PROPERTY ACQUISITION

FOR

FLOOD DAMAGE REDUCTION

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Except where otherwise acknowledged in the text, this thesis is the result of original research by the author.
ABSTRACT

The plight of people living on land subject to frequent and severe flooding constitutes the focus of this study. Development in such areas is generally the result of historical necessity or accident, and protection by engineering works is often not feasible. However valid the original reasons for settlement, the areas are now characterised by low property values and deteriorating public utilities and housing stock.

In keeping with the increasing government interest in issues of public safety, recreation and waterfront access, many local authorities now intend to take action to alleviate the situation in these severely flood prone areas. Their action is facilitated by recent policy initiatives at the state and federal levels of government.

One approach gaining acceptance as a means of providing permanent solutions to otherwise apparently intractable flood problems is the purchase or acquisition of the property by government. This approach appears to have the potential to contribute to other community aims, for example the provision of waterfront recreation, preservation of natural floodplain storage and so on.

This thesis presents the case for acquisition by establishing where and how the strategy should be implemented. In doing so it attempts to provide an improved basis for floodplain land-use decisions.
Numerous individuals in private and official capacities have contributed to this study. My appreciation goes also to those not specifically mentioned below.

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The study is based on a range of data collected with the assistance of many individuals and organisations. Ian Burton, as Director of the Institute for Environmental Studies, University of Toronto, generously made facilities available while I was collecting material on the Toronto acquisition program. A special thanks is due to the state and local government officials who lent their time and support especially: John Russell of the NSW Department of Public Works; Ken Parr and Fred Hogan of the NSW PWD Lismore District Office; Fred Barlow, Richmond River County Council Flood Mitigation Authority; John Wade, Lismore City Council; Kevin McCartney, Echuca City Council; Colin Knott, Wagga Wagga City Council; David Stringer, Victorian State Rivers and Water Supply Commission; and
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CHAPTER 1

INTRODUCTION

1.1 SUMMARY STATEMENT: STUDY RATIONALE, SCOPE AND APPROACH

Flood losses are not new to Australia and catastrophic floods have been recorded since the beginnings of European settlement. Nevertheless, the potential for serious losses has escalated over the last two decades as settlement expands into flood prone areas. Comprehensive action by federal and some state governments now promises to halt this trend. Action has included the promulgation of state floodplain management policies involving: restrictive regulations, the cancellation of normal development subsidies for new construction on floodplains, and the provision of enabling legislation to enforce policies on recalcitrant local governments and developers.

Rigorously enforced regulations may stop or limit the further spread of urban development into hazardous areas, but the problem of existing development remains. In many cases the flood prone development may be protected by structural works or flood proofing. However, for some development the only feasible solution may be acquisition, which involves the purchase of property by government, and the permanent evacuation or relocation of any activities to flood free areas. Also, under some circumstances purchase and public ownership of vacant land may be the only way to prevent its development. Despite scepticism and doubt over the cost effectiveness of acquisition, there is an increasing commitment of public funds for the purchase of flood prone property in NSW and Victoria. Difficulties experienced by governments in the past in implementing land-use regulations, however, give cause for concern. Problems have arisen from the lack of sustained political commitment, enabling legislation and appropriate funding procedures and firm implementation criteria, and from the construction orientation of the relevant government authorities. These points and the absence of comprehensive studies in the field of floodplain acquisition justify the present study.

The conceptual framework of the study is provided by geographic hazards' research. This branch of geography has a history of applied
policy oriented studies, based on an ecological model of the interaction of people with their physical environment. Within this framework the study is to examine the development and implementation of acquisition policy, and will argue that the strategy has a significant and viable role to play in flood damage reduction. To begin with, the history of flood damage reduction policy in Australia, and the use of certain flood adjustments, will be reviewed to develop an understanding of problems associated with the implementation of land-use flood mitigation measures. This section will also demonstrate that acquisition has a viable role to play in flood damage reduction. Criteria for acquisition are to be established around a number of broad policy objectives including: public safety, economic efficiency, social welfare and flood damage reduction. Attention is also paid to procedures designed to facilitate program implementation.

Primarily due to the virtual absence of previous studies in the field suitable data are largely lacking. To generate the required information a case study approach is adopted. Three sites, Lismore, Echuca and Wagga, are chosen to represent different approaches to acquisition. The data collection and analysis techniques employed are standard social science and economics procedures, except where otherwise noted. Wherever possible results are presented thematically. However, care is taken to ensure that the effects of individual case study site differences are not overlooked.

1.2 THE FLOOD PROBLEM IN AUSTRALIA

Riverine floods are natural, inevitable, and occur in well defined areas. They affect many Australian settlements (Figure 1.1). Devin and Purcell (1983) estimate that there are 61,000 buildings at risk from flooding in urban areas, with an average annual damage of approximately 20 million dollars. It is probable that these figures underestimate the extent of the problem (Smith and Handmer, 1984). Apart from riverine flooding many areas are also subject to inundation by high sea levels, urban streams and urban drainage problems. Fortunately Australia has been spared the heavy loss of life that characterises recent flooding in Asia
Figure 1.1: Map of Australia showing a selection of flood prone settlements. Major drainage divisions are also shown.
and to a lesser extent the US. Nevertheless the toll in terms of economic loss, disruption and personal stress and anxiety has been large.

The flood problem is becoming worse as urban development spreads into additional flood prone areas, and into more dangerous locations, but the phenomenon is not new. Severe and chronic flood losses have been documented since the earliest European settlement. For example, the first of many major Hawkesbury River floods occurred in 1799 (Williamson, 1975). Descriptions of flooding prior to colonisation came from Aboriginal oral history. In some cases they described floods of such magnitude that the settlers took them as nothing more than legends, to their cost in cases like Gundagai.

Despite these early warnings, initial town surveys, land sales and settlement often took place in an atmosphere of ignorance or commercial necessity. Urban growth frequently commenced at important river crossing or trans-shipment points. Residential development concentrated around places of major employment, such as the sawmills and docks of Echuca and Lismore. With the growth of colonial trade these towns became increasingly important and prospered despite serious flooding. But riverside locations brought costs as well as benefits, and both the settlers and authorities were involved in flood mitigation from the early 1800s.

The colonial government was aware of the developing flood damage potential, and as early as 1819 Governor Macquarie exhorted settlers to avoid floodplains. In general though, governments were unable or disinclined to influence the pattern of settlement. "Some of these settlements became towns like Maitland, Grafton, Lismore, Wagga Wagga and Gundagai; disastrous floods became part of their history" (Williamson, 1975:6).

The earliest flood related controversy faced by Australian authorities, the location of new urban development, is no less at issue today. Similarly, alleviating the plight of existing flood prone development has concerned governments for over a century.
1.3 COPING WITH THE FLOOD PROBLEM

1.3.1 Approaches and Trends

A wide range of measures, adjustments or strategies, is available to reduce the effects of flooding on human activities. These may be classified in a number of ways, but the most common is the division between structural and non-structural. In essence the difference is that structural measures attempt to control flood water, while non-structural adjustments attempt to control peoples' activities. Despite its almost universal use the classification has been criticised for failure to address the causes of disaster or method of adjustment implementation.

Structural adjustments such as embankments or levees, dams and diversions have been by far the most widely used flood damage reduction measures. Levees, in particular, have been employed by numerous communities, in some cases to protect the entire settlement. In contrast, the non-structural measure of land use control or management has only occasionally been successfully implemented, although authorities have long been aware of its potential (Section 3.2). Other non-structural measures including flood forecasting and warning, emergency action, and flood proofing, have always been employed but are now receiving increased attention. It should be noted that insurance, although often advanced as a non-structural measure, does not by itself reduce flood damages, it acts in the same way as relief to simply redistribute the loss.

Levees appear to have been quite successful in many communities, especially in inland Australia. However, while the real success of these structural solutions is the subject of debate, there is no doubt that urban development has intensified in many protected areas (White, 1974(b); and local observation in Lismore). Sometimes this has been the intention when levees have been built to allow the development of flood prone locations, thus increasing the potential for catastrophic flood losses should the works be overtopped or otherwise fail.

Dissatisfaction with the heavy reliance on structural measures is resulting increasingly in the consideration of alternative flood damage
reduction strategies, in particular land-use management. Dissatisfaction stems from the economic and environmental costs of structural adjustments, their apparent inability to halt the rise in flood damages, and a greater political concern with public safety.

For the first time floodplain land-use management appears to have a solid basis for success. There is strong political commitment to a mixed non-structural/structural approach by both the federal and a number of state governments. Apart from policy statements, the commitment includes new enabling legislation and appropriate funding arrangements. Furthermore these actions have reasonably broad based support, in part as a result of the increasing interest in consumer and environmental protection.

Unfortunately, local councils, who usually exercise control over land use, do not always share state and federal government concern over floodplain settlement. Testimony to this difference in opinion are recent residential developments on flood prone land, including some presently underway in especially dangerous locations such as estuarine islands of low relief. These areas are developed only with the explicit permission of local councils or the courts, and as such suggest that land use criteria for particularly hazardous areas should be clearly spelt out in legislation. Until this happens however, situations will arise where even with the best intentions development cannot be prevented by local regulations. Also, there are developed areas subject to severe and frequent flooding where structural protection or flood proofing is not feasible on economic, engineering or environmental grounds. Under such circumstances, particularly if concerns about human safety loom large, the areas may be acquired. This approach is now arousing considerable interest as a possible solution to locations with apparently intractable flood problems.

1.3.2 Acquisition and Relocation

Relocation of settlement out of flood prone areas is not a new concept. In the days before publicly funded river control works and flood relief, settlement location was an important form of adjustment to floods. Nevertheless many towns suffered flood damage repeatedly, and during the
19th century a number of NSW towns were relocated after their initial sites proved too hazardous: these include Gundagai, Moama and Terrara (to Nowra).

Such relocation efforts relied entirely on local initiative and funding and were a response to near total devastation and large death tolls. However, representatives within state and federal governments for some time have given consideration to acquisition and relocation as a means of flood damage reduction. Overseas, the US Federal Flood Control Act of 1938 provided for government subsidies for relocation out of floodplains where it would be cheaper to relocate than to protect (White, 1945). But, the funding and institutional arrangements still favoured structural works. In Australia the possibility of State and Federal government involvement in acquisition was first examined in 1956. Following the 1955 flood, the Maitland Council unsuccessfully proposed to the NSW Committee of Advice on Flood Control and Mitigation (1956-57) that the city centre be relocated.

Despite these early government initiatives it is only very recently that state and federal governments in either Australia or elsewhere have started implementing acquisition for flood damage reduction. Voluntary acquisition programs are just commencing in NSW and Victoria. In NSW "It is State Government Policy to promote the removal of urban development from flood prone areas where possible..." (Planning and Environment Commission (PEC) Circular 15, 16/8/77). "In some areas (where structural works are not possible)... funds will need to be directed more towards the relocation of existing settlements" (PEC Circular 22, 12/4/78). The Victorian guidelines on Flood Plain Management in Victoria (Water Resources Council of Victoria, 1978) set out the case for flood prone property acquisition in that state. The Australian Commonwealth government is now involved in acquisition through the provision of funds for programs in Lismore, NSW, and Echuca, Victoria.

In the US a wide range of federal funds have been employed for floodplain property purchase including: Section 73 of the Water Resources Development Act (1974), Section 1362 of the National Flood Insurance Act (1968), and a variety of urban redevelopment and improvement funds (NERBC, 1976). Three federal agencies increasingly involved in
acquisition are the Tennessee Valley Authority, which has organised and funded a number of successful voluntary projects, the Corps of Engineers, which is rapidly expanding its use of relocation (Platt, 1979; Ralf M.Field & Ass., 1979; Devine, 1980-1), and the Federal Insurance Agency (FIA). Through Section 1362 of the National Flood Insurance Act the FIA is potentially the largest property acquirer. Essentially the section allows purchase where it would be cheaper to acquire than to continue insurance payouts for flood damage (Bailey, FIA, per. comm., 1981; Emergency Management, 1980).

In a completely different context, thousands of flood prone villages have been relocated during the last decade by the national governments of India (UNDRR, 1977(a)), and Mozambique (Wisner, 1979).

Various local governments in Australia, such as Wagga and Bankstown Councils, and North America, have been employing acquisition for many years, usually as a result of severe and repeated flooding. Floodplain acquisition has also been used to achieve environmental or recreational objectives, e.g. Milwaukee, Wisconsin (David, 1973; US-NERBC, 1976). One of the most successful acquisition programs implemented by a local or regional government is that in Toronto, Ontario, a city of 2.5 million people, where most of the floodplain has come into public ownership. The program was developed after a particularly devastating flood in 1954 (Handmer, 1981(a); Ontario-MTRCA, 1981).

1.4 THE GEOGRAPHIC CONTRIBUTION TO FLOOD DAMAGE REDUCTION

As the field of natural hazards research has been the subject of many reviews the following discussion is brief. Readers are referred to Mitchell (1974), White (1973, 1975), or Burton et al (1978) for more details on the earlier work, and to Hewitt (1983) for a critical appraisal and review of recent trends. Much of the early research concerned floods.

Geographic hazard research is generally acknowledged to have started in the 1940's with the publication of White's (1945) Human
Adjustment to Floods. But the field is part of a broader and older section of geography concerned with the relationship between people and their environment (Barrows, 1923). Thus it is quite logical that the working definition of "hazard" should be based on a human ecology concept. A hazard is seen as a negative consequence of peoples' interaction with the environment, it is a threat or possibility of loss, in this case from floods. The positive side of the interaction between people and their environment produces resources (Burton et al, 1978). Floodplain agriculture typically benefits from a rich soil resource, but will also occasionally suffer flood damage. Hazards do not exist apart from people in this model. In formal English usage and much of the flood literature, hazard is used as a synonym for risk. But risk is frequently used by flood researchers in a technical sense to apply to probabilistic and other statements concerning the physical dimensions of floods.

Out of the flood hazard work has evolved a dominant research paradigm consisting of five themes (Mitchell et al 1978:14; see also Burton et al, 1968):

"1. The nature of the flood process.

2. The types of adjustment or adaptations people have made to deal with flooding.

3. The theoretical range of adjustments to flooding.

4. The explanation of differences in adjustments as these differences occur through time and from place to place.

5. The influence of changing public policy institutions and values on the choice or adoption of adjustments."

Understanding of the decision process appears to be the key to explanation and prediction of choice of residential location and flood adjustments. Initially, models of "economic optimization" and "subjective expected utility" were employed. According to these models people would seek to optimise their location and adjustments in economic terms. Except that under the subjective expected utility approach their judgement would be based on incomplete knowledge and a subjective view of the possible consequences (White, 1973).
Neither approach was satisfactory. In 1962 Kates put forward Simon's (1957) model of "bounded rationality", and formalised the use of behaviouralism in hazards research. The decision maker must "construct a simplified model of the real world in order to deal with it. He behaves rationally with respect to this model... To predict his behaviour we must understand the way in which this simplified model is constructed, and its construction will certainly be related to his psychological properties as a perceiving, thinking, and learning animal" (Simon, 1957:198).

Using the behavioural approach as its dominant methodology the field enjoyed some success and appears to have made rapid progress during the 1960s and early 1970s. It was felt that "Rational explanations can be found for the persistence of human occupancy in areas of high hazard by examining the perception of the occupants of such areas" (White, 1973:209).

However, according to some observers hazards research has advanced little since this period, and others are not enthusiastic about the contribution of behaviouralism. Waddell (1977), Mitchell (1980), Torry (1979,1980), Hewitt (1983), and others have attacked mainstream hazards research (for replies to this criticism see Burton et al, 1981). Among other things the critics point to the lack of a solid coherent body of work on which theoretical advances could be based, and to the limits of the positivist behavioural methodology. Commenting on the results of risk perception research Roumasset (1976) suggests that the apparent explanation is often based on the wrong reasons, which leads to poor predictive ability. Bunting and Guelke (1979) are more damming: "The results of behavioural and perception research are of little value in the explanation of real-world human geographical activity".

One reason for the apparent inadequacies of many hazard perception studies is their preoccupation with choice, and their disregard for the constraints or external factors limiting freedom of choice. This problem is explored in more detail in Section 6.3, but is in part a result of an almost slavish application of the hazards paradigm. The original workers in hazards were among the first to point out the importance of external factors (Burton, 1962), and later that these factors had largely been ignored by researchers (White and Haas, 1975:95):
"Ignorance of those forces (which affect the choice of adjustments to hazards at both the individual and community level) reflects a major bias in past research on natural hazards and presents two major problems. One problem is a neglect of external forces which shape the choices."

The attention now being devoted to psychological variables does little for the problem.

A related shortcoming evident in much hazards work is the emphasis given to the role of the physical environment, known as environmental determinism. Hazards were seen "as those elements in the physical environment harmful to man and caused by forces extraneous to him" (Burton and Kates, 1964). Despite the adoption of an ecological model, research usually assumes that the social system is reactive to, or dependent on the the natural environment. Location and adjustment adoption are therefore generally explored in terms of flood knowledge and perception of the flood risk.

An increasing number of workers, especially those operating in third world countries, argue that in many circumstances detailed examination of factors other than flood knowledge and perception will provide satisfactory explanations for location patterns and hazard response (Ball, 1975; Jeffery, 1981; Wisner et al, 1976; Hewitt, 1983). This does not deny that the natural environment is important, but it is seen as subservient to the organisation of society. Certain groups of people are disadvantaged in social and economic terms by forces largely beyond their control (Australian Commission of Inquiry into Poverty, 1975). Such people, it is argued, have a relatively low resilience or ability to cope with environmental (or any other) perturbations due to a lack of material and social resources. Resource deficiency may manifest itself in hazardous dwelling locations, a lack of savings or assets, racial or other discrimination, or ignorance and fear of government agencies. In this interpretation an understanding of everyday life is the basis to understanding disaster (Westgate and O'Keefe, 1976). Urban squatters in third world countries occupying cliffs, gullies and caves constitute the most obvious evidence in support of this hypothesis.

Evidence for this process is by no means as obvious in Australia. Yet, it is quite possible that occupation of some hazardous areas is
determined by social and economic forces largely beyond the control of those making the location decision. In such cases, the behavioural questions of hazard knowledge and perception may be unimportant, and those implementing flood damage reduction programs may be confronting broad social problems.

1.5 THE INVESTIGATION

The fundamental aims of this study are to establish that acquisition has a role in flood damage reduction, to determine exactly in which circumstances the option can be recommended, and how it might best be implemented. To this end effort will be devoted to developing apolitical specifications for acquisition areas. Research will proceed through an investigation of acquisition within the context of a number of themes which may be seen as broad policy objectives: public safety, efficiency, social welfare and flood damage reduction. Other policy objectives to be examined include: satisfying legal requirements, post-acquisition use, and satisfying public demands for action following a major flood disaster.

Selection of these themes or objectives followed an extensive review of the flood hazard literature, an examination of acquisition schemes in Australia, Canada and the US, and a review of flood damage reduction policy in Australia (Section 3.2). The rationales underlying selection of objectives are set out individually in the body of the study.

It will be shown that although land use measures have long been available their effective implementation to control floodplain development has been elusive. To ensure implementation of the present comprehensive floodplain management policies a detailed knowledge of the reasons for past successes and failures is required. To help achieve this the development of flood damage reduction policy in Australia, and flood mitigation measures at the case study sites will be subject to scrutiny.

In addition, during the course of the study it became evident that the conventional residential location models employed in hazards and other
geographic research are not applicable to the acquisition areas under study. Attention is given to these theoretical questions and their policy implications.

