damage

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.

<u>Direct damages</u> 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.

<u>Indirect damages</u> 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 <u>surprisingly little loss of life</u>. 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.

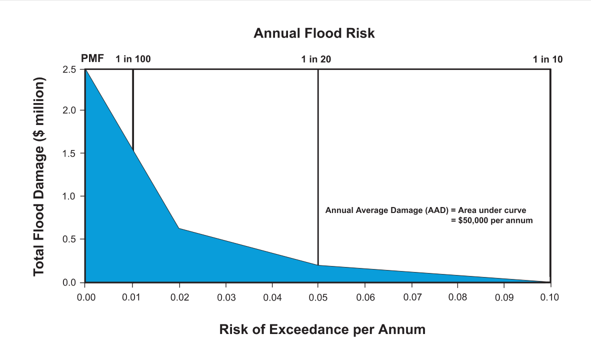

FIGURE M2 - Flood Damage Variation with AEP

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.

M8 References

Abrahams, M.J., Price J., Whitlock, F.A. & Williams, G., 1976 'The Brisbane Floods, January 1974: Their Impact on Health'. Medical Journal of Australia 2: 936-39.

American Red Cross and the Federal Emergency Management Agency, 1992 Helping Children Cope with Disaster.

AWRC, 1992 'Floodplain Management in Australia', (2 Volumes), Australia Water Resources Council, Water Management Services, Report No. 21, 1992.

Bennett, G., 1970 'Bristol Floods 1968, Controlled Survey of Effects on Health of Local Community Disaster'. British Medical Journal, 3: 454-458.

Chamberlain, E.R., Handshorn, A.E., Mugglestone, H., Short, P., Svensson, H. & Western, J.S., 1981 'Queensland Flood Report - Australia Day 1974', (Canberra: Aust Govt Publishing Service, 1981).

CMP, 1977 'Brisbane Suburban Creeks: Report on Flood Warning and Flood Education' by Cameron McNamara and Partners for Co-ordinator Generals Department, July 1977.

Handmer, J.W. & Smith, D.I., 1983 'Health Hazards of Floods: Hospital Admission for Lismore'. Australian Geog. Studies, 21: 221-230.

Joy, C.S. & Markar, M.S., 1991 'Local Council Responsibilities in the Estimation of Flood Damage'. Paper to Flood Mitigation Authorities Conference, Port Macquarie, NSW May 1991.

Smith, D.I., Handmer, J.W. & Martin, W.C., 1980 'The Effects of Floods on Health: Hospital Admissions for Lismore'. (Canberra: ANU Press).

Wallace, A.F.C., 1953 'Memorandum on Worchester Study', Washington: National Academy of Sciences - National Research Council.

Wallace, A.F.C., 1956 'Tornado in Worchester: An Explanatory Study of Individuals and Community Behaviour in an Extreme Situation'. Disaster Study No. 3. Washington: National Academy of Sciences - National Research Council.

Water Studies, 1990 'The Cost of Flooding, Nyngan, April 1990'. Report for NSW Dept of Water Resources by Water Studies Pty Ltd, 1990.

Water Studies, 1992 'Forbes Flood Damage Study, August 1990 Flood'. Report for NSW Dept of Water Resources by Water Studies Pty Ltd, 1992.