1.6 **FORM OF THE THESIS**

Chapters One and Two contain introductory material. The research problem is set out in Chapter One in both conceptual and policy contexts. Chapter Two describes the study methods, case study site selection, and examines each study site in terms of its flood problem.

The main purposes of Chapter Three are to explore reasons for the successes and failures of land use management for flood damage reduction, and to demonstrate how acquisition might be combined with other flood adjustments. This is achieved at the state and federal government levels by an historical review of flood policy development, and at the local level through an examination of adjustments at the study sites. Flood adjustments are also reviewed from the perspectives of public safety and compatibility with acquisition.

Having made the case that acquisition is a viable flood adjustment, Chapters Four and Five develop criteria for delimiting areas which should be acquired if under residential development. Criteria are presented for public safety and economic efficiency policy objectives. The limitations of the procedures are investigated with emphasis on reducing political inconsistency over the use of high risk areas.

Social issues do not permit criteria development in the same way as economic and physical factors. Instead two chapters attempt to develop acquisition guidelines for different socio-economic and political circumstances. Chapter Six examines why people live in locations demonstrably dangerous and uneconomic, and Chapter Seven investigates local reaction to acquisition. The investigation is based on hypotheses which emerge from a detailed study of the three acquisition schemes under examination.
Chapter Eight deals with a number of important implementation details, especially post-acquisition issues.

Finally, the conclusions present the results as modified decision trees. One decision tree summarises the acquisition criteria under different policy objectives, while the other summarises implementation recommendations. Separate sections comment on the implications of the results for the case study sites and theory.
CHAPTER 2

STUDY METHODS AND SITE DESCRIPTIONS

2.1 INTRODUCTION

The research is based on three Australian case study sites representing different approaches to the voluntary acquisition of urban residential areas. This is not to suggest that acquisition of commercial or industrial areas does not or should not occur, but rather that property values and therefore the costs of purchasing such areas are relatively high, and that the issues of public health and safety are best served by concentrating resources on removing high risk residential development. The major study site is Lismore, NSW, where an acquisition scheme is being implemented by the local council and the Public Works Department. The other sites are Echuca West, Victoria, which is being acquired by the State Rivers and Water Supply Commission, and North Wagga, NSW, where Wagga Wagga City Council's acquisition scheme has been operating for over twenty five years with little apparent success. As well, a large scale and successful floodplain acquisition scheme in Toronto, Ontario, was examined to provide additional comparative material, and to assist in study design.

Data for the study comes from a range of sources both within and outside the study sites. Much of the material was collected and analysed using standard social science techniques. Exceptions are the procedures used for calculating flood damages when assessing the economic merits of acquisition, and those used to delineate areas for acquisition on safety grounds. The derivation and application of these procedures are described in the body of the report.

A number of limitations to the study are apparent. First, the geographic distribution of the study sites is such that direct generalisation of results is limited to non-metropolitan urban areas, in particular those in NSW and Victoria. Second, although the three acquisition schemes vary they possess certain major similarities which again act to limit the scope of the study: the schemes are voluntary, and are concerned with residential areas, either already developed or under development pressure.
This chapter reviews the research methods employed in the report, apart from those used in the economic and hydrologic analyses. It focusses on the questionnaire survey and the representativeness of the samples. (Further detailed methodological material is appended as indicated). Selection of the study sites is discussed, and the three cities are thoroughly examined with emphasis on the development and management of their flood problems.

2.2 RESEARCH METHODS

2.2.1 Introduction

There were three main data sources at each site:

(i) **semi-structured interviews** with "key people",
(ii) **questionnaire surveys** of acquisition area residents and, in Lismore, control samples from non-acquisition floodplain and flood free areas,
(iii) **documentary data** including: census material, state and local government files and reports, newspapers, information held by historical societies, and property transaction records from state Valuer General's Departments. The collection and analysis of economic and hydrological data is described separately in Chapters 4 and 5.

2.2.2 Interviewing Key People

To explore the history of, and response to acquisition, and to assist with questionnaire design, semi-structured interviews were conducted with local and state government officials and key local figures. The philosophy and process of this form of investigation is reviewed in detail by Dexter (1970). He describes such interviews as:

1. stressing the interviewee's definition of the situation.
2. encouraging the interviewee to structure the account of the situation,
3. letting the interviewee introduce to a considerable
extent his notion of what he regards as relevant, instead of relying upon the investigator's notion of relevance."

People interviewed include mayors, town clerks, planners, local government councillors, builders, bankers, real estate agents, state government officials, and floodplain residents and businessmen representing organisations with an interest in the floodplain. Over 60 interviews were completed. Details of interviewees are listed in Appendix E. An interview guide sheet prepared to ensure that certain issues and questions were covered is also appended (Appendix D). The actual number of issues canvassed in any given interview depended, naturally, on the interests and expertise of the interviewee.

2.2.3 Questionnaire Survey

2.2.3.1 General

Questionnaire data for Wagga was obtained from the report North Wagga Wagga Development Strategy Study (Sinclair Knight and Partners & MSJ Keys Young Pty. Ltd., or SKP & MSJKY, 1979). Surveys for Lismore and Echuca were conducted by the author.

The method of questionnaire development was essentially the same at all three sites. After reviewing the relevant literature informal interviews with government officials and local people, conducted prior to questionnaire construction, helped to identify issues of particular importance at each case study site and to ensure that these were covered by the questionnaires. The questionnaires sought information on reasons for location, mobility, socio-economic characteristics, flood experience, and attitudes and behaviour towards the acquisition scheme. The final form of the Lismore and Echuca survey schedules is shown in Figure 2.1. The Wagga schedule is similar.

1 Detailed material on survey sampling accuracy is contained in Appendix C, and Appendix B contains a copy of the questionnaire.
Both open and closed question formats were used in the Lismore and Echuca surveys. Unfortunately, the Wagga questionnaire generally restricted itself to the closed format. Closed questions present a set of predetermined choices to the interviewee, and were used where specific information was required, for example on the importance of cost and neighbours in location decisions. Open questions, on the other hand, were used where views were sought on the advantages and disadvantages of the area and on the acquisition scheme. They tend to "maximise the respondents view of the situation and minimise the effect of the researcher's preconception on the responses" (Whyte, 1977:40), but are relatively time consuming to analyse.

2.2.3.2 Sampling Unit

The household was selected as the sampling unit. Interviewees answered on their own account or on behalf of a couple. This is the approach followed by Wadley and Ballock (1980), on the basis of findings by Booth and Camp (1974). In group households the respondent is assumed to be representative of the whole household.

2.2.3.3 Survey Representativeness

Questionnaire analysis and the statistical tests employed assume that the samples are random and are therefore characteristic of their parent populations. Two procedures were used to check representativeness: demographic features of the samples are compared with census figures, and in Lismore and Echuca refusals were monitored to establish whether any systematic bias was occurring, such as renters or aborigines refusing to be interviewed.

Where possible, refusals were monitored for house condition and size, and the occupants for sex, age, tenancy type, and ethnic extraction. No significant differences for any of these factors were found between interviewees and those who refused.

Good general agreement is found when the tenancy and occupation sample characteristics are compared with those of the parent population. However, agreement between the age distribution and sex ratios of the
FIGURE 2.1: Questionnaire Model

TABLE 2.1 Sample Representativeness: Sex Ratio
Expressed as a percentage

<table>
<thead>
<tr>
<th>Location</th>
<th>Male:Female survey response ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lismore</td>
<td>Male:Female</td>
</tr>
<tr>
<td>North Wagga</td>
<td>46:54</td>
</tr>
<tr>
<td>Echuca West</td>
<td>49:51</td>
</tr>
<tr>
<td>North Lismore</td>
<td>43:57</td>
</tr>
<tr>
<td>Victoria Ltl Keen St.</td>
<td>36:64</td>
</tr>
<tr>
<td>Floodplain Control</td>
<td>42:58</td>
</tr>
<tr>
<td>Flood Free</td>
<td>42:58</td>
</tr>
</tbody>
</table>

EXPECTED:


OBTAINED:

Male:Female survey response ratio No 46:54 27:73 31:69 41:59 32:68

* Based on Census data. Each member of a couple was considered to have an equal probability of being interviewed.
samples and their respective populations is not as close. The survey appears to have missed a substantial proportion of the 30-39 year old group, probably working couples as this group would be the most difficult to contact. The omission is not considered serious because it occurred in all samples, and because working couples represent a socially mobile group less likely to be seriously affected by acquisition.

Achieving a balance between the sexes is often a problem in questionnaire surveys. Those using personal interviews tend to have a preponderance of female respondents while drop off/pick up surveys elicit a predominantly male response. In Lismore and Echuca an attempt was made to secure more male interviewees by conducting some interviewing at weekends. This strategy appears to have been at least partly successful. Because, despite the apparently disproportionately large number of female interviewees, the survey sex-ratio is in reasonable agreement with that of the population when the substantial number of households headed by single women is taken into account (Table 2.1).

The close agreement of tenancy-status figures obtained by the Project's Lismore and Echuca surveys with those of the census is interesting when tenancy figures obtained by the North Wagga and Munro Lismore (Section 2.2.3.5) surveys are examined. Both these surveys attempted a complete coverage and employed a drop off/pick up procedure. However, both appeared to have missed many of those renting.

2.2.3.4 Statistical Testing

As the surveys consist of samples from much larger populations it is necessary to test any apparent relationships for their significance and strength. Tests of significance indicate the probability that the relationship observed in the sample exists in the population, or put another way that the observed relationship did not occur by chance. Other tests are used to examine the strength of the relationship within the sample. To properly evaluate any association within a data set both types of test are required, as neither a strong but barely significant, nor a highly significant weak relationship are of any practical value. The Chi-square test is employed to measure significance, and the contingency coefficient and asymmetric lambda strength of association. These tests are
discussed in more detail in Chapter 7 where their results are applied. As used in this study they are described in Nie et al (1975) and Levin (1973).

2.2.3.5 Lismore

A draft questionnaire was pretested on 30 Echuca West households on 2 May 1981, by three interviewers.

After some minor changes the questionnaires were administered in Lismore on weekdays and weekends during June 1981, by seven interviewers. The survey was completed before the Census of June 30 1981. As the Lismore floodplain has been subject to a number of surveys over the last few years, a special effort was made to inform people about the aims of this survey. Pre-interview publicity included an article in the local newspaper and the delivery of an explanatory letter to houses in the acquisition areas (Appendix B).

Interviews were successfully completed in two hundred and seventy two cases: 153 in the acquisition areas and 119 in the two control areas. One of the control groups is drawn from the flood-free section of Lismore, the other is from the non-acquisition part of the floodplain. Interviewees in the control sample were selected randomly by numbering city blocks, selecting numbers from a random number table and then attempting to contact every third house on the blocks selected. Approximately the same number of interviews were completed in each block. In the acquisition areas an attempt was made to contact every household. Although response rates were fairly low at 50-60% (Table 2.2), the samples are representative of their populations. The acquisition sample comprises some 60 per cent of the households in the relevant areas, and the control samples less than 10 per cent of their parent populations. Sample sizes were arrived at through an assessment of resource availability and acceptable levels of statistical accuracy as discussed in Appendix C.

Additional survey material from work by Munro et al (1980), in which the author was involved, has been employed in the study. This relatively short questionnaire dealt with attitudes to flooding and
TABLE 2.2 : Survey Response Rates. Figures are percentages, "N" is the number in each sample.

<table>
<thead>
<tr>
<th></th>
<th>LISMORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North Wagga (N=201)</td>
</tr>
<tr>
<td>CONTACT NOT POSSIBLE</td>
<td>No Data</td>
</tr>
<tr>
<td>Houses vacant or abandoned. Occupants mentally unable to respond to questionnaire, and drunks.</td>
<td></td>
</tr>
<tr>
<td>CONTACTS POSSIBLE</td>
<td>Refusals</td>
</tr>
<tr>
<td>Not Home (3 + call backs)</td>
<td>6</td>
</tr>
<tr>
<td>Useable Interviews</td>
<td>84</td>
</tr>
<tr>
<td>TOTAL (%)</td>
<td>100</td>
</tr>
<tr>
<td>Useable Interviews as a % of Contacts Possible</td>
<td>No Data</td>
</tr>
</tbody>
</table>
acquisition. Questionnaires were delivered to households, left for completion and collected later. An attempt to obtain a complete coverage of the floodplain achieved a response rate of 61%, (1033 useable questionnaires). A control survey of flood free Lismore was also completed with a response rate of 50%, (249 useable questionnaires). Because of the very large number of questionnaires covering properties representing the full range of flood severity, it was worthwhile matching these responses with a pre-existing computer data base on individual dwelling flood risk. This data base consists of a list of the ground and floor height of every developed property in the Lismore floodplain. Thus it was possible to explore certain questions in terms of detailed flood risk information.

2.2.3.6 Echuca

An attempt was made to contact every household in Echuca West (the questionnaire area). Fifty two interviews were completed which represents a response rate of between 79 and 89%, depending on how the rate is calculated (Table 2.2).

Interviewing was conducted in two distinct periods:

(a) the project's pilot questionnaire was administered to 30 households on the weekend of 2/5/81 by three interviewers.

(b) An additional 22 households were interviewed by one interviewer during the week of 31/8-5/9/81. The questionnaire schedule used for these interviews was essentially that developed for Lismore with some minor changes to ensure its comparability with the pilot questionnaire.

Echuca West was flooded two weeks before the second interviewing phase, and one or two houses were isolated by floodwater and could not be reached until the end of the interviewing period. Normally it would be considered undesirable to conduct a survey under such conditions as the results would be expected to show a heightened concern about flooding. In the context of the present study the flood was useful in illustrating the impact of immediate experience on both flood perception and support for acquisition.
24.

No surveying of non-acquisition areas in Echuca was undertaken. Some flood perception data of non-acquisition floodplain residents is available from a small survey undertaken in 1979 by the (Victorian) Loddon & Campaspe Regional Planning Authority.

2.2.3.7 Wagga Wagga

The questionnaire schedules were distributed to every household (and business) in North Wagga in July 1979. The purpose of the survey was explained and the schedules left for completion. If no-one was home the form and explanatory letter were left in the letterbox. Upon collection the questionnaires were checked and any queries clarified. Up to three call-backs were made to each dwelling. Of the 201 forms distributed 168 were completed representing a response rate of 84% (Table 2.2).

This high response rate is almost certainly a result of the extensive newspaper, radio, and T.V. publicity given to the survey, and the importance attached to the issues by North Wagga residents, the majority of whom appear to have a strong desire to preserve their community.

No survey data apart from that contained in the Census is available for the non-acquisition parts of Wagga.

2.2.4 Census Data and Property Transaction Records

Records containing the full details of property transactions are held by both local councils and state Valuer Generals' Departments. Because of their convenience, the study used council records dating from about 1940 to 1981. Extraction and use of this type of data is described in Johnson (1973).

The main potential problem associated with the use of Census material in the present study is that of matching acquisition area boundaries with Census divisions. Fortunately, the areas matched well with the only significant disparity being Echuca West. Here, the relevant

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1 Summarised from Sinclair Knight & Ptns and MSJ Keys Young (1979).
Census Collector's District (CD) is bisected by the Campaspe River. Nevertheless, this is not a serious problem as the acquisition area falls entirely within the one CD, and the surrounding property is similar, though in better condition.

2.3 THE CASE STUDY SITES

2.3.1 Site Selection and Summary

The study is based on three case study sites: Lismore in northern coastal NSW, Wagga Wagga on the south western slopes of NSW, and Echuca on the southern riverina plain.

Site selection was governed by the limited number of settlements in southeastern Australia where acquisition programs were underway. Despite the limited choice the sites chosen for study, after some initial investigations, appeared to represent three different approaches to acquisition with three quite different levels of local support. Furthermore, each site presents a different degree or type of flood hazard. Southeastern Australia, specifically Victoria and NSW represented the practical geographic limits to fieldwork. For simplicity it was also considered desirable to restrict the number of state jurisdictions involved in the research. On the other hand diverse state approaches to acquisition would probably expand the scope of the study. As it happens, the very different attitudes to acquisition management presently held by the NSW and Victoria governments enable examination of the effectiveness of direct state intervention.

These differences should enable the identification and exploration of a wide range of factors important in program success. At the same time certain major variables are constant across the three sites providing a reasonably stable base for evaluation. Although the cities vary considerably in population, all function as major service centres and are experiencing relatively sustained growth. No site has a shortage of flood free land, parts of all three cities have been subject to severe flooding on a regular basis since settlement began, and the acquisition areas are generally of lower status with low property values.
The schemes are entirely voluntary, with the authorities offering to buy property at its estimated "market value", usually as determined by the Valuer General's Department. There is no obligation for people to sell to the scheme or for the authorities to buy property offered for sale. The schemes are also characterised by the absence of clear post-acquisition plans.

Lismore's (population 24,000) 100 year floodplain contains almost all the city's commercial and industrial enterprises, offices of all three levels of government, primary, secondary and tertiary education institutions, and 1900 dwellings, some of which are flooded nearly every year. The nature of the catchment and city topography are such that floods peak rapidly with short warning times of between 6 and 12 hours, and structural flood protection is not feasible. With financial assistance from federal and state governments the City is acquiring residential and vacant land in the most frequently flooded areas. The scheme is low key and is proceeding reasonably smoothly with no significant local opposition, but is on a fairly ad hoc basis. Areas to be acquired have not been delineated clearly, though priorities have been established. Council is reluctant to rezone purchased properties, or to restrict development on adjacent land which may be within the purview of the scheme.

Echuca (population 8,500) is protected by a 1:36 levee. Flooding is slow and relatively shallow, water may remain high for months and warning times are correspondingly long. Echuca West, outside the levee, an area consisting of 65 dwellings, has been proclaimed flood prone under the Victorian Drainage of Land Act (1975) and the State Rivers and Water Supply Commission (SR & WSC) have commenced acquisition. As required by law every house owner was notified of the scheme. Local reaction has been variable with pockets of strong opposition.

The main city of Wagga (population 40,000) is protected by a 1:100 levee. However, the suburb of North Wagga comprising 220 dwellings and other uses is unprotected and lies in the middle of the Murrumbidgee's flood plain. In major floods the village is inundated and also isolated by

---

1. In this study flood frequencies are generally expressed as a ratio, 1: flood recurrence interval (the average period between a flood of that magnitude). Put another way the ratio expresses the chance per year of the flood occurring, thus a 1:100 flood has a 1 in 100 chance of occurring in any given year, it may also be called the 100 year flood.
floodways to its north and south. Wagga council zoned the area non-urban and has been acquiring property there on a haphazard basis since 1956. Local opposition has become increasingly strong and organised, and Council now proposes to levee the village. But the state government seems determined to remove the settlement.

2.3.2 Lismore, NSW

2.3.2.1 Physical Dimensions - The Catchment

Lismore is located in northeastern NSW at the junction of two major tributaries of the Richmond River's north arm: Leycester Creek and Wilson's Creek. This junction is near the head of the north arm's estuary, some 30km direct and 125 river km from the sea. Above Lismore the two tributaries themselves split into six streams of approximately equal length and catchment area (Figure 2.2). These streams, with a total catchment area of approximately 1400 square km, were largely cleared for dairying by the turn of the century. The unusual fan shape and steep stream gradients allow rainfall runoff to be rapidly concentrated at Lismore, often with the peak flows of contributing catchments coinciding (Sinclair Knight & Partners, or SKP, 1980).

The far north coast is one of the wettest parts of NSW. Over the Lismore watershed annual median rainfall varies from 1270mm to 1678mm (NSW-Water Conservation and Irrigation Commission, 1966). Although rainfall is fairly evenly distributed throughout the year, intense flood producing rains show strong seasonality and are usually associated with either decaying tropical cyclones in the early months of the year, or "extra tropical cyclones" originating in the polar latitudes between February and September (SKP, 1980).

Flood Duration and Prediction

The unusual catchment shape and intense rainfall result in a very rapid rate of river rise and are responsible for major flooding at Lismore. The start to peak duration in the record floods of 1954 and 1974 (1:60 events) was about 18 hours, while for the very sudden 1976 (1:5) event it
Figure 2.2: Map of Lismore and its flood catchment.
was less than 6 hours. The actual overbank flood duration even for major events is typically less than 30 hours and for slightly smaller floods is considerably less. Thus warning time is extremely limited, typically between six and twelve hours. Generally this is adequate for an experienced community to effect a substantial reduction in flood damages (Smith, 1981; Section 4.3). However, the failure to properly communicate last minute changes to the flood height forecast, or a major system failure as in 1976 when an unusual storm occurred, demonstrates the flood prediction difficulties inherent in the catchment physiography.

**Flood Record**

Through the work of the Richmond River County Council a reasonably accurate flood record is available for the period since 1857. The full record is reproduced in NSW-PWD and SKP (1980) and Smith et al (1979). It shows that damaging floods have been frequent, with eighteen floods reaching 10 metres (local gauge height) or more since 1945. At 10m water starts to enter houses and the main city block. The highest floods recorded reached 13m (gauge height) and occurred in 1954 and 1974 (1:60); while the estimated maximum probable flood (MPF), based on a maximum probable precipitation estimate, is 14.5m on the Lismore gauge, or 13.7m Australian Height Datum (AHU) (NSW-PWD & SKP, 1980).

There appears to have been a major increase in the frequency of floods since 1945. The change is thought to be due to rainfall rather than land use changes because similar patterns have been observed on other coastal rivers (Smith and Greenaway, 1983; Bell and Erskine 1981), and because work by Pittock (1975, 1981) shows that mean annual rainfall on the NSW coast in particular, has been substantially higher since 1945. Smith et al (1979) presents flood frequency/magnitude curves for Lismore based on 3 periods: 1875-1975, 1921 to 1975 and 1945 to 1975 (Figure 2.3). (The record since 1921 is thought to be more complete and reliable). Mean annual damages based on the post 1945 record, which is known to be of a high standard, are approximately double those obtained from using the full record length, 1875-1975 (Smith et al, 1979). Clearly this difference is significant to any cost-benefit analysis.

Throughout this report the post 1945 record and damage level, and Lismore gauge datum, are employed unless otherwise stated.
Figure 2.3: Flood probability curves for the Richmond River at Lismore. Curves are based on pre and post 1975 flood records. Data from D.I. Smith, CRES, ANU.
The City

Lismore City is split into three sections, around the Y river junction described above (Figure 2.2): Lismore or Browns Creek Basin, South Lismore and North Lismore. Lismore Basin is surrounded to the south, east and north by high flood-free ridges. In all three sections land near the river banks is generally slightly higher than that further back which contained swamps and lagoons prior to development. The river banks of approximately 10m, (lower in North Lismore) are not continuous and before small levees and floodgates protected parts of Lismore Basin and South Lismore, a rising river would fill up the lower land by flowing up creeks which would normally drain the back swamps.

The lowest land is found in North Lismore. McKenzie Park for example is 5.3m, and parts of Lismore Basin where the Council Caravan Park and some adjacent industrial development is at 7.3m (1:1.5 flood risk). In general, land below 7.8m (1:1.5) has not been developed and the business district is above 10m (1:3). Table 2.3 shows the number of residential properties flooded at ground and floor level for different flood heights. The lowest areas flood every year or so, and the rest of the floodplain is effectively put under water by a 1:20 (12.5m) event as relatively little additional area is inundated by higher floods, because the spread of water is limited by high ground. As well, parts of the city are subject to very deep fast flowing water during floods, greatly exacerbating the potential for flood damages.

2.3.2.2 Development of the Flood Hazard and Settlement History

"Lismore" station was established by William Wilson in 1844, a few years after squatters and cedar cutters first arrived in the area. In 1855 a Government surveyor F.S. Peppercorne selected the home paddock of "Lismore" station as a town site and mapped out the street plan. The following year the village of Lismore was gazetted and the first land sales were held (Bass, 1980). Fortunately the early development of Lismore was slow, for 10 years after Peppercorne's survey another government surveyor examined the town layout and commented that "the whole of the town to the east of Dawson Street...being deeply inundated in flood water, is unfit for building purposes" (Lismore City Council or L.C.C. 1979:8). The area he
Table 2.3: Distribution by Ground and Floor Height of Residential Property in Relation to Gauge Height (Smith et al 1979:13).

<table>
<thead>
<tr>
<th>Height in relation to flood gauge in metres</th>
<th>Ground Height</th>
<th>Floor Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Houses</td>
<td>Number of Houses</td>
</tr>
<tr>
<td>6.5 up to 7.0</td>
<td>2 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>7.0 up to 7.5</td>
<td>2 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>7.5 up to 8.0</td>
<td>3 (0.15%)</td>
<td></td>
</tr>
<tr>
<td>8.0 up to 8.5</td>
<td>9 (0.7%)</td>
<td></td>
</tr>
<tr>
<td>8.5 up to 9.0</td>
<td>24 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>9.0 up to 9.5</td>
<td>75 (4.0%)</td>
<td>3 (0.2%)</td>
</tr>
<tr>
<td>9.5 up to 10.0</td>
<td>147 (7.8%)</td>
<td></td>
</tr>
<tr>
<td>10.0 up to 10.5</td>
<td>269 (14.3%)</td>
<td>11 (0.6%)</td>
</tr>
<tr>
<td>10.5 up to 11.0</td>
<td>413 (22.0%)</td>
<td>15 (0.8%)</td>
</tr>
<tr>
<td>11.0 up to 11.5</td>
<td>304 (16.2%)</td>
<td>54 (2.8%)</td>
</tr>
<tr>
<td>11.5 up to 12.0</td>
<td>321 (17.1%)</td>
<td>131 (6.9%)</td>
</tr>
<tr>
<td>12.0 up to 12.5</td>
<td>225 (12.0%)</td>
<td>239 (12.6%)</td>
</tr>
<tr>
<td>12.5 up to 13.0</td>
<td>84 (4.5%)</td>
<td>396 (20.9%)</td>
</tr>
<tr>
<td>13.0 up to 13.5</td>
<td>463 (24.4%)</td>
<td></td>
</tr>
<tr>
<td>13.5 up to 14.0</td>
<td>277 (14.6%)</td>
<td></td>
</tr>
<tr>
<td>14.0 up to 14.5</td>
<td>189 (10.0%)</td>
<td></td>
</tr>
<tr>
<td>14.5 up to 15.0</td>
<td>112 (5.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1878</strong></td>
<td><strong>1895</strong></td>
</tr>
</tbody>
</table>
identified, the lower part of Brown's Creek Basin was proclaimed a public reserve in 1887 and remains so today.

At the early stages of settlement the Richmond River Valley was sparsely settled, but with the encouragement given to farming by the Robertson Land Act of 1862 (The Crown Lands Alienation and Occupation Acts), and as demand for Richmond cedar grew, the population swelled, and Lismore achieved Municipal status in 1879 with a population of 500 (Daley, 1966). The following decade was one of major expansion in the timber industry and key to the importance of Lismore's riverside location as a port. There were other towns on the Richmond, but Lismore was at the head of river navigation for ocean going vessels of up to 600 tonnes and gave transport access to the timber getters as the industry moved progressively inland (Daley, 1966).

Although river transport started to decline by the turn of the century it continued until 1954 when the North Coast Steam Navigation Co. ceased operations (Richmond River Historical Society, or RRHS, nd:ll). A short rail section connected Lismore to the coastal port of Byron Bay in 1894, but the city was not part of the NSW rail network until 1933, 2 years after the introduction of regular air services (Hall, 1977).

By federation in 1901, and the decline in the importance of river transport, Lismore was firmly established around the junction of Leycester and Wilson's Creeks as an agricultural service centre with a population of 4,500.

Thanks to the 1865 revision of Peppercorne's original survey the lowest parts of Brown's Creek Basin were never developed but the earliest paintings (1881) and photographs (1884), show that the higher parts of the basin's floodplain to the west and north were already developed as a commercial and residential area, and that there was considerable building in North Lismore. The development of South Lismore was slower until the opening of the railway station there in 1894 speeded development. Bridges linking the three parts of the city were completed in the 1880s. Maps from this period show that while the present street pattern appears to have been surveyed in North Lismore the area was largely devoted to suburban farm allotments. Nevertheless, despite major floods, by the 1890s much of the
North including Baillie and (east) Terania streets had been subdivided and built on. Later, in the early 1900s the North Lismore swamp was filled in and a high school (now the Richmond River High) was constructed nearby. The last major development in the North occurred just after the severe 1931 flood, with the subdivision and sale of the Simmons estate to form Simmons Street (land sale poster, RRHS), one of the highest parts of North Lismore.

The repeated severe flooding of the city does not appear to have strongly influenced either the location or pattern of settlement. New development in the most flood prone areas continued until World War II, and many houses were not raised (Section 3.3.8.3). One of the last low areas to be developed was that along Victoria and Market Streets known as the "Lagoon". Subsequent residential development has been mainly in the flood free areas of Lismore Heights, East Lismore and Goonellebah, though considerable expansion, particularly in the industrial sector, has occurred in South Lismore.

Present Situation

There are over 700 commercial and industrial establishments in the flood prone business district of Lismore giving the city a diverse economic base as a regional service centre with strong manufacturing and tourism components. The floodplain also contains the regional secondary and tertiary education establishments and state and federal government offices. Until recently this development had no alternative but to locate in or near the old flood prone business district. Now alternate flood free sites are being developed by Lismore City Council in Goonellebah, an area to the east of Lismore. Nevertheless there has been a very rapid expansion of the scale of industrial and commercial operations in flood prone South Lismore over the last few years.

Almost one quarter of the city's 24,000 people live in the regulatory floodplain (1:100) which contains 1900 of Lismore's 7000 dwellings. Most new residential development is occurring in Goonellebah largely due to the absence of flood free building sites in East Lismore and the more attractive surroundings on the higher land. Goonellebah's expansion accounts for most of Lismore's 2% p.a. growth rate and the suburb
has more than trebled in size over the last decade (Ueagan, 1981-1).

To date regulation has not played a part in directing development away from the Lismore floodplain despite the obvious dangers. The Council, with state and federal financial assistance, is now acquiring the most flood prone dwellings, including those in the "Lagoon" and Little Keen Street areas of Lismore Basin, and much of North Lismore. These three low areas, marked on Figure 2.2, contained 295 houses in mid-1981.

The provision of a flood free alternative business centre in Goonellebah, the active enforcement since 1974 of a previously largely unused floor level requirement dating from 1956, the acquisition, or voluntary purchase of the worst flood areas of North Lismore and Lismore Basin, and attempts to prevent further residential subdivisions on the floodplain, are the first efforts, after over a century of serious flooding, to influence the growth of Lismore and direct it away from the floodplain. However, the apparent encouragement from Council to industrial and commercial establishments to locate on the floodplain, and its reluctance to rezone flood prone areas to prevent residential development is disappointing.

2.3.2.3 Response to Flooding

The most effective response to flooding in Lismore in terms of damage reduction has come through the flood awareness of the local population, and their individual reaction to flooding consisting primarily of house raising and appropriate emergency action following flood warnings. Given the very limited warning time, effective emergency response is contingent upon the flood forecasting system provided by federal and local governments. Opportunities for structural flood protection in Lismore other than against small floods are very limited especially for North Lismore, due to the catchment topography and the depth and speed of flood waters. Various schemes have been put forward, but have been considered economically if not physically infeasible.

Government, as opposed to individual, response to flooding has come mainly as a result of the recommendations of the Richmond River Valley
Flood Mitigation Committee constituted in 1948 after the floods of the 1930s and 40s. The 1954 flood gave the work of the Committee some urgency and an interim report was produced in 1954 followed by a supplementary report in 1956. The final report was released in May 1958. Basically it recommended for Lismore a combination of minor leveeing and other works, with building and zoning regulations, and the development of a local flood warning system. The committee also recognised the need for a valley-wide coordinating authority to implement its recommendations (Table 2.4).

"The present multiplicity of unrelated authorities operating in respect of the various drainage areas militates against the effective management of such systems as flood mitigation measures... The committee reiterates the view...that a county council should be constituted to undertake the construction of the .... works".

Unfortunately, as is apparent from the above quote, the county council was to be a construction authority. All State and Federal government funding for flood mitigation (see Section 3.2) was directed through the County Council. Thus, until recently when the County Council started to administer money for acquisition, funds were not available for non-structural measures (apart from flood forecasting) and it comes as no surprise that these received little attention.

The implementation status of the 1958 recommendations is summarised in Table 2.4. Most of the recommended works have been completed. However, Lismore City Council's failures to use its zoning power or to adequately enforce its floor level regulations are conspicuous. This failure is doubly unfortunate as the rapid, primarily industrial, development of South Lismore has taken place at least in part because of the levee protection (NSW-PWD & SKP, 1980). Thus in the absence of strict development controls the levees have served to increase the amount of property exposed to flooding and the average annual damages.

Two additional studies of the Lismore flood damage reduction options have been completed recently (NSW-IDC, 1982; PWD & SKP, 1980). The severe floods of 1974 acted as an impetus for these studies. The NSW Government constituted another Richmond River Flood Mitigation Committee (the Inter-Departmental Committee or IDC) on 29 September 1975 and financed
Table 2.4: Summary of Inter-departmental Committee (1958), and Public Works Department & Sinclair Knight & Partners (1980) Richmond River Reports.

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>INTER DEPARTMENTAL COMMITTEE (1958)</th>
<th>IMPLEMENTATION</th>
<th>EFFECT</th>
<th>PWO AND SKP (1980)</th>
<th>RECOMMENDATION OR FINDING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEVELS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Lismore and Brown's Creek Basin</td>
<td>Richmond River County Council</td>
<td>Completed</td>
<td>Effectively eliminates damage from minor and moderate floods in the protected areas but North Lismore and parts of the main city remain unprotected.</td>
<td></td>
<td>No further structural works are feasible. The existing South Lismore levee has encroached too far into the floodway and encourages undesirable development.</td>
</tr>
<tr>
<td>Flood Warning</td>
<td>An effective flood warning scheme should be constituted, preferably based in Lismore.</td>
<td></td>
<td>Has proved reasonably reliable but its shortcomings were shown in 1976. The PWO &amp; SKP (1980) report and some local officials feel that reliability would be improved by the development of a local scheme.</td>
<td></td>
<td>An improvement to flood warning is a highly cost-effective way of reducing flood damages. &quot;A locally operated forecasting model in parallel to the Bureau of Meteorology would be the most efficient way of improving the system.&quot;</td>
</tr>
<tr>
<td><strong>REGULATIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Council should use its zoning power to prevent further floodplain encroachment, especially in South Lismore. Also floor levels of new buildings should be above flood levels and the buildings should be designed to withstand flooding.</td>
<td>Lismore City Council</td>
<td>The Council has not used its zoning powers to prevent floodplain encroachment. Its 1956 floor level regulation does not appear to have been effectively enforced until after the 1974 flood. For industrial/commercial establishments flood proofing is just &quot;advice&quot;.</td>
<td>Considerable floodplain encroachment has occurred since 1956. New residential and commercial/industrial subdivisions have been developed particularly in South Lismore. The pace of industrial development in South Lismore has quickened recently and the main floodways are under increasing threat.</td>
<td>Prevent additional residential development in South Lismore. Prevent encroachment into the South Lismore floodway zone. Prevent occupation of hazardous areas.</td>
<td></td>
</tr>
<tr>
<td><strong>IMPLEMENTATION &amp; CO-ORDINATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A county council should be established to undertake the construction of the recommended work.</td>
<td>State Government under Local Government Act</td>
<td>The Richmond River County Council was constituted.</td>
<td>The body is a construction authority. This and its role in administering flood mitigation funds made implementation of non-structural measures less likely.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER MEASURES</strong></td>
<td>Acquisition</td>
<td></td>
<td></td>
<td>Acquisition is an attraction measure in view of the impracticality of other measures. Expenditure should be at least $500,000 per ($1980) which is the present value of average annual residential damage. The scheme should be greatly expanded to include all &quot;hazardous&quot; areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access</td>
<td></td>
<td></td>
<td>It is not possible to provide complete flood free access to Lismore but some improvement would be justified.</td>
<td></td>
</tr>
</tbody>
</table>
a series of investigations into the flood problem. These focussed on flood damages (Smith et al, 1979), but also examined the effects of floods on health (Smith et al 1980; Handmer & Smith, 1983) and the attitudes of flood plain residents to the flood problem (Munro et al 1980). Where appropriate, the results of these studies are included in the present study. Final results from the NSW Public Works Department and Sinclair, Knight & Partners (PWD and SKP) report were available at the time of writing and are also presented in Table 2.4.

Findings from both the PWD & SKP (1980) report and the 1982 IDC report are broadly similar to those of 1958, except that on this occasion non-structural measures are receiving more attention and the institutional and funding arrangements, and political will, exist to help ensure some success (Section 3.2).

Other mitigation action taken on local and District PWD Office initiative has been the raising of certain access roads in North Lismore and the gradual acquisition of particularly flood prone property. Key access roads were raised as it was felt that this would give flood workers an extra 4 hours to lift goods and would allow residents and flood workers back into the area up to 36 hours sooner (Northern Star 29.3.74).

Council had been purchasing some low lying property as part of its riverside park program. Following the serious flooding of the early and middle 1970s, the scheme was extended to residential property in other low lying parts of Lismore. Federal and state governments meet 80% of the costs. The scheme is entirely voluntary and operates on a largely ad hoc basis. When properties are offered for sale the Council may make an offer based on the "market value" as assessed by the Valuer General's Department. Implementation has gone smoothly, and there appears to be little local opposition. Acquired land is owned by the Council. There are no firm plans for post-acquisition use.

Effectiveness of Flood Damage Reduction Measures

The details and effectiveness of the various flood damage reduction strategies employed in Lismore are examined closely in Chapter 3. A summary of the damage reduction achieved is presented in Table 2.5.
Table 2.5: Effectiveness of flood damage reduction activity in Lismore. Residential direct damages at 13m gauge height (approximately 1:100 flood). All figures in 1974$. Data from Smith et al (1979) and Smith (1981).

<table>
<thead>
<tr>
<th></th>
<th>Present Situation</th>
<th>Without the Strategy</th>
<th>Difference Without - With</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Raising</td>
<td>1,118,900</td>
<td>2,376,034</td>
<td>1,257,134</td>
</tr>
<tr>
<td>Preparedness</td>
<td>1,118,900</td>
<td>2,139,000</td>
<td>1,020,100</td>
</tr>
<tr>
<td>Levees</td>
<td>1,118,900</td>
<td>1,118,900</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total Damage Reduction</strong></td>
<td></td>
<td></td>
<td>2,277,234</td>
</tr>
</tbody>
</table>

Some 87% of the houses on the Lismore flood plain (1:100) are raised 1m or more above ground level. Raising for many floodplain dwellers has been shown by Smith and Penning-Rowsell (1981) to be an economically rational action. For Lismore as a whole, flood damages are virtually eliminated for small floods, and are more than halved for events greater than 1:15. Raising is not feasible for the existing commercial centre. However, the new Lismore Square Shopping Mall is raised some 4m and the underfloor space is used as a car park.

The effect of an experienced and well prepared population on flood damages is often overlooked. Lismore's floodplain population could hardly be more experienced (Section 3.3.4.7). Smith (1981) compared actual 1974 flood damage with the potential damage, that is "the damage that would be sustained if no action was taken to lessen the impact of the flood water on the contents of the flooded building". Actual direct damages consisted of 52.4%, 23.5% and 6.1% of the potential damage for the residential, commercial and industrial sectors respectively. Although major structural works are not feasible, small levees and flood gates appear to have been quite successful at reducing damages from smaller floods for much of South Lismore (11.5m, 1:5) and Brown's Creek Basin (11m, 1:4), though they have no effect on damage from larger events (Table 2.5). This apparent success
must be weighed against the fact that the levees have undoubtedly been a factor behind the industrial development of South Lismore, which in turn has increased average annual damages and the potential losses from large floods. From an overall flood damage reduction viewpoint these levees, at least in South Lismore, have been a failure.

2.3.3 Echuca, Victoria

2.3.3.1 Physical Dimensions - The Catchment

Appropriately enough, the name "Echuca" is derived from a local aboriginal word meaning "meeting of the waters" (Coulson, 1979), as the town is located at the junction of the Murray and Campaspe Rivers (catchment 4,150km²) 7.5km downstream (west) from the Murray/Goulburn River confluence (Figure 2.4). All three rivers are arterial drainage systems which do not contain a large proportion of mountainous country. The Goulburn and Campaspe flow north through Victoria from gentle foothills onto extensive alluvial deposits, known as the Riverina Plain, where they join the Murray River. The Murray rises in the Snowy Mountains and flows through steep rugged country, dropping 1500 m in 200 km, before entering the Riverina Plain near Albury. The plain is over 75,000 km² (Butler et al, 1973) and it "is traversed by ancestral stream courses and depressions, and has a very flat gradient of 1:5000" (Victorian Parliamentary Public Works Committee, or the PPWC, 1975:5). This gradient means "that usually insignificant land forms such as natural river levees, up to 1 m high, have a significant effect on flood flow paths and cause extensive sheets of water to become ponded behind them" (Currey and Uole, 1978).

A number of storages have been constructed on the river system, but are designed for water conservation not flood mitigation. Furthermore most of the storage volumes normally available for flood control are insignificant compared with the maximum recorded flood inflow. Nevertheless the largest works may exert a considerable influence on discharges, for instance, during the 1974 flood "inflows to both Hume and Eildon (reservoirs) were almost completely absorbed within the storages" (PPWC, 1975:7).
Flood Heights at Echuca Gauge

- 1975-94.75
- 1%—95.63
- 1870—96.20

Figure 2.4: Map of Echuca and its location.
Flood Duration and Prediction

Water levels at Echuca are influenced by individual floods from the Murray, Goulburn and Campaspe rivers or combinations of these floods. Floods are lengthy and somewhat leisurely affairs compared to those on the coastal rivers. The water is neither deep nor fast flowing, and may remain high for months. Though this is the normal pattern the potential for serious deep flooding at Echuca certainly exists (see comment in Flood Record below).

Flood warning periods are substantially longer than those of the other sites. Typical river times during a major flood are (Echuca City Engineer, 1982 pers.comm.):

<table>
<thead>
<tr>
<th>Campaspe River</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eppalock (Lake) to Rochester</td>
<td>12 hours</td>
</tr>
<tr>
<td>Rochester to Echuca</td>
<td>36 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goulburn River</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shepperton to Echuca</td>
<td>120 hours</td>
</tr>
<tr>
<td>McCoys Bridge to Echuca</td>
<td>60 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Murray River</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barmah to Echuca</td>
<td>60 hours</td>
</tr>
<tr>
<td>Yarrawonga to Echuca</td>
<td>120 hours</td>
</tr>
</tbody>
</table>

However, predicting flood flow is not the simple matter it might appear to be. Murray River flooding behaviour at Echuca is very complex because of the two major tributaries, the Goulburn and Campaspe; and the function of the ancestral stream beds, in particular that now occupied by the Edwards River. Above Echuca the greater part of major flood discharges leave the main stream spilling into the Barmah-Moira forests and the Edwards River to Deniliquin. "An extreme instance is the situation...where the effect of flood inflows from the Goulburn River (between Barmah and Echuca) has been to reverse the hydraulic gradient to the extent that flow at Barmah actually reverses" (Currey and Dole, 1978). "Thus although the peak flow passing Tocumwal in May (1974) was 202,000 mega litres per day (ML/d) and at the same time a flood flow of 214,000 ML/d was occurring in the Goulburn River at McCoy's Bridge, the peak flow (downstream) at Echuca was less than half either of the above inputs at 98,000 ML/d" (PPWC, 1975:24). Figure 2.5 illustrates this situation.
The complexity of Murray River hydrology and its effect on floods and floodplain management is examined by Currey and Dole (1978) and PPWC (1975), while Butler et al (1973) have mapped and discussed the area's geomorphology.

**Flood Record**

Historical flood data for Echuca is well documented, largely as a result of its early importance as a river port, and the sensitivity of river navigation to water depth. "A (water) level gauge was installed in 1866 near the Echuca Wharf and was replaced in 1886 with a new gauge at the Echuca Wharf. This new gauge was set at the same zero as the previous gauge. The Water Commission carried out survey checks of the gauge zeros in 1931, 1957 and 1978 and these checks have indicated that the gauge zeros have not been altered" (Victorian State Rivers and Water Supply Commission, or SK & WSC, 1979:1). Figure 2.6 shows the flood frequency/magnitude curve at Echuca Wharf. Information on the effect of the Murray water storages on flood probabilities at Echuca was not readily available, but is expected to be negligible in major events due to the river's flooding behaviour (above).

Echuca West has experienced serious damaging flooding as an urban area in 1956, 1974, 1975 and 1981. Other major floods have occurred at Echuca in 1867, 1870 (record flood), 1916, 1917 and 1939.

It is interesting to observe that the 1870 record flood reached a height on the Echuca Wharf gauge of 96.2m (AHD) or 1.62m higher than the 1956 flood which until recently was used as the regulatory flood, and that a geomorphically determined "upper flood limit" is about 1 m higher than the 1870 event, or 2.62m above the regulatory flood (SK & WSC, 1979).

**The City**

The original part of Echuca, and the present business district, is situated on a narrow isthmus of land between the Campaspe and Murray Rivers. Though relatively high it was inundated by the record flood of 1870 (1:188). A recurrence of this event today would flood some 800 developed and undeveloped commercial and residential properties.
Figure 2.5: The effect of tributaries and effluents of the Murray River on the May 1974 peak flood discharge (Currey & Dole, 1978:68).

Approximate river distances between points (kms):
- Tocumwal - Barmah = 120
- Barmah - Echuca = 50
- Echuca - Torrumbarry = 50
- Torrumbarry - Swan Hill = 190
- Swan Hill - Wakool Junction = 100
Annual recurrence probability (%)

Recurrence interval (years)

Stage height gauge (m)

Stage height A.H.D.

Lowest Residential Area

Figure 2.6: Flood probability curve for the Murray River at Echuca. Data from Victorian SR & WSC (1979).
Additional areas of flood prone residential development are located to the east and west.

Echuca West, the area with which the study is concerned, is that part of the original town layout lying west of the Campaspe River. The area forms a flood "basin" and apart from a small sand ridge was largely inundated in 1975 by a 1:36 flood. Areas of East Echuca subject to flooding are on a gently sloping plain. The lowest parts of both the East and West, being about 93m (AHD) are subject to floods with a 2.5-3 year recurrence interval (Figure 2.6). Both the bulk of Echuca East and the main city are protected against floods of the 1956 magnitude (1:35) by levees, but permanent levee protection has not been extended to the West.

Though floods of either the Murray or Campaspe can directly inundate Echuca West, in general both rivers must be high before serious flooding occurs. The high Murray prevents Campaspe water from escaping and forces it to back up and enter the West. Flooding is slow, relatively shallow, except in the centre of the area (2.5 m at 1:100 flood), with little debris carried into the built up zone, though snakes and insects, especially mosquitoes, are a problem. If the Murray is high the Campaspe may be kept near bankfull stage and flood water may take months to drain completely.

2.3.3.2 Development of the Flood Hazard and Settlement History

The first European to settle in the Echuca area was James Maiden. By 1845 he had set up an inn and installed a punt on the NSW side of the Murray opposite its junction with the Campaspe, at a location to be known as Moama (Priestly, 1965:6). In 1847 competition arrived in the form of a punt owned by Henry Hopwood. Within a few years Hopwood had obtained permission to occupy "a paddock situate at the junction of the Campaspe and Murray" (Priestly, 1965:15), which he felt was an ideal site to establish a port for the anticipated Melbourne-Murray River trade, being the closest point on the Murray to Melbourne. It appears that the colonial government of Victoria had already reserved the area for a town which was formally laid out as Echuca in 1854. The surveyor approved of Hopwood's site observing that there was plenty of flood free land (Priestly, 1965:22).
Echuca expanded rapidly as a river crossing point, a rural service centre and a port while Moama declined in importance. The completion in 1864 of the railway link between Echuca and Melbourne served to reinforce the city's importance as a port and point of trans-shipment. Further northwards extension of the railway only extended Echuca's hinterland (Priestly 1965:74). During this period the population jumped from 221 in 1861 to 1,649 by the 1871 census and the settlement was proclaimed a municipality.

The occurrence of major floods appears to have done nothing to inhibit the development of Echuca, apart from limiting urban expansion into the West. The most devastating (and record) flood occurred in 1870 when for the whole of September and October the Murray was kept at a high level by melting snow and spring rains. On two occasions the Campaspe rose to meet the Murray and together the rivers inundated the town completely (Priestly, 1965:99). Moama was not so fortunate. The 1870 flood spelt the end for the original township where all the buildings were completely submerged. The settlement was abandoned and a new town gradually took shape on high ground (Coulston, 1979:45).

After the 1880s river trade boom Echuca gradually declined, and the population did not regain its 1880 level until after World War II (Priestly 1965:152). The 1890's depression and vine blight, phylloxera, affected rural industries and the river trade severely. River traffic was further reduced by droughts which made the Murray virtually unnavigable in 1896. Increased competition from railways and the expansion of motor and rail traffic effectively finished the river as a major transport mode early this century, though a small fleet of boats continued to trade until the 1930s. Echuca's economic base had become predominantly that of a rural service centre. After the 1930s the river again became important, this time as a base for tourism and recreation.

Due to frequent flooding Echuca West developed slowly as an urban settlement. Instead, the area had value for intensive agriculture and the high sand ridge was used as a cemetery. By the late 1860s Chinese market gardeners were working blocks by the Campaspe, and 30 years later when the area had been subdivided a number of irrigated market gardens of two or three hectares had appeared in the West (Priestly, 1965:156; Echuca Parish Map, 1894).
The 1950s saw Echuca and in particular Echuca West again subject to severe flooding.

**Present Situation**

Today Echuca is a major rural service and tourist centre. The town's population is 8,500 and growth is steady at 0.75% p.a. which is above average for rural Victoria (McCartney, 1981-1). Moama (population 1,600) has recently experienced a more rapid growth rate. Differential state policies, among other things, have contributed to Moama's resurgence. For example NSW's relaxed liquor licensing and poker machine laws are certainly largely responsible for the rapid growth of licensed clubs in Moama catering for a regional clientele including Echuca. In addition, some Echuca officials feel that the uncertainty in the late 1970s, while their city was resolving which regulatory flood to adopt, diverted much growth to Moama where they believe flood-related regulations were not strictly enforced.

A comprehensive floodplain management plan has been developed since the 1% or 1:100 regulatory flood was adopted. The plan provides for floor level regulations, land use zoning and levee protection for the main town, and acquisition of the 102 properties and 65 dwellings in Echuca West.

**2.3.3.3 Response to Flooding**

The most obvious and effective flood adjustment in Echuca is the use of levees. These have been constructed by both the Council and individual property owners. As well, some houses and yards in Echuca West have been raised on fill, though whether as a result of the Victorian Uniform Building Regulations or individual initiative is not clear.

Parts of the city were protected by levees many years ago and in 1970 the city levee was made continuous and uniform to the 1956 flood level (1:35). Since its construction the levee has kept out floods in 1973, 1974, 1975 and 1981. It is probable that some additional parts of Echuca East will be leveed. Echuca West is not protected by the city levee, much to the disappointment of residents. However, private levees have a long
tradition in the West and were employed by the Chinese market gardeners of last century. Today over 60% of the dwellings there are leveed or raised and virtually all those in the lowest area (the "basin") are so adjusted. Though private and government levees have worked reasonably well the fact that they could be overtopped by as much as 2.6 m needs to be considered by emergency planners (see Flood Record above). Section 3.3.4.4 discusses the levees in detail.

After detailed investigations state and local authorities decided that structural flood protection for Echuca West was not feasible. Instead the area was proclaimed flood prone by the State Rivers and Water Supply Commission (SR & WSC) under the provision of the Drainage of Land Act (1975), and an acquisition, or voluntary property purchase, scheme was started in 1980. Proclamation effectively removes the local planning powers and prevents further construction or substantial renovations. In contrast to the other sites publicity was extensive prior to scheme commencement. This was partly because of a requirement in the Drainage Act that property owners must be notified individually if their land is to be proclaimed flood prone (Section 3.2). In addition a number of public meetings were organised, and SR & WSC officials held private discussions with residents.

The scheme is administered directly by the state authorities and title to acquired land is held by the Crown. The authorities hope to purchase all properties lying below the 1:100 flood level over a ten year period at a cost of approximately $1 million (1980$). Implementation, as judged from sales records, has gone smoothly despite vigorous opposition from many older well established residents.

The City's new town plan, currently on display for comment contains some flood related zoning, which if enforced will prevent development below the 1:36 flood line (1975 flood level). Development above this line and below the 1:100 level will be permitted behind levees and subject to floor level regulations. The draft plan appears to represent a significant step forward in local hazard planning. However, opposition to some of the proposals from those whose land would be regulated is growing, and may persuade Council to change its position. If this occurred the S.R. & W.S.C. would possibly extend its flood prone area Proclamation and direct planning control to other low lying parts of Echuca.
2.3.4 Wagga Wagga, NSW

2.3.4.1 Physical Dimensions - The Catchment

Wagga is situated on the Murrumbidgee River on the south-western slopes of NSW (Figure 2.7). The river is part of the Murray-Darling system and has a catchment above Wagga of 27,700 square kilometers. Rising in the Snowy Mountains "the snow fed Murrumbidgee" drains a large area of mountain and plateau country before emerging on to the "dry western plains, just west of Wagga, to join the Murray near Balranald some 880 km from its source" (Water Resources Commission, 1977).

Between the Snowy Mountains and Wagga the Murrumbidgee is fed by only one significant tributary, the Tumut River, which joins the main stream about 80 km above Wagga. The partial regulation of this tributary by the Blowing Dam (completed in 1974) reduces the incidence of minor to moderate flooding as far as Wagga. The only other storage with any effect on flooding is Burrinjuck Dam (completed in 1920) located on the main Murrumbidgee stream some 160 km upstream from Wagga. Like Blowing this structure was built for water conservation and has the same limited effect on flood flows, because of the conflict inherent in maintaining air space for flood storage and a full reservoir for irrigation.

However, depending on antecedent moisture conditions, a high degree of flood flow reduction may be achieved by water storage in the natural channel, in billabongs, back swamps and so on.

Flood Duration and Prediction

Floods at Wagga are not as sudden or fast flowing as those on the NSW north coast. When in flood the river may remain at a moderate level (178m AHD) for up to five days, though water may remain in low lying areas for over a month. The city is over 160 km from the headwaters of the river and between 32 and 50+ hours of warning is generally available. Nevertheless accurate flood stage predictions are elusive due to the difficulties in calculating the degree of flood peak attenuation by natural channel storage, and to a lesser extent the contribution of tributaries.
Figure 2.7: City of Wagga Wagga and its location.
Flood Record

Systematic stage heights have been kept for the Murrumbidgee at Wagga since 1887 (SKP, 1977), and the city engineer has been able to extend the flood record back to 1844. Over the period of accurate record collection the river has broken its banks (exceeded 7.8 m at the Hampton gauge or 177.8m AHD) on average every 2-3 years. At this level the lagoons around the city begin to accept flow (Figure 2.8).

Wagga's worst periods of flooding this century occurred during the 1950s when there were sustained periods of high river levels including 17 peaks, and the 1970s. There were 5 flood peaks in 1974, including the highest since 1853 (180.8m AHD; 1:90), 4 in 1975, and one each in 1976 and 1978. Other serious floods (>179.6m AHD, when water enters North Wagga) occurred in 1844, 1852, 1853, 1867, 1870, 1879, 1891, 1900, 1922, 1925, 1931 and 1934 (Wagga Wagga Council, 1977).

The City

The bulk of the original city is located on the south bank of the Murrumbidgee, within a large meander loop, where it is protected by a levee tied to high ground from floods of up to approximately 181m (1:100) AHD (or 10.9m local gauge height) This area is partly bisected by a billabong known as Wollundry Lagoon (Figure 2.7).

North Wagga, the specific area under investigation, is situated in the middle of the floodplain, 1.5km from the city centre, and is surrounded by open space. The village consists of 216 buildings (202 dwellings), occupying approximately one square kilometre with two residential streets extending some 600m beyond this area. The settlement is built on a slightly raised area consisting of three low profile sand ridges. Ground height varies by 1.6m so although water starts to enter the village at 179.6m AHD (1:12) only in the 1974 flood (1:90) has water entered all dwellings. Access to Wagga city is cut well before water reaches this level and the village is essentially isolated by floods of 179m AHD (SKP & MSJ KY, 1979).
Figure 2.8: Flood probability curve for the Murrumbidgee River at Wagga Wagga (Sinclair Knight & Partners 1977).
The city area does not appear to have functioned as a major floodway prior to levee construction though localised high flow rates were reported (Shaw, 1960), and the levee has raised major flood levels approximately 30 cm (SKP, 1979). North Wagga itself is not in a floodway but the village is isolated by small events and in major-floods flow is equally divided between the floodplain to the north of the village and the normal Murrumbidgee channel between North and South Wagga.

2.3.4.2 Development of the Flood Hazard and Settlement History

The Best family founded the "Wagga Wagga" station in 1832. Within a few years a ford over the Murrumbidge near the Wagga homestead had become the district's principal river crossing point (Shaw, 1960).

A small settlement soon grew at each end of the crossing and achieved official recognition in 1847 when a Clerk of Petty Sessions and police constable were appointed. Two years later the township was surveyed and proclaimed. The town plan was similar to others of the period in that it provided for settlement on both sides of the river. According to the surveyor provision was made for a settlement on the north bank "beyond the reach of the highest floods" to accommodate people trapped there by flooding (Swan 1970:41).

"Unfortunately in designing Wagga, Mitchell (the Surveyor General) appears to have disregarded the probability of flooding and hence concentrated upon street development in the lower-lying areas adjacent to the river" (Shaw 1960:8). As a result land sales were occasionally affected by flooding: "The dreadful flood of July 13, 1853, prevented the sale of those lots unbidden for and I very much fear it will be long ere fresh applications are made to purchase other lots in this unfortunate place" (Shaw 1960:14; quoting an 1853 writer).

There is some debate over the impact of these early floods on the form of the settlement. Shaw (1960:14) writes that "The Genesis of morphological change in the town pattern arose from these early floodings" and resulted in the abandonment of North Wagga as the major town site. North Wagga "came to be regarded as an unfavourable area for town building and is still regarded as such". However, Swan (1970:52) disputes this and
argues that it was not until economic development caused major urban expansion that people built on high ground. He also points out that the court house and lock-up were established in South Wagga before the town was surveyed and they formed the nucleus of the main settlement.

Nevertheless, regardless of which view is correct there was official reaction to Wagga's early flood problems when in 1858 the district surveyor was given the task of investigating escape routes. "He recommended the construction of a bridge across Wollundry Lagoon (as the original settlement was to the north of the lagoon), and in order to defray construction costs suggested that land to the south of the lagoon should be subdivided into town lots and sold" (Shaw 1960:15). He also deleted much from the original plan of North Wagga retaining only one block for town lots - that enclosed by Hobkirk, Brotherhood, Rowan and Gardiner Streets. The remaining land was subdivided into small country lots (Morris 1980:7) (Figure 2.9). The town block was that closest to the river crossing point and was quite heavily developed last century, but it is also the lowest part of the village and in 1982 contained only 7 houses.

The municipality of Wagga Wagga with a population of about 1,000 was incorporated in 1870, one year after the river was bridged (Shaw 1960:17). In this year there were four floods, the highest being very serious. These floods marked the first, albeit unsuccessful, attempt by the townspeople to organise levee protection (Shaw 1960:18). Further floods last century saw Wagga Council approach the State Government for a levee in 1890, but after investigation, the request was turned down on the grounds of the embankment's projected size and cost (Swan 1970:152).

Although Wagga was still important as a crossing point, by the 1870s its administrative and service functions were becoming increasingly significant. River trade existed along the Murrumbidgee at this time but had only local significance due to shallow water and competition from Echuca and Adelaide suppliers.

From the early 1860s to 1880s the city's growth outstripped that of its neighbours, Deniliquin and Albury, but during the drought and depression of the late 1880s and 1890s, growth fell dramatically (Swan 1970:135). Development that did occur saw the urban area consolidated
rather than extended south away from the floodplain, and by the turn of the century Wagga had become an important regional centre of 4,500 people. Scattered development had occurred throughout North Wagga, and the residents, feeling that they were being neglected by the Wagga Council, formed their own progress association (Morris, 1980). Certainly in terms of municipal services the area has been neglected, for example electricity was provided 3 years after the main city, and gas and sewerage have still not been installed.

The post war period saw Wagga proclaimed a City in 1946 with a population of 15,340; and continued growth as a service and administrative centre fuelled by the War Service Land Settlement Act and the establishment of a teachers college. Throughout the "city new homes were built in large numbers and even North Wagga,... shared in this building boom" (Shaw 1960:38). Most of the new commercial development occurred in the original flood prone site, but much of the residential expansion was to the south away from the floodplain, a trend that has continued to the present.

Serious repeated flooding during the 1950s did not hamper growth in the commercial/industrial sector, but resulted in the construction in 1960 of a levee (1:100) around the main City, South Wagga. Apart from small emergency embankments levee protection was not extended to North Wagga, then a suburb of some 230 dwellings. Instead, the village was placed under a controversial restrictive "non-urban" zoning and a limited voluntary property acquisition scheme commenced.

**Present Situation**

Wagga is a city of 40,000 people steadily expanding at 2% per annum. The economic base as a major regional service centre is diverse, with substantial commercial, industrial, government and education components. At present the river has no real economic function.

Although most new construction is taking place away from the floodplain there is pressure for industrial subdivision and some residential development, such as the McNickel subdivision, in flood prone areas. The levee protecting existing floodplain development in South Wagga, which includes the city core, is being upgraded after being
Figure 2.9: The effect of floods on the official plan for North Wagga Wagga. Townsend's original 1840 plan, and the results of the 1858 revision are shown (Morris, 1980).
overtopped, but not breached in 1974 (1:90 flood).

The controversy over North Wagga is continuing, with the council now supporting the residents call for levee protection after 26 years of very tight regulations, haphazard property acquisition and indecision.

2.3.4.3 Response to Flooding

The response to flooding in Wagga City and North Wagga has not been characterised by individual response or adjustments. Rather, major attempts to reduce the damage potential have come from the council in the form of a levee for the main city area of South Wagga, development control for the unprotected floodplain area, and an acquisition scheme for North Wagga. It is interesting to speculate on the lack of individual householder flood proofing in Wagga compared with the other sites. The reason probably relates to the relative lack of severity and frequency of flooding compared to Lismore, but a greater depth and shorter warning time than Echuca making rapid individual levee construction difficult in the higher areas and impractical in the lower parts. The cold winters would also act to discourage house raising which is not a local building style. An additional disincentive might be the enduring hope that council would construct a levee similar to that protecting the main city.

Regulation and Acquisition

The acquisition scheme is entirely local in its inception and funding. While the City's Planning Scheme was under preparation Wagga Council took the decision to gradually phase out development in North Wagga and not to provide the village with levee protection.

North Wagga was zoned "non-urban" in the Planning Scheme (gazetted in 1965 but adopted by Council in 1956): new development was prohibited, only minimal existing user rights were recognised, and limited property acquisition commenced. These actions precipitated a controversy within both the political and administrative arms of Wagga Council, and between the Council and residents of North Wagga who fought the restrictions. As a result the number of dwellings has been reduced by less than 20% over the 25 year period. Local opposition now appears to have almost overturned the
scheme, and the "temporary" levees erected as an emergency measure in 1974 may be upgraded and made permanent. However, the regulations have been quite successful in halting new development (see Section 3.3.3.4), and the NSW Department of Environment and Planning appears to be increasingly determined to acquire the village.
CHAPTER 3

THE DEVELOPMENT AND IMPLEMENTATION OF

FLOOD DAMAGE REDUCTION POLICIES

3.1 INTRODUCTION

Until recently any review of flood damage reduction in Australia would have concluded that non-structural measures had received little attention and that the major emphasis was on flood water control through engineered works. Land-use management, especially regulation through zoning, and the acquisition of severely flood prone areas, has not been widely employed. Furthermore, where such measures are in use application has frequently been haphazard and ineffective. With a few exceptions governments have also given little encouragement to individual initiative such as house raising.

The last decade has seen a change in emphasis at all levels of government, but especially at the state and federal levels, where there has been sustained interest in land-use management. Considerable energy has been devoted to the shift in attitude, as discussed in the following sections.

At first sight the change in attitude appears to have followed the heavy flood losses of the early 1970s, and the realization that the long period of sustained expenditure on structural works has not reduced the flood damage potential. On close inspection, however, the reasons for the change appear rather more complex and reflect, among other things, societal concerns about environmental and public safety issues, which were emerging before the 1970s flooding (Leigh, 1982; Curtis, 1980-1).

Regardless of the reasons it is clear from a review of present policies that land use measures are now expected to play a major role in reducing flood damages. These measures have not on the whole been successfully implemented in the past. Knowledge of the reasons for failure is an important prerequisite for future success. Also important is an examination of the functions and performance of the various flood adjustments. Can any one adjustment alone substantially reduce the flood
damage potential? How does acquisition complement other flood damage reduction measures, and what combination of measures is most likely to achieve the desired result?

Attempts to answer these questions are provided by an historical review of flood damage reduction policy in Australia. This broad review is complemented by a detailed examination of flood adjustments, their individual problems and benefits, performance, and interaction with other adjustments, especially acquisition.

3.2 FLOOD DAMAGE REDUCTION POLICY IN AUSTRALIA

3.2.1 Fragmentation of Authority

The Australian Constitution (1900:s.51) allocates specific legislative powers to the federal government. Those areas not allocated such as natural resources, including water, remain with the states. However, this does not mean that the state governments have sole responsibility or authority over natural resources. While the states enjoy propriety rights, various broad legislative areas are reserved for the Commonwealth including defence, federal territories, and meteorological observations. The Snowy Mountains Hydro-electric Power Act (1949), for example, relied on the defence and territory powers for its authority. Also recent legal cases suggest that the Commonwealth, on top of its constitutionally enumerated powers, enjoys certain implied powers stemming from its character as a national government (Victoria v. Commonwealth, 1975, 50 A.L.J.R. 156). Valid Commonwealth legislation will prevail over any inconsistent state legislation (s.109).

In addition a distinction should be made between the resource ownership and legislative power of the states and the financial power vested in the Commonwealth. Section 96 of the Constitution reads "During a period of ten years after the establishment of the Commonwealth and thereafter until the Parliament otherwise provides, the Parliament may grant financial assistance to any State on such terms and conditions as the Parliament thinks fit." The High Court has treated the section as if it were a permanent provision (Richardson, 1973:60). Extensive use has been
made of section 96 by the federal government: "The section is employed in making grants to the States by way of reimbursement for abandoning the field of income taxation to the Commonwealth" (Richardson, 1973:61). In theory the grants could be used to influence state policy. This has not occurred very often in the past, but increased use of the federal financial power in this fashion seems likely. Two examples from the field of water resources are: first the public pressure exerted on the Commonwealth not to fund any further dams in South-West Tasmania, and second the new federal requirement making broad ranging studies a prerequisite for flood mitigation funds (Manderson, 1981). Thus the federal power over natural resources and the environment is rather more extensive than at first it appears (Fisher, 1980).

The Constitutional division of powers means that the states have authority for flood policy development and implementation. The states are also active in data collection, applied research and various disaster relief activities (Pickup & Minor, 1980). Water resource responsibilities of the federal government are exercised in research, data collection, regional flood warnings, disaster relief, persuasion and funding.

Though the state governments develop policies, decide priorities and allocate funds, and construct major flood control works, the primary responsibility for flood policy implementation rests with local government and special purpose local and regional government bodies. "Local government authorities in Australia are established under Acts of State Parliament with the exception of the Northern Territory" (Butler & Doessel, 1979:12). Local authorities act as the state governments' agents on many matters, including land use control through their zoning power and building and health ordinances. Some land use control is exercised by state agencies through the official plan and subdivision approval requirements, but in practice non-structural flood damage reduction has been largely in the hands of local government. The management of water resources, complicated by the hierarchical or vertical division of responsibility, is made more difficult by the functional and spatial fragmentation of authority. There is a vast number of local government areas. Often a single watershed or river will contain several, with their frequently conflicting interests - rural/urban, upstream/downstream, trying to attract/control development - rendering coordinated river basin management
almost impossible without some special purpose body designed to transcend local political boundaries. A number of special local or regional authorities constituted to serve a single function, here flood mitigation, have been created. Those with river basin jurisdiction include the county councils of the NSW coastal rivers, the Dandenong Valley Authority (DVA) of Victoria, and the Hunter River Valley Trust of NSW. The county councils, of which only two remain, were set up after the 1950s flooding. They are single purpose agencies to which the constituent councils have delegated specific powers. The situation is made more complex in some areas by the existence of relatively small bodies organised by local residents, such as the "drainage unions" of NSW and the "river improvement trusts" of Victoria. These bodies operate in rural areas to construct drainage works and clear river channels. On the Richmond River floodplain the drainage unions have become very powerful, in part because of the absence of penal provisions in the relevant legislation, the Drainage Act (1939). The charter and funding arrangements of these special authorities, with the exception of the DVA and Hunter River Trust, make them in effect construction authorities, and further reduces the viability of non-structural flood mitigation proposals.

The divisions found within local functional and spatial jurisdictions for flood mitigation also exist at the state and federal levels. In NSW the Department of Environment and Planning has drawn up the state's floodplain policy and is technically the enforcement authority. However, other bodies are currently responsible for policy administration: the Public Works Department (PWD) in tidal parts of the state and the Water Resources Commission (WRC) elsewhere, although neither of these bodies have the necessary planning powers, except for the somewhat punitive measures available under section 38 of the Coastal Protection Act (1979). Water quality is the province of separate agencies further complicating the management of water resources. Federal functions are split between the CSIRO, Bureau of Meteorology, Department of Housing and Construction, Natural Disasters Organisation, the Department of Resources and Energy which attempts to coordinate federal activities, the Australian Water Resources Council (AWRC), and the National Water Research Council (NWRC).

Thus fragmentation of authority, and the lack of financial and legal responsibility of local government, among other issues, threaten to
confound any attempts to implement comprehensive floodplain management policies. The Commonwealth has the financial power, and responsibility in the event of disaster, but clearly must work through the states, though grants may be made conditional. States must develop and attempt to implement policy through either cooperating with local governments, or by bypassing them and intervening directly. Fortunately the trend at the local level at least is towards amalgamation of authorities, and the Victorian regional planning authorities offer one approach to planning rationalisation.

The following sections examine the development and implementation of flood damage reduction policy within this constitutional and administrative framework.

3.2.2 Flood Mitigation Policy Before 1944

3.2.2.1 Pre Federation

Severe flooding was reported from the earliest days of the colony of NSW with the first documented flood occurring on the Hawkesbury River in 1799. The governor of the early 1800s, Lachlan Macquarie, attempted to direct settlement away from flood prone areas. In 1810, he founded six townships, all on the principal location criterion that they be flood free (Fitz-Henry, 1981). A few years later following further floods, he had reason to chastise settlers for "their wilful and wayward habit of placing their Residences and Stock Yards within the reach of the floods" and for their failure "to remain within the flood marks of the townships assigned for them on the high lands" (Williamson, 1975).

Macquarie's admonitions appear to have been largely disregarded, and most towns were not laid out to avoid flooding. Numerous devastating floods with occasional heavy loss of life throughout the nineteenth century attest to this oversight. Most major centres in south eastern Australia suffered damage: including Melbourne, Brisbane and settlements on the NSW coastal rivers, especially those along the Hawkesbury and Hunter. A few floods were so devastating that whole towns were relocated out of the floodplains. In 1852 89 of Gundagai's 250 residents were drowned and the town was moved to its present location. The floods of the 1870s resulted
in the relocation of Moama, and Terrara (to Nowra). Terrara suffered its first severe flood in 1860, of which the Illawarra Mercury's regional correspondent reported (21.2.1860), "I now come to the great, the awful, and most appalling scene of wild desolation, irrecoverable wreck, loss of life and property in the much written about... much talked about, highly praised locality, of Terrara township." The residents battled on. Further floods occurred in 1864 and 1867 and the end for the town came with the flood of 26.4.1870: "The highest flood ever known here has just swept over our district... spreading ruin and desolation throughout its course... Far and wide have been the ravages of this dreadful visitation. The scene at Terrara is desolate in the extreme - dead horses, drawing room tables, posts and rails, couches, pigs, calves, buggies turned over, and sanded up roofs of houses... the ISN Company's steamer high and dry in one of the streets... The damage to the crops is final." (Illawarra Mercury, 4.1870).

The government did not assist with these relocations though assistance was available for structural works. A paper presented to the 1890 meeting of the Australasian Association for the Advancement of Science (Sulman, 1890) stressed the need to locate towns in flood free areas and commented on the typical response to a hypothetical recent flood. "The inhabitants are petitioning for extensive works of embankment, and in course of time will, no doubt, obtain a large grant of public money for the purpose". Other government activity was devoted to the production of flood mitigation reports. These generally recommended embankments, diversions, reservoirs, river channel dredging or widening, and were prepared for the Hunter River alone in 1870, 1877, 1890, 1894, 1897 and 1899 (NSW-Hunter River Flood Mitigation Committee, 1948). Of course report production on the Hunter did not stop with federation.

The Victorian Colonial parliament was rather more active. The 1881 Water Conservation Act and 1886 Irrigation Act effectively nationalised the state's water resources (Senate Standing Committee on National Resources, 1978:5). Also in 1881 under its Land Act (1862) the Victorian government created permanent reserves, between 1 and 2 chains wide, along 280 lakes, rivers, inlets and watercourses (McKay, 1981). This action, which was strengthened and extended by the Water Act (1905), has probably helped to limit the total number of dwellings at risk. In addition the government carried out various major flood mitigation works (Leigh, 1982).
Despite the efforts of visionaries like Macquarie, governments were not successful in guiding towns to flood free locations during this critical period of initial settlement and consolidation. Response to flood damage consisted of the largely uncoordinated construction of mitigation works.

3.2.2.2 Post Federation

"The Commonwealth was slow to develop a role in water resources with the main involvement arising from its taxation collection role, the provision of fiscal incentives and in questions transcending State boundaries" (Australia-Senate Standing Committee, 1978:6). The first instance of such involvement occurred in 1902, when the Inter-State Royal Commission was set up to consider the rival claims of South Australia, Victoria, and New South Wales to the waters of the Murray River. Following the Commission's report the River Murray Commission consisting of the three states and the Commonwealth was established. The Commission has functioned as a construction authority with the federal government meeting 25% of its costs.

At the state level the post federation period saw a continuation of the essentially ad hoc structural response to flooding with increasing government involvement in all forms of water resource projects; in particular those connected with irrigation. Paralleling this involvement was the development of suitable institutional arrangements. The Water Act, 1912-1952, vested control of NSW's rivers and lakes in the Water Conservation and Irrigation Commission, while the Victorian Water Act (1905) established the State Rivers and Water Supply Commission.

Institutional reorganisation in some major metropolitan centres also took place. Regional drainage and water authorities were established in Sydney and Melbourne. The Melbourne and Metropolitan Board of Works was given the necessary authority by the Metropolitan Drainage of Rivers Act 1923 (major amendments 1926). Under this legislation the Board became responsible for the control and management of certain named watercourses and for catchments greater than 150 acres. The powers conferred on the Board by the Act "were basically powers to construct, operate and maintain works, but the Act did not include any substantial powers to control the
use of riverine lands adjacent to the watercourses vested in the board" (Earl, 1975:3). The equivalent NSW body, the Metropolitan Water, Sewerage and Drainage Board was established in 1925 with a mandate broadly similar with respect to flood mitigation (NSW Year Book, 1973). Not only are the charters of these authorities largely restricted to construction, but they are staffed with professionals whose whole training and orientation has been that of resource development in an engineering and construction sense. In many cases it is likely that an organisation's perception of its own role, and lack of management expertise, created further obstacles to the implementation of non-structural measures.

Flood mitigation activity in the form of reports, investigations and structural works continued in NSW: for example, further reports were produced for the Hunter River in 1901, 1903, and 1913 (Weir, 1948); and in Victoria a series of detailed flood studies on the Gippsland rivers, among others, was completed. Most of the Gippsland works involved channel clearing and bank stabilisation. It is an interesting comment on the times that two thirds of the $22,620 cost was met from unemployment relief funds (Strom, 1936).

Federation saw the introduction of very limited, and ineffective, land use controls. Local government was established by Acts of the state parliaments in the early 1900s but generally were not given planning powers. An exception was the 1914 amendment to the Victorian Local Government Act (Section 569(B)) where councils were given discretionary power to refuse to seal a plan of subdivision if, in their opinion the area was subject to flooding and this was not marked distinctly on the plans or the area could not be properly drained (Earl, 1975). At the same time the health acts in most states provided the only avenue for regulating building on flood prone lands. The relevant Victorian provision (Section 205) was introduced in 1919 and states: "No person shall erect...any dwelling on any land liable to flooding from the overflow of waters from any river, creek, stream, lake, lagoon, swamp or marsh."

3.2.3 1944 to 1970

By the end of the Second World War planning legislation existed in all states, which theoretically made non-structural flood mitigation
measures a real possibility. Unfortunately with a few exceptions this potential was not realised. Although, after the disastrous 1950s flooding in NSW, a first, albeit unsuccessful, attempt was made to promulgate a general state policy on the development of flood prone lands. The post-war period also saw substantial federal involvement in water resource development and flood related activities.

Planning legislation was introduced to NSW in 1945 as an amendment to the Local Government Act. This gave councils some control over land use, including that in floodplains, through subdivision control, zoning based on an official plan, and building regulations. While plans were in preparation control was possible through interim development orders. Although many councils passed building ordinances requiring floor levels to be a certain height, usually 30 cm, above an historical flood, enforcement was another matter. Similar planning provisions were introduced into Victoria in 1944. Though there the floor level requirement was part of the Uniform Building Regulations (Section 1701) which did not require specific local government ordinances. However, councils could pass a special resolution to allow building on land liable to flooding, and as elsewhere terms like "liable to flooding" had many definitions.

Most councils did not use the various planning provisions to prevent the development of flood prone land and after the 1950s floods both NSW and Victoria pressed for structural solutions. The various reports and plans of action following the flooding reflected this bias though some mentioned the need to prevent further development of hazardous areas through the zoning power. As well, in a few particularly badly flooded settlements councils pushed for non-structural measures. Maitland City Council put forward a plan for the relocation of the city centre to a flood free site, which was rejected by the NSW Committee of Advice on Flood Control and Mitigation (1956), and Wagga and Bankstown Councils proceeded without state assistance to zone and then acquire badly flooded property.

At this time the NSW Department of Local Government issued Circular No.1981 (31 Jan 1958), which referred to the need for floodplain development control. Instead, the NSW state government established flood mitigation county councils on the coastal rivers to carry out the recommendations of the post-flood studies. The initial funding was on a
Two significant exceptions to the lack of commitment to regulatory measures were the Hunter Valley Flood Mitigation Act (NSW) 1956, and the Dandenong Valley Authority (DVA) Act (Victoria) of 1963. The Hunter Valley Act gives far-reaching powers to the Public Works Department and Water Resources Commission in areas proclaimed to be within the Hunter River floodplain. The Act does not mention existing use rights and everything including fencing and filling requires consent. In fact only the most critical parts of the valley have been proclaimed and protected under the Act, "but it has been very effective in preventing development in important sections of the floodway" (Fitz-Henry 1981).

The Dandenong Valley Act was based on experience gained in administering the Melbourne and Metropolitan Board of Works Act, and the Conservation Authorities Act of Ontario, Canada. The DVA is a catchment-based authority with the power to proclaim lands adjacent to the watercourses under its jurisdiction to be flood prone, and to control all development, building and works within the proclaimed areas. Thus floodways and certain wetlands have been preserved for the passage and storage of flood waters (Earl, 1975; Thompson, 1981).

The first major involvement by the Commonwealth in water resources development came in this period with the commencement of the Snowy Mountains Scheme in 1949 (Senate Standing Committee on Natural Resources 1978). This project was financed wholly by the federal government, but is managed jointly with the benefiting states, Victoria and N.S.W. A 1945 report by the Rural Reconstruction Committee on water conservation and land drainage, emphasised national aspects of water conservation and use, and
recommended the adoption of an Australia wide plan to obviate state rivalries and lack of coordination (Australian Year Book, 1946-47). Little seems to have come directly from the recommendations.

However, in the early 1950s increasing interest in inter-state liaison between water authorities led to the formation of the Water Resources Conference and later the Underground Water Conference of Australia. Although these bodies met regularly their effectiveness was limited due to their lack of formal status. Proposals were put to the Commonwealth for the establishment of a water resources council and in 1962 the Australian Water Resources Council (AWRC) was formed. "The Council is now established as the major forum for the development of Commonwealth-State collaborative programs and functions as a national water resources organisation as far as activities at the national level are concerned (Senate Standing Committee, 1978). In November 1982 the research functions of the AWRC were handed over to the newly established National Water Research Council. The work of this body was suspended in March 1983 by the new federal government pending the results of a review (as at August 1983).

The Commonwealth also became increasingly involved in flood damage reduction. Shortly after the 1950s disaster a case for federal financial assistance for flood mitigation works was prepared by the NSW flood mitigation authorities (county councils) at their 1963 annual conference. Subsequently the Commonwealth passed the NSW Flood Mitigation Grants Act (1963), which provided $8 million for a 6 year period to be allocated on a 2:2:1 (Federal:State:Local) basis. After 6 years a further $9 million was allocated for the 6 years to June 1976. The money was effectively under state control as at that stage the federal government did not want to be involved in approving individual works. Flood mitigation in other states did not receive the same level and type of financial support.

3.2.4 1971 to the Present

3.2.4.1 General

The 1970s have seen a major shift in approach to water resources planning including flooding. The water industry is moving "from an era of
Table 3.1: State level floodplain management policies for urban areas. States are listed in descending order of average flood damage.

NB: Local government has primary responsibility for floodplain management except in Tasmania, South Australia and the Northern Territory.

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>Comprehensive Policy</th>
<th>Relevant Legislation</th>
<th>Institutional Arrangements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Australia</td>
<td>Policy under development</td>
<td>Site by site flood problem evaluation. Policy based on Victorian policy is under development. At present consultative committees are being employed to plan landuse strategies for specific flood prone areas. Also extensive flood plain mapping is under way.</td>
<td>Amendments to the Land Drainage Act based on Victorian Drainage of Land Act 1975, are being considered by a Parliamentary committee.</td>
</tr>
<tr>
<td>South Australia</td>
<td>Under development</td>
<td>The policy is being developed in response to a large flood damage potential rather than heavy losses. The main thrusts are the structural protection of existing flood prone Adelaide development, strict control of further development, and flood warning and public education programs.</td>
<td>Planning Act 1982 Amendments are being considered to the Building Act, Local Government Act and Water Resources Act, 1976-79.</td>
</tr>
<tr>
<td>Tasmania</td>
<td>None</td>
<td>No statewide policy but in general structural works have been used in major centres and new building has been prohibited or floor level conditions have been applied.</td>
<td>No recent legislation Water Act 1957 Local Govt. Act 1962 Building Regs. 1978.</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>Policy, as of June 1981</td>
<td>Very similar to Victorian Govt. Guidelines 1978. Restricts use and imposes development conditions on flood-prone land. Structural works are used to protect existing development. The floodplain defined as the maximum probable flood but the regulatory floods are the flood of record or 1:100 and 1:20 levels.</td>
<td>No specific legislative base.</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>Policy</td>
<td>Emphasis is on comprehensive planning that is sympathetic to the natural drainage system. Structural works, apart from retarding basins, are not used. Settlement is theoretically outside the 1:100 zone, except for that along the Murrumbidgee R., which is above the 1:500.</td>
<td>Ordinances under the National Capital Development Act.</td>
</tr>
</tbody>
</table>
development (construction) to one of management" (AWRC, 1982:1; and Crabb, 1982). Change is in response to a wide range of social, economic and environmental problems. Unfortunately "an industry with a strong orientation towards engineering solutions is not well placed to resolve them" (AWRC, 1982:1). Reasons for the trend include: escalating costs of capital works construction and maintenance, increasing concern over issues of environmental quality and public welfare in particular safety issues, the influence of trends overseas, and the fact that in many areas opportunities for few "viable flood mitigation works remain" (Mathlin, 1981:58).

The new approach is evident in legislative and institutional changes at the state and federal levels which reduce the bias towards engineered flood mitigation works and favour a balance of non-structural and structural measures. This is not to say that changes have occurred in all states. In fact Queensland, the state with the worst flood problem in terms of average annual damages, has not developed a comprehensive policy on flood prone land.

Space prevents a discussion of the situation in each state. Instead a summary of the present status of flood damage reduction policy in each state/territory is presented in tabular form (Table 3.1). The following sections examine recent developments at the federal level, and in NSW and Victoria, the states where the case study sites are located.

3.2.4.2 Federal

"Largely as a result of the recommendations of the report of the Senate Select Committee on Water Pollution in Australia (1970), a statement of the principles on which national water policy should be based, entitled 'A National Approach to Water Resources Management', was developed by the Commonwealth Government in 1973" (Senate Standing Committee on Natural Resources, 1978). The statement survived the 1975 change in government and following revision the Commonwealth and all states accepted the document in 1978 as a framework of objectives for the management of the nations water resources (Crabb, 1982:99). Regrettably, some of the states have yet to produce clear policy statements on the implementation of the objectives.
The "National Approach to Water Resources Management" was taken a step further when a policy statement on the Commonwealth's role in water resource development and management was presented in 1979. The statement identified seven priority areas, one of which was "to minimise losses and disruption caused by floods". "Basic to this objective is the development of comprehensive floodplain management strategies which take account of structural works and non-structural measures - including flood forecasting and policy instruments available to the relevant authorities - to minimise flood losses" (Newman, 1979).

In an effort to implement the policy the Fraser government employed its funding power (see Section 3.2.1). A substantial amount of money, $200 million, has been made available under the National Water Resources (Financial Assistance) Act (1978) for water resource development and management. This money is available on a 2:2:1 (federal:state:local) basis for both structural and non-structural approaches, largely ending the funding bias towards engineering solutions. Voluntary floodplain acquisition is proceeding in Lismore and Echuca under such arrangements. However, as of early 1982 only $111 million of the $200 million had been committed. This has been interpreted in some quarters as revealing a lack of federal commitment (Crabb, 1982; Eurobodalla Shire Council, 1981). In its defense the Commonwealth points out that it was never envisaged that its contribution would replace or significantly supplement state expenditure, bearing in mind that the States spend approximately $1.8 billion per annum on water resources compared to a federal commitment of some $40 million per annum (Manderson, 1981). It is also quite likely that the federal requirement for comprehensive studies, as a precondition for funds, was seen as an attempt to exercise undue control over state or local affairs.

Other recent federal initiatives in water resources and related areas have fared far worse. The "commitment in principle" to a national natural disasters insurance scheme (Canberra Times, 5.3.76), prompted by the major flood and cyclone disasters of the early 1970s, was abandoned in 1979. "The Government is satisfied that a scheme of the kind that had been under discussion ... would be inappropriate on budgetary, technical and insurance policy grounds. Beyond that, however, the government also believes that such a scheme would be inconsistent with a basic tenet in its
political philosophy - namely that governments and government authorities should...avoid intervention in matters that can be left to the private sector" (Howard, then Federal Treasurer, 1979:iii).

The fate of other Commonwealth initiatives provides further evidence that politics are more important than substance. Following the expiry of the 1968 National Water Resources Development Program, a further $100 million was pledged to be spent in cooperation with the states over the next five years. The program was discontinued in 1973 with the change of government. During the term of the Whitlam government, 1972-75, various programs involving water resources were established and funded, principally: water projects of the Department of Northern Development, the National Sewerage Program, and the beginnings of the National Water Program. These programs lapsed in 1975. The National Water Resources (Financial Assistance) Act (1978) (mentioned above) reintroduced direct assistance to the states and provided an initial $200 million for the first five years.

At the time of writing, this policy, along with all other water-related policies of the Fraser government, is under review following the election of the Hawke Labor government in March 1983. Before announcing any policy commitments the new government is awaiting the completion of the "Perspective on Water Resources to the Year 2000" study, a major review begun under Fraser.

3.2.4.3 New South Wales

The institutional arrangements for floodplain management in NSW have been discussed in previous sections of this chapter.

The severe flooding and very heavy losses in the early 1970s, among other factors (Section 3.2.4.1/2), occurring at a time when most of the works called for in the post 1950s flood reports had been completed, stimulated a reappraisal of the state's approach to flood damage reduction. The first works constructed on the coastal floodplains exhibited favourable cost/benefit ratios, but the costs or disbenefits seemed to grow for subsequent works and there were now few viable projects left. This is in
contrast to the situation on the inland rivers.

The reappraisal led to the development of a NSW policy on flood prone land initially stated by the Planning and Environment Commission (PEC) in Circular 15 (16/8/77), clarified by PEC Circular 22 (12/4/78) and further clarified by Department of Environment and Planning (DEP) Circular 31 (15/2/82) which states that "Essentially the policy promotes the removal of urban development from flood prone areas (1:100 flood zone) where this is practicable and appropriate and aims to clear floodways (1:20 flood zones) of unnecessary obstruction to the free flow of flood water." Other thrusts of the state's policy include floodplain mapping for all flood-prone communities and the provision of flood hazard information to the public.

The policy firmly removes the earlier bias towards structural works. Although implementation is only "strong advice for local government and for private development" (DEP Circular 31), enabling legislation exists in the form of the Environmental Planning and Assessment Act (1979) and the Coastal Protection Act (1979). Both these Acts contain provisions for direct state level regulation of hazard land, in effect removing part of the local council's planning power.

Some councils have been slow to cooperate in implementing the policy, and in some areas, especially the north coast, much new development is occurring in particularly hazardous areas such as low flat sand islands, two examples being Newry Island on the Bellinger and Cabbage Tree Island on the Richmond River. It is difficult to avoid reaching the conclusion that a voluntary policy will have the full support of local government once there is no further developable floodplain land. However, officials of the relevant state authorities are optimistic and expect to achieve compliance. One factor on their side is the uncertain legal situation. It appears that councils might be liable to a third party if they allow building to proceed in a flood prone area (Local Government Association, 1980). This follows precedent established by two English cases, Dutton V. Bognor Regis (1972) and Sparham-Souter V. Town and Country Developments (1976), which has been applied by the NSW Supreme Court in two matters involving council negligence in the issue of town planning consents. Another legal problem concerning local governments is the possibility that compensation might be
required if very restrictive land regulations are enforced.

Other policy implementation concerns are the lack of adequate data for flood plain delineation, and issues surrounding the acquisition of flood prone land. These issues are examined elsewhere in the report.

Federal funds have been provided on an annual basis since the expiry in 1976 of the second six year coastal flood mitigation agreement, and are now employed in non-structural as well as structural flood damage reduction strategies. To assist in policy implementation the state government has allocated an additional one million dollars per annum for flood mitigation, and has extended the 2:2:1 funding formula to the rest of the state.

3.2.4.4 Victoria

Flood mitigation in Victoria is administered through three spatial jurisdictions: the Dandenong Valley Authority (DVA); the Melbourne and Metropolitan Board of Works; and the State Rivers and Water Supply Commission; with the Victorian Water Resources Commission, established in 1975, fulfilling a coordinating role. As in NSW water quality is managed separately, through the Environmental Protection Authority established under the Environmental Protection Act, 1971.

Parliament established a Joint Select Committee on Drainage in 1965. The Committee's final report issued in 1970 recommended many changes to the drainage laws. Those to do with flooding were aimed at the implementation of regulatory measures. The first action to follow from the report was the Environmental Protection Act 1970. Then, in 1973 the Local Government Act was amended to give the Drainage Authorities powers to object to proposed subdivisions on grounds of drainage (Earl, 1975:4).

The most significant result of the enquiry from a flooding perspective was the Drainage of Land Act (1975). In essence this Act extended some of the provisions of the DVA Act to all Victoria with the Board of Works and the State Rivers and Water Supply Commission the drainage authorities for Melbourne and the rest of the state respectively. The Act provides for 3 levels of regulation:
1. The strongest is the **Proclamation** of land as liable to flooding. This is done by the drainage authority and is very time consuming due to appeals, review of planning applications etc. When an area is proclaimed planning power is taken from local government and put in the hands of the drainage authority. The Board of Works have not used the measure yet, but the DVA and the Water Commission have proclaimed areas.

2. **Designation** of an area is administratively simpler. Again the drainage authority delimits the zone, but enforcement is in the hands of the municipality.

3. **Flood levels** can be specified by the Municipal engineer after consultation with the drainage authority. This is related to the provisions of the Uniform Building Regulations and applies principally to buildings for existing subdivisions.

Initially the regulatory flood was unusual in that it could be whichever was the greater of either the flood of record, or the 1:100 event. This caused considerable argument in Echuca where the largest recorded flood is very much higher than the 1:100 event and if adopted would have restricted development in the business district. The 1:100 flood has since been selected as the State's regulatory base.

Victorian authorities are not pursuing the same approach to flood-plain mapping and public information as their NSW counterparts. Flood-plains are being mapped, but for planning purposes only, and there is no public hazard awareness campaign at this stage. Instead the DVA and State Rivers and Water Supply Commission have started using consultative committees as part of the planning process. The committees' legislative authority is provided by an amendment to the Drainage Act. They consist of local people who help define the problem and examine the options, costings and so on. Ideas are exposed to the local communities through these committees and public meetings. John Mann of the Victorian Water Resources Council describes them as a political idea which has worked well (*pers comm 10/4/81*).

To assist in the application of the Drainage of Land Act the Water Resources Council (1978) prepared a comprehensive report *Flood Plain*
Management in Victoria which has been adopted as a policy document, though it is stressed by the Victorian authorities that the report presents guidelines only.

3.2.5  **Historical Review of Flood Policy: Conclusions**

Reasons for the apparent past disinterest in acquisition and other non-structural measures are explored by an historical review of government flood policy in Australia. Four major causes of the structural bias emerge from the review.

First, the responsibility for floodplain management in Australia is fragmented or split, both vertically and horizontally, between a large number of agencies. The vertical division of authority refers to the hierarchy of local, state and federal powers, and is such that the levels of government with responsibility for flood disaster relief and policy development, the state and federal levels, lack much of the power necessary for land use regulation. Except for almost punitive provisions this power has rested with local government, with all that councils' susceptibility to pressure from local land interests implies. Horizontal fragmentation refers to the maze of authorities, with overlapping or poorly defined areas of functional and geographical jurisdiction over floodplain management. This type of fragmentation is found at every level of government, with by far the greatest number of separate spatial jurisdictions occurring at the local level, though the most intractable functional and geographic divisions occur at state government level. In some areas the local situation is complicated by the existence of private and quasi-private organisations. Thus a single river valley may be under the administration of a large number of bodies with conflicting approaches to floodplain management. To overcome this problem, special purpose agencies, such as the NSW coastal river flood mitigation county councils, are occasionally employed.

Unfortunately, most agencies involved in flood mitigation have construction rather than regulatory powers. Agencies established as construction authorities and staffed with engineers are quite naturally most likely to see solutions in terms of major structural works - water control rather than settlement control.
The complex division of responsibility with, until recently, little interference with local government was exacerbated by the state and federal funding procedures for flood damage reduction. These not only clearly favoured structural works but practically excluded non-structural measures, with the exception of flood forecasting systems. Any local government wishing to implement acquisition, land-use regulations etc., was on its own financially, while money was available for levees and other structural adjustments - a powerful disincentive acting against non-structural strategies.

The fourth reason for the structural bias in flood damage reduction relates to legal and legislative issues. In most states health or other legislation enacted shortly after federation gave local governments some limited control over land use should they choose to exercise it. But, by the end of World War II the land use control potential was considerably strengthened by the existence of planning legislation in all states theoretically making non-structural floodplain management a real possibility. However, for various reasons including concern over their legal position if they refused development permission, doubt about the strength of the relevant legislation, and other local pressures, most councils have only recently begun to enforce flood related regulations.

Today, most states have strong floodplain management policies which emphasise a non-structural or combined approach. The Fraser federal government had a similar policy, but at the time of writing this was under review by the Hawke Labor government. The state policies are generally buttressed by enabling legislation, and funds are available for their implementation. The major factors underlying this shift in attitude include dissatisfaction with the performance of structural works, and a growing community (and political) concern with environmental and public welfare issues. The latter factor is reflected in legislation in a variety of areas such as environmental protection, occupational health and safety, and all types of transportation.

With these major changes it appears that non-structural flood damage reduction measures, in particular land use management, should enjoy success in future. Yet many difficulties remain. Despite recent
improvements the fragmentation of authority is essentially unchanged, there is a chronic shortage of funds, the engineering perspective of many of the responsible organisations is changing slowly, and local councils find themselves under increasing pressure to allow development of flood-prone land. In addition, at the federal level at least, party politics appear to have been more important than policy substance. This has not inhibited policy initiatives as such, but has severely curtailed their full development and implementation.

3.3 FLOOD DAMAGE REDUCTION MEASURES

3.3.1 Introduction

The second part of the Chapter takes the examination of flood adjustment implementation further by shifting the focus of inquiry to the local level where much of the ultimate responsibility for implementing state policy lies. It is hoped to discover why, despite the major changes in attitudes, policy and legislation, implementation of non-structural measures still encounters serious difficulties.

Another important aim of the section is to demonstrate that acquisition may be a viable part of a flood damage reduction program. It should be understood that no single measure used alone, including acquisition, is likely to solve a flood problem. The early emphasis on structural works, almost to the exclusion of all else, has given way to a realisation that an integrated approach, sensitive to local physical and socio-economic conditions, offers the most hopeful prospect for flood damage reduction.

3.3.2 Classification of Measures

Flood damage reduction methods are conventionally examined within a classification based on whether the measure seeks to influence flood waters or people: the two classes being termed structural and non-structural respectively (Table 3.2). The "do nothing" response is treated as a separate category. Like other classifications of flood mitigation
Table 3.2: Types of flood adjustments using three classifications: structural - non-structural, mode of implementation, and the theoretical effect on losses.

<table>
<thead>
<tr>
<th>AUTHORITARIAN</th>
<th>INSTITUTIONAL</th>
<th>INDIVIDUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENGINEERING</strong></td>
<td><strong>INSTITUTIONAL</strong></td>
<td><strong>INDIVIDUAL</strong></td>
</tr>
<tr>
<td>- dams</td>
<td>- diversions and channel improvements</td>
<td>- major levees constructed by NSW &quot;drainage unions&quot; and other groups</td>
</tr>
<tr>
<td>- levees</td>
<td>- weather modification</td>
<td>PREVENT LOSSES</td>
</tr>
<tr>
<td>- catchment treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **NON-STRUCTURAL** | | |
| - acquisition | - house raising | MODIFY LOSSES |
| - non-regulatory measures: fiscal and financial incentives, infrastructure provision | - small levees | |
| | - other flood proofing | |
| | - flood fighting | |
| | - local warning systems | |
| | - response to warning | |
| | | |
| | - salvage | |
| | - information and education | |
| | - forecasts, warning systems, emergency plans | |
| | - salvage | |
| | - insurance | REDISTRIBUTE LOSS |
| | - relief | |
| | | |
| **DO NOTHING** | | ACCEPT LOSS |
options the structural/non-structural division is a useful heuristic device which emphasises some broad differences between the two categories. These are set out in Table 3.3 as class criteria. In the present context the most interesting of these criteria are the greater potential of non-structural measures to reduce the disaster potential, provide investment flexibility, and their reliance on the active cooperation of the potential beneficiaries. Other common classifications use some variation of the measures effect on flood losses as their classifactory standard. A typical taxonomy puts measures into one of three classes: those that redistribute flood losses (insurance and relief); those that modify the susceptibility to loss (such as warnings and land use planning); and those that attempt to prevent losses (generally engineered works). More sophisticated versions may employ damages from events of different magnitudes, average annual damages for different design floods, residual damages, or the disaster potential (which is the damage from the estimated maximum probable flood, or MPF). Flack (1976) and White (1975) have produced classifications combining disaster potential and average annual benefits (Figure 3.5).

In all these classifications, however, flood strategies are categorised in complete isolation from practical application. The classifications fail to take account of the broad similarities between many of the measures in the different classes, they do not provide information on adjustment implementation, and fail to direct attention towards the factors underlying development of the hazard.

An important similarity is the dependance of structural and most non-structural adjustments on a strong government agency (or equivalent level of organisation) for their implementation. Structural or engineering measures require technical expertise, the ability to procure large amounts of land and capital, the overseeing of construction, and an indefinite maintenance commitment. Most land-use measures also require technical expertise, and although they do not need substantial capital investment, overseeing and enforcement capacities are required in the case of regulatory measures; while non-regulatory approaches rely on the bureaucracy to administer fiscal and other incentives, or to distribute warnings. These non-structural measures may be termed institutional flood adjustments. Together with the engineering approaches they form a category of authoritarian adjustments.
<table>
<thead>
<tr>
<th>Main criterion</th>
<th>STRUCTURAL measures</th>
<th>NON-STRUCTURAL measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures that attempt to control water</td>
<td>(i) Generally includes all or higher levels of government</td>
<td>(i) Generally of a local or individual nature</td>
</tr>
<tr>
<td>Other criteria and characteristics (partly from Johnson, 1978)</td>
<td>(ii) Apply equally to existing and future development</td>
<td>(ii) Usually for either future or existing development</td>
</tr>
<tr>
<td>(iii) Large investment cost</td>
<td>(iii) Small investment cost and greater investment flexibility</td>
<td></td>
</tr>
<tr>
<td>(iv) Same degree of flood protection for all structures/lots</td>
<td>(iv) Degree of protection varies from structure to structure</td>
<td></td>
</tr>
<tr>
<td>(v) Used alone generally reduce average annual damages over planning period - if built to a high enough standard - but increase the disaster potential</td>
<td>(v) Apart from methods which simply redistribute losses (relief, rehabilitation and insurance) there is a similar effect on average annual damages, but the disaster potential may be held the same or decreased.</td>
<td></td>
</tr>
</tbody>
</table>
In contrast other damage reduction measures rely on the initiative of individual floodplain dwellers, and may be quite successful in the absence of government action. These individual adjustments include house raising, the construction of small levees, and response to flood warnings.

Certain physical characteristics of flooding may also affect the choice of coping strategies. For example, areas subject to relatively shallow inundation with a small "flood range" (that is the height difference between the commencement of flood damage and regulatory flood), are more suited to levees and house raising. Flood duration will determine whether salvage can play a role, and length of warning influences flood fighting plans. In many inland areas, for instance, the warning time permits levee construction.

Discussions of flood damage reduction methods in more detail than is necessary or possible here, are found in publications referenced in the relevant sections. General discussions of the options are contained in Owen (1981), Smith & Tobin (1979), UNDRO (1977(a)), White (1945, 1975) and Williamson (1975). Penning-Rosell and Chatterton (1977) use a synthetic damages approach to provide a rigorous economic examination of flood adjustments for the UK. For Australia a similar approach is contained in a flood damage assessment manual by Sinclair, Knight & Partners et al (1982), while Higgins and Robinson (1981) employ a more conventional historical damages approach. Further references and a review of the economic procedures applied to flood damage reduction studies are contained in Chapter 5.

3.3.3 Authoritarian Action for Flood Damage Reduction

3.3.3.1 General

Authoritarian adjustments generally impact the same two classes of people: land and development interests, and owner occupiers. It is these people, representing the interests of capital, who tend to support structural measures and oppose land-use regulations. Engineering measures are usually paid for by the Australian taxpayer and constitute a substantial subsidy to these interests, while land use control restricts
development activity and is seen as detrimental to land values (though there is little evidence for this, Section 3.3.3.4). As business interests frequently form powerful local lobby groups directly represented on council, and affected residents often comprise identifiable sectors of the local electorate, it is not surprising that regulations have often not found favour.

This is not to say that the emphasis on structural solutions is necessarily uneconomic or unwise per se. However, where public safety is important various institutional adjustments, including land use control and forecasting, are essential. It is the failure to appreciate the limits of engineering works and the necessity for complementary action that underlies past experience. In terms of the local economy measures may be quite logical, though they may be highly uneconomic from a national perspective (Chapter 5).

Increasingly, governments are resisting pressures for works. They are aided in this by a shortage of funds for major construction, and by strong pressure groups protesting against flood control structures on environmental grounds. Furthermore, as the power of planning and environmental authorities grows, state governments are less reticent to intervene directly in local planning.

Nevertheless it is often the failure of both engineering and institutional adjustments that leads to the need for acquisition. Land use controls may be unable to prevent inappropriate development, and floodproofing and structural protection may be uneconomic or otherwise not feasible.

3.3.3.2 Engineering Adjustments in the Case Study Areas

Levees are the only structural measure that has proven feasible in the case study sites. Local flood factors and topography dictate the type and success of the measure at each site.

The main city areas of all three sites are protected by levees, though to very different standards, such that only Echuca and Wagga would normally be considered leveed. Levees are not feasible for the acquisition
sites in Lismore, but have been used as an emergency measure in North Wagga, and Echuca West property owners use small embankments extensively.

The three sites present an opportunity for examining levees which perform different functions:

(i) Wagga, where an embankment protects the main city area against floods of about 1:100,

(ii) Lismore, where parts of the city, including the business district, are protected against very frequent floods of about 1:4, and South Lismore is protected against floods of about 1:8, and

(iii) Echuca West, where small privately constructed levees protect individual properties (discussed later under "Individual Measures").

Levees consist of a wall or embankment typically constructed of concrete or earth though occasionally of sandbags, designed to prevent water from entering the protected area. It is generally necessary to have some arrangement for removing water from within the leveed area, as the area's internal drainage is usually inoperable during a flood, and this accumulation is increased by levee seepage and local runoff. Leveeing reduces the natural valley storage and displaces substantial amounts of flood water. Thus flood peaks locally and downstream may be increased, exacerbating other flood problems.

Local land and business interests frequently regard levees as the logical approach to a flood problem, as land so protected to a fairly high level, generally the 1:100 flood, is often seen as flood free. Councils may be put under considerable pressure by these groups to allow virtually unrestricted development. Of course councils themselves are frequently keen to maximise development within their jurisdictions even if the development occurs in flood-prone locations. Unfortunately levees do not make an area flood free. Even when constructed to withstand the maximum probable flood, a risk still exists that the embankment could be breached, due to poor maintenance or some unforeseen circumstance.

Results of levee overtopping or collapse may be catastrophic if the area is heavily developed. These dangers are widely known and
documented (Bolt et al. 1975), the worst aspect being that when the design flood is exceeded and they are overtopped, generally much greater damage results than would be the case if the levees did not exist. This is basically because a properly functioning levee provides full flood protection (from external flood water) up to its design level and then no protection at all, and this characteristic in turn tends to encourage the development of a false sense of security. The flood preparedness of the population will decline over time leading to a gradual increase in potential damage from floods greater than the levee design level (Table 3.4). As explained in Section 3.3.4.7 preparedness is a function of flood experience. Right up to the last minute people just do not believe the embankment will fail and hence emergency preparations and other necessary flood damage reduction measures are likely to be neglected (Bolt et al., 1975, Kuiper, 1965)

Wagga's city levee illustrates the point. The protected area, containing the business district and some 2000 dwellings, is not subject to any flood related regulations or emergency plans. The ring levee proposed for North Wagga is particularly dangerous, as there is no escape to higher ground. Although Echuca City is protected by a levee the embankment is low and floor level regulations are being enforced for development behind it. On the other hand, the levees in Lismore and Echuca West do not themselves increase risk to life as local flood preparedness remains high because the low embankments exclude only the more frequent events.

The most appropriate use of levees from a public safety perspective is in areas of shallow sheet flooding where the potential flood depth and water velocity are low and where a levee collapse or surcharge would not endanger life. Nevertheless the provision of rescue and other emergency services to people trapped by levee overtopping is hazardous especially in the case of a ring levee where the only access to the area may be across a floodway.

Deaths due directly to flooding in Australia have been rare. When they have occurred they have generally been the result of flash flooding or an inexperienced population. Both these conditions may be met by a major levee system collapse or surcharge. It is essential that flood forecasting and warning services and evacuation plans receive continued
Table 3.4: The dynamic effect of a 1:50 levee on flood preparedness and damages from the 1:100 flood: a hypothetical example. Population preparedness decreases as flood-free time increases (Intangible damages from Handmer 1982; overall method and data set out in Sinclair Knight & Partners et al, 1982)

<table>
<thead>
<tr>
<th>FLOOD DAMAGES</th>
<th>Just after levee construction</th>
<th>10 years after construction</th>
<th>20 years after construction</th>
<th>50 years after construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P = 0.65</td>
<td>P = 0.4</td>
<td>P = 0.25</td>
<td>P = 0.115</td>
</tr>
<tr>
<td>Tangible damages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>$2,200,000</td>
<td>$2,640,000</td>
<td>$2,860,000</td>
<td>$3,520,000</td>
</tr>
<tr>
<td>Indirect (15% of direct)</td>
<td>330,000</td>
<td>396,000</td>
<td>429,000</td>
<td>528,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$2,530,000</td>
<td>$3,036,000</td>
<td>$3,289,000</td>
<td>$4,048,000</td>
</tr>
<tr>
<td>Intangible damages (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disruption</td>
<td>1047.5</td>
<td>1257</td>
<td>1383</td>
<td>1496</td>
</tr>
<tr>
<td>Self-reporting of ill-health</td>
<td>298</td>
<td>467</td>
<td>681</td>
<td>1276</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>52.5</td>
<td>281</td>
<td>704</td>
<td>1407</td>
</tr>
<tr>
<td>Cost of hospital bed provision (0 $200/day)</td>
<td>($10,500)</td>
<td>($56,200)</td>
<td>($140,800)</td>
<td>($281,400)</td>
</tr>
<tr>
<td>TOTAL DAYS LOST</td>
<td>1398</td>
<td>2005</td>
<td>2768</td>
<td>4179</td>
</tr>
</tbody>
</table>

1 Unofficial health department estimate of actual cost of provision.

p = preparedness index
emphasis with levee construction. This may require an innovative and sustained public education program of the type outlined in McDonald et al (1982).

Lismore

Protection for Lismore by structural measures against other than small frequent floods is not feasible. There are no suitable dam sites and levees designed to exclude the maximum probable flood (MPF) would have to be over 5m high. As time passed levees would act to increase the disaster potential through the effects of failure on an increasingly unprepared population (Table 3.4), downstream flood problems would be aggravated, and their construction would cost some $34 million with a poor benefit-cost ratio of .25 (NSW-PWD & SKP, 1980:24). Most of the interviewees recognised the infeasibility of structural measures and three quarters felt that floods could not be stopped or prevented. Among those who felt that floods could be stopped diversions were the most popular solution (50%), followed by dredging (18%), levees (11%), and dams (11%).

Two small levees and a pumping station were constructed in the early 1960s, following the report of the 1958 Flood Mitigation Committee (RRVFMC). South Lismore is protected from floods of less than 12m (1:8) while the Brown's Creek flood gates and pumping station prevent flooding in Lismore Basin until the river reaches 11m (1:4). If flood levels exceed these heights gradual inundation of the areas takes place. North Lismore remains completely unprotected due to the difficulty and expense of leveeing such a low site.

Smaller floods are largely eliminated from the two protected areas. Table 3.5 shows that for very small events the levees reduce the total direct damages by over 80%, but for an event of 1:8 frequency (>12m) they have no effect. Thus their impact on average annual damages is marginal. Furthermore it appears that the levees, in particular those around South Lismore, have encouraged substantial industrial and commercial development (PWD & SKP, 1980). In the absence of strict land use controls the levees have served to increase the amount of property exposed to flooding and the disaster potential.

<table>
<thead>
<tr>
<th>River Stage</th>
<th>Stage recurrence interval (years)</th>
<th>Residential Actual</th>
<th>Residential Without</th>
<th>Commercial Actual</th>
<th>Commercial Without</th>
<th>Industrial Actual</th>
<th>Industrial Without</th>
<th>TOTAL Actual</th>
<th>TOTAL Without</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.5</td>
<td>6,800</td>
<td>17,800</td>
<td>45,600</td>
<td>246,000</td>
<td>800</td>
<td>1,700</td>
<td>53,200</td>
<td>265,500</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>74,500</td>
<td>80,100</td>
<td>600,000</td>
<td>607,800</td>
<td>13,800</td>
<td>24,700</td>
<td>688,300</td>
<td>712,600</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>328,600</td>
<td></td>
<td>1,944,300</td>
<td></td>
<td>77,800</td>
<td></td>
<td>2,350,100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO</td>
<td>EFFECT</td>
<td>ON</td>
<td>DAMAGES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>100</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.5</td>
<td>MPF</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Clearly, the fact that protection against such frequent events is provided for South Lismore, an area that is isolated in major flooding without, until recently, any complementary or effective land use regulations, makes a mockery of the public safety concerns embodied in the NSW 1:20 floodway standard.

**Relationship to Acquisition**

As flood control structures are generally used to allow floodplain development, they may be seen as the antithesis of acquisition. Once investment in flood works is made, the prospect of acquisition or other non-structural measures being accepted as viable alternatives diminishes (French, 1980).

Nevertheless in settlements where levees are the main flood adjustment acquisition has a role for areas which are outside the scope of the protective works, or for areas within the works where for one reason or another conditions are particularly hazardous.

For example, in the levee scheme proposed for North Wagga (SKP & MSJKY, 1979) one dwelling which will remain unprotected and in a floodway is scheduled for acquisition. Although Lismore Basin is protected by levees, flood gates and a large capacity pumping station, local runoff frequently floods houses on Little Keen Street, the Council caravan park and some adjacent industrial development. Little Keen Street is one of Council's priority areas for its acquisition scheme.

3.3.3.3 **Institutional Measures: Land-Use Management**

Land-use management is a broad term encompassing, in the context of the present study, all measures employed by government to control or influence floodplain use. There are three major categories of management tools: indirect government action principally through financial incentives, and direct intervention by regulation and acquisition (Table 3.6).
Table 3.6: Land use management techniques. Explanation of the non-regulatory measures are found in Table 3.11.

REGULATORY MEASURES

(i) Reservation of land for public purposes.

(ii) Subdivision regulations (for example)
- development density
  - open space provision

(iii) Building regulations:
- elevation requirements
  - construction requirements

(iv) Building and location regulations made under Health Acts.

(v) Zoning regulation:
- activity location

ACQUISITION

(i) - May be voluntary or compulsory

NON-REGULATORY MEASURES

(i) Provision of infrastructure and housing; including the construction of secondary centres and new towns.

(ii) Fiscal and financial incentives:
- taxation
- direct development subsidies
- mortgage policies
- insurance policies
- government guarantee of development bonds
- non-profit, limited dividend companies.
Purpose

The broad purpose of land use management is to make human activities on floodplains more compatible with natural processes. "Undeveloped floodplains suffer little economic damage from floods, and wise government policy will do nothing to encourage damagable property to be located on them" (US-NSF, 1980:69).

The first emphasis of flood-prone land management, and indeed of most non-structural measures, tends to be public health and safety including the minimising of risk to life. Other functions include:

- promoting the wisest use of land throughout a community,
- attempting to minimise public expenditures on disaster relief and rehabilitation by acting to prevent or reduce flood damages.
- in the case of regulations preventing "nuisances" (in the legal sense) by controlling floodway and upstream development.
- ensuring that development is environmentally compatible,
- maintaining the broadest range of future options by minimising irreversible commitments of land.

Land-use management may be corrective or preventive. Corrective measures attempt to actually reduce the existing flood damage potential, typically by prohibiting the rebuilding, repairing or renovation of existing structures (also termed "substantial improvements"), or by acquiring the property. Much more common are measures designed to prevent potential and average annual flood damages from rising: these may consist of direct and indirect government action including the purchase of undeveloped land.

Unfortunately, by themselves land-use measures of either type generally fail to achieve their objectives unless they are exceptionally strict. The performance of corrective regulations in particular has been disappointing (Sheaffer and Roland, 1981), even in North Wagga where the tightest restrictions in NSW are enforced (Section 3.3.3.4). Furthermore, when regulations reach these levels of rigidity it often becomes legally necessary, and occasionally morally desirable, to acquire the regulated property.
Mode of Administration

Management may be in the hands of local government, a decentralized arrangement, or may be exercised through a central, ie. state or federal, authority. Occasionally special purpose bodies constituting an intermediate level of government may be created to oversee floodplain use.

To implement state or national policy a decentralized administration relies on cooperation between local and central governments and inherently encourages fragmentation of authority. Direct state regulation of hazardous areas, on the other hand, appears to be quite effective. A major study of 1203 flood prone US communities by French (1980:157), "identified only two contextual factors which were negatively related (prevented) flood plain invasion; the supply of development sites outside the hazard area and direct state regulation of hazard areas". Nevertheless, centralized administration is not without its difficulties, and may not even be capable of implementing its own policies (Pressman & Wildavsky, 1973). For example, it may be unaware of, and ignore local conditions (UNDRR, 1977), and thus generate considerable political opposition to the program.

In Australia, as with many other countries, land use management is primarily the responsibility of local government (Section 3.2). State governments exercise some legislative control through their subdivision and Planning Scheme approval powers and through the invoking of special provisions contained in the various planning and water acts. Non legislative control is exercised by the states through various development subsidies and other financial measures. As Echuca West is a proclaimed flood area under the Victorian Drainage of Land Act (1975), development there is under direct state control. To date NSW authorities have been pursuing a cooperative approach to policy implementation, as much because of insufficient staff to handle direct administration as through a desire to avoid confrontation. Flood prone land in NSW may be put under the control of the Public Works Department through Section 38 of the Coastal Protection Act (1979), and Section 101 of the Environmental Planning and Assessment Act (1979).

Direct federal land use regulation of state territory does not
occur in Australia. Federal authorities administer their own territories, including Canberra, and are generally exempt from local land use regulations and state policy. Despite Commonwealth support for NSW's flood prone land policy, this exemption of federal facilities from state control has created problems in Lismore (see Section 3.3.3.5).

Special purpose bodies for floodplain management are rare in Australia, but exist in the form of the Dandenong and Hunter-River Valley Authorities. Other flood mitigation authorities have construction rather than planning functions (Section 3.2).

3.3.3.4 Regulatory Land Use Management

Types of Regulations

Regulations take a number of distinct forms. They may control activity location, as zoning ordinances; regulate aspects of construction, as building regulations; and specify through subdivision regulations, development density, public utilities provision, and the spatial relationship of different activities, for example by indicating minimum individual residential lot size, or the proportion of a subdivision to be open space. Land may also be reserved by state authorities for public purposes including open space, public access, parkland and cemeteries. Governments must make provision to acquire such land as a form of compensation to the owner for the development restrictions.

This classification is illustrative only, and categories are not mutually exclusive; zoning ordinances may specify type of construction, and building regulations may effectively prohibit dwellings in certain areas, and so on. Table 3.6 sets out commonly employed measures. Land use measures are usually tied to some development master plan, a Planning Scheme or in NSW an Environmental Planning Instrument, which guides development in a general way.

In the context of the present study the degree of flood risk will determine which measures are most appropriate. Kates and White (1961) set
out the principles of flood risk evaluation as a basis for regulation. They suggest three risk zones, prohibitive, restrictive and warning, covering the area from the normal river channel to the maximum probable flood (MPF) (discussed in the Australian context by Williamson, 1975). In practice only two zones are generally employed: the floodway, that area delineated by the 1:20 flood in NSW, and defined by afflux in Victoria; and a restrictive zone up to the 1:100 limit. The calculation and mapping procedures for such hypothetical floods contain large inherent errors (Section 4.4.2). To avoid these problems an historic flood may be used as the regulatory basis. But, both the historic and hypothetical methods suffer from two major weaknesses: the delineations are based on existing hydrologic conditions, and they tend to ignore the effects of events larger than the regulatory flood (Chapter 4).

The three basic regulatory means described above exist in all the case study sites as part of the local Planning Schemes. Apart from Wagga, however, their employment to control the development of flood prone land has been very limited. At present flood prone land is neither designated on Town Plans nor zoned as such in any of the study sites, though North Wagga is zoned "non-urban" on the Wagga Planning Scheme. Building regulations specifying minimum floor levels have existed for Echuca and Lismore since the 1950s but until recently were not very effective. Some attempts have been made to restrict new subdivisions in the Lismore floodplain with varying degrees of success.

**Effectiveness of Floodplain Regulations**

A clear indication of regulation performance would be the extent to which the development patterns under regulations varied from those under free market conditions. Ideally properly controlled experiments should be undertaken where matched parcels of land are subject to different degrees of regulation. As this is not possible it is necessary to employ whatever data are available. Essentially two types of study are used to assess effectiveness: one type examines the impact of regulations on property values; and the other the ability of regulations to reduce floodplain encroachment, using changes in either amount of development or flood damage potential as a measure. Both the case study and other research is examined. Much of the study site material is less quantified than the
other research reviewed, but is believed to be no less valid. In fact, the apparent precision often disguises severe data deficiencies.

Land use regulations often provoke a strong negative reaction from local property owners and business interests who feel that the restrictions will reduce property values. Pressure is typically put on Councils to revoke or water-down the regulations, or in some circumstances acquire the property as compensation for reducing its profitability.

Certainly the severely flood prone areas in the case study sites constitute a distinct housing submarket (Section 6.3), and other flood-prone property sells at a discount. But is this the result of regulations?

Almost definitely not; until recently there were no strictly enforced flood related zoning or building regulations in any of the sites except Wagga. Property transaction records, which show the amount of money involved each time property changes hands (the "market value"), were used to examine trends in the appreciation rates of flood prone and equivalent flood free property values since 1945. Results show that after the 1950s flood prone land values have appreciated at a substantially lower rate than flood free land (Figure 3.1). In other words these severely flooded areas did not take part in the property booms of the late 1960s/1970s. Two characteristics of the property markets common in all three acquisition sites are the low rate of property turnover and the high proportion of transactions among relatives which did not involve cash. These cashless transfers are excluded from the analysis. Both characteristics are typical of the population type described in Chapter 6 (Bourne, 1981), and serve to reinforce the existence of a housing submarket. (Transaction records for Lismore were not analysed, but other information, discussed in Section 6.2.2, shows a similar pattern Lismore).

Property values are closely associated with the flood problem, and the run-down nature and lack of public investment in the area are not a result of regulations. Any effects regulations may have are masked by the severity of flooding. Even in North Wagga, with its highly restrictive regulations, values are depressed 30% while those of North Lismore, where there is only a floor level regulation, are depressed by more than 50%. These results are in broad agreement with those of a number of North
Figure 3.1: Property transactions. Data for Echuca West and Echuca East, a flood-free area of largely similar housing. However, some expensive development has occurred in the East recently. Data from Echuca City Council.
American studies employing rather more sophisticated methods applied to property tax assessment data (Damianos and Shabman, 1976; Moore and Cost, 1973; Muckleston et al, 1982; Turner, 1981). Turner's (1981) summary is representative of research conclusions and caveats: "Interpretation of the (assessor's valuation) data was complicated by assessment procedures such as development discounts, allowances for the availability of water and sewer services, and reductions due to building site limitations. Statistical testing indicates little significant difference between the appreciation rates of the two parcel categories (flood free and flood prone) during the years of observation (7 years). The results suggest that in the North Albany area the demand for desirable residential properties may outweigh the impact of floodplain regulations".

Sheaffer and Roland reached a similar conclusion in their study (1981:8); "Market values do not appear to be depressed by the enforcement of existing floodplain regulations". They observed that if the regulations prevent the conversion of land to higher density uses then anticipated windfall profits associated with such changes may not be realized. "However, it is important to note that windfall profits associated with land speculation frequently are not realized independent of any regulations" (p.9).

**Regulations and Floodplain Encroachment**

As long ago as 1958 Murphy (p.161) reported that "results of the extensive field investigations" into all forms of floodplain regulations "indicate conclusively that as now applied they do not halt the continued increase in flood losses". Recent assessments of regulation effectiveness based on a further 20 years of experience reach somewhat similar conclusions.

Cheatham (1977) analysed construction trends in two Mississippi communities and found that while ordinances required under the US flood insurance scheme (US-FIA) had not halted floodplain encroachment, they had substantially reduced the amount of residential construction (Table 3.7). Non-residential construction was largely unaffected by the regulations. "Evidence suggests that while FIA required land use control measures may not have reduced total exposure to the flood hazard, they are capable of eventually achieving this objective if communities are required to comply
with"... strict regulations (p.111). "There is no indication that a wide-spread increase in the exposure to flood hazard is in any way attributable to laxity of FIA enforcement of land use requirement criteria" (p.110).

The broader consensus, however, is not so optimistic. It appears that only the most stringent and rigorously enforced regulations will hold damages at their present level (French, 1980; Sheaffer & Roland, 1981). Sheaffer and Roland used a scenario analysis to examine the effects of different degrees of regulation in 21 US communities. They found that stringent regulations would prohibit new development or substantial improvements to existing properties and would gradually remove structures from very hazardous locations. While in terms of inhibiting floodplain encroachment, a moderate degree of regulation was much more effective than no regulations at all (Table 3.8). Another study, by French (1980), employed questionnaires administered to the local officials of 1203 flood prone US settlements. "In summary, the research indicates that land use management as currently practised has little effect on floodplain invasion" (p.164). However, French found that the regulations required under the regular phase of the federal flood insurance scheme were effective in protecting future floodplain development from flood damage (floor elevation requirements) but did not prevent new development except in floodways. He also established that direct state regulation prevented floodplain encroachment.

Other research into the general effectiveness of land-use zoning reaches similar conclusions. Reporting on his work in Toronto, Ontario, Moore (1982) comments that "(I)n the long run, zoning and the political control of zoning responded to, rather than modified, the dominant economic and social forces which produced change in the neighbourhood". Similar findings are described by Graham (1981) in a review of land-use planning in Hobart, Tasmania.

Regulations and Floodplain Encroachment: the study sites

Again, study site experience collaborates the results of American research: that floodplain land use regulations administered by local councils are often ineffective, because of Council's inability to resist development pressure, lack of technical experience and so on. However,
TABLE 3.7: The effect of regulations on residential floodplain development. (Figures in brackets are the percentage change in total residential and commercial construction) (Cheatham, 1977:111).

<table>
<thead>
<tr>
<th></th>
<th>Percentage change in the value of average monthly new residential construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regulated floodplain</td>
</tr>
<tr>
<td>Hattiesburg</td>
<td>-21.8% (-3.2)</td>
</tr>
<tr>
<td>Columbus</td>
<td>-62.2% (-58.1)</td>
</tr>
</tbody>
</table>

Table 3.8: Effect of land use regulations on tangible flood damages for the 1:100 flood plain (Data source: Sheaffer & Roland 1981).

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>No regulations</td>
<td>29%</td>
<td>71%</td>
</tr>
<tr>
<td>Moderate(^1) regulations</td>
<td>4%</td>
<td>10%</td>
</tr>
<tr>
<td>Stringent(^2) regulations</td>
<td>0</td>
<td>-1%</td>
</tr>
</tbody>
</table>

1 Moderate regulations are similar to the current U.S. flood insurance requirements. Use of the floodway is restricted and development elsewhere in the floodplain is permitted subject to flood proofing requirements.

2 Stringent regulations forbid new development and substantial improvements and gradually remove unwarranted structures from the floodway.
direct state level regulation appears to be-effective, and stringent local regulations incorporated into a Planning Scheme thereby binding Council, have succeeded in halting floodplain encroachment and causing a gradual decline in average and potential damages.

All three sites have had regulations for over 25 years. Echuca and Lismore enacted floor level ordinances in the 1950s, and Wagga Council zoned North Wagga non-urban in 1956. Since 1975 new development in Echuca West has been prohibited.

**Echuca**

Flood prone areas in and around Echuca have not been zoned as such, but zoning proposals are contained in the new Planning Scheme, floor level regulations are enforced, and development in Echuca West is presently under direct state control following Proclamation of the area as flood prone. The new Planning Scheme prepared in August 1980 and presently (October 1983) awaiting approval includes a number of special flood zones:

- a floodway zone, ie. - land below the 1975 flood (1:36); and
- three flood fringe zones
  (a) land above the 1975 level and below the 1% line,
  (b) land below the 1975 level but which is or will be protected by levees,
  (c) land above the 1975 level and below the 1% line and which is either public open space or reserved for residential development.

Restrictions specifying minimum floor levels, as required under Victorian law appear to have done little to hinder development. Although enforced, they were based on a relatively small 1:35 (1956) flood, and to satisfy them in most of Echuca West required less than a metre of fill. Regulations based on a new criterion, the hypothetical 1% (1:100) flood which is about 0.7m higher than the 1956 level, may be more effective. The new measure appears to have been strictly enforced and also applies to future development protected by levees (Section 7.4.3 deals with the political pressures leading to the adoption of this standard).

The most effective restrictions have certainly been those
associated with the Proclamation of Echuca West as flood prone under the Drainage of Land Act, 1975. Proclamation places the area's development under the direct control of the Victorian State Rivers and Water Supply Commission, and prohibits further development or substantial improvements. The placement of fill to raise yards and to construct levees requires a permit, but this was ignored during the 1981 flood. Acquisition of proclaimed areas as compensation for the land use restrictions is not a legislative requirement, but is proceeding in Echuca West.

Wagga

Under the City of Wagga Wagga Planning Scheme gazetted in 1965, but adopted by Council and in effect from 1956, North Wagga was zoned "Non-urban 1(c)". The only uses permitted in this zone are agriculture, forestry, extractive industries, roads, drainage, non-residential clubs, and road transport terminals. There was virtually no existing user rights provision for the residents of North Wagga. Instead, by way of compensation, the Council would acquire the regulated land if requested and if a price could be agreed on. Though the initial zoning provisions have been modified by three Interim Development Orders (I.D.O.s), the situation is still very restrictive.

That the North Wagga restrictions have remained in force for so long is as much a tribute to the State instrumentalities as to the local government. From the early 1960s Council tried to resolve the issue of North Wagga, seen as a planning problem, through: protection by a levee, or reservoir air space, wholesale relocation or by rezoning the area urban and removing the development restrictions (Section 7.4.4). However, as the area is zoned non-urban in the city's Planning Scheme any variations must have state approval. Council is now seeking state government support to levee the village.

Despite these restrictions, and the Council's parallel acquisition scheme, North Wagga remains a viable, cohesive community. The regulations have prevented the flood damage potential and average annual damages from worsening, but even in conjunction with voluntary acquisition have only reduced potential flood damages by some 20% (measured by the number of dwellings removed) - a reduction of less than 1% per annum (Table 3.9). Worse, the disaster potential for all Wagga is rising steadily as

<table>
<thead>
<tr>
<th>Year of Survey</th>
<th>Dwellings</th>
<th>Shops</th>
<th>Hotel/motel</th>
<th>Halls</th>
<th>Primary School</th>
<th>Churches</th>
<th>Service Stations</th>
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<tbody>
<tr>
<td>Dwellings</td>
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<td>236</td>
<td>212</td>
<td>208</td>
<td>202</td>
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<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel/motel</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halls</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary School</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Churches</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Stations</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
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</tr>
</tbody>
</table>
development behind the main city levee intensifies.

**Lismore**

There are no floodplain regulations in Lismore apart from a minimum floor level requirement based on the 1974 flood. Recently the Council produced a *Flood Plain Development Management Strategy* (1981), which contains guidelines rather than strict criteria, for future floodplain development. At the time of writing (July 1983) the Strategy's scope has been extended to include limitations on further commercial expansion in the worst flood prone areas.

The 1958 IDC report on flooding in the Richmond River Valley put strong emphasis on regulation to prevent further floodplain encroachment (Table 2.4). But, Lismore Council was much keener to follow up the IDC levee recommendations and passed only one regulation; a requirement that "living" floor levels be 46cm or more above the 1954 flood level (the 1954 flood was the same height as the 1974 event). Until the 1974 flood the regulation does not appear to have been strictly adhered to and was even abandoned briefly in 1970. A local engineer could not recall a single pre-1974 case of regulation enforcement, and felt that the situation up to 1980 had been effectively one of unrestricted development. Lismore real estate agents had a different view and described the floor level ordinance as "a good law which acted as a deterrent to floodplain residential construction" (Deegan, 1981-I) (see Section 3.3.4.2).

There is no shortage of examples to illustrate Council's past lack of resolve in controlling floodplain development: only two weeks after the 1974 flood a residential subdivision was approved for Scotts Place, South Lismore (Barlow, 1980-I). But, the most instructive perspective is probably gained by comparing the extent of floodplain development in the mid 1950s when the Flood Mitigation Committee was preparing its report, with the situation in 1981 (Figure 3.2). Apart from infilling within the 1950s development limits, a substantial amount of new encroachment has occurred (surprisingly, most of it since the 1974 flood): residential development to the north and north west; new commercial development, a combined Jack the Slasher and Norman Ross Store acts to block much of the South Lismore floodway; new industrial development especially to the south and around the north end of the airport. The commercial and industrial
Figure 3.2: Floodplain development in Lismore.
development has involved considerable filling, and it is this development that most threatens the South Lismore floodway. During the 1974 flood the floodway carried one-third of the total flow, and it is estimated that the proportion would increase in larger floods (Hogan/Parr, 1981-1).

Over the last two years Council appears to have toughened its stance on floodplain development. Apart from the floor level requirement and Flood Plain Development Management Strategy Council has also begun refusing or restricting new subdivision and building applications. The City's change in attitude is probably largely due to the threat of Section 38 of the Coastal Protection Act, 1979. Under this section the Public Works Department can obtain the power to control development in specified areas where development might adversely affect or be adversely affected by any watercourse or other body of water.

Regulation Implementation in Lismore: Some Comments

In the Lismore situation where floodplain development is not strictly controlled by the Planning Scheme or other zoning, floodplain encroachment depends on the local balance between development proponents and opponents in each individual case. The following points deal with pressures placed on council to, on the one hand prevent, and on the other permit development of flood-prone areas. Other issues of importance are the institutional, funding and legal arrangements covered in Sections 3.3.

(i) Pressures on Council to allow development:

- the powerful Chamber of Commerce which represents principally businesses in the established shopping centre and has the support of the local newspaper, the Northern Star.

- The Northern Star has carried a large number of articles and editorials since the late 1970s which, in essence, support floodplain encroachment. For example an editorial of the 16/2/82, entitled "The State's flood-prone land policy must be revised", commented that as the North Coast was the "fastest growing region in the State all land must be put to its best use". ("Best use", here refers to intensive urban use).

- A number of Councillors who see Council as fanatical about floods feel that "everyone here knows how to cope with flooding" and that while "Lismore has floods - out west they have droughts" (Interviews).

- The threat of legal action by developers whose applications are rejected.
- The virtually unrestricted floodplain development up to 1974 has created precedents making it difficult for Council to refuse development applications.

- Many new development applications bring different additional lobby groups into action. For instance the greyhound club's pavilion was destroyed in 1976 by a flood which occurred at night with virtually no warning. At the time the club recognised how dangerous the location was and moves were commenced to relocate the facilities in a flood free area. However, the club has changed its mind and is now seeking to rebuild on the old site.

- Finally, there are organisations beyond the control of local government, and which are exempt from local zoning requirements. Federal and state government instrumentalities fall into this category (see Section 3.3.3.5).

(ii) Pressures on Council to prevent development:

- On the other side Council is under pressure not to allow development from the state government departments implementing the NSW flood prone lands policy: the Departments of Public Works (PWD) and Environment and Planning (DEP) though there is even some dispute between and within (see (i) above) these bodies. The PWD has felt that the DEP might have permitted zoning changes, which would allow the development of hazardous areas, without referring the proposals to the PWD as required under the Coastal Protection Act.

- Although the DEP may refuse to allow new subdivisions it did not use this power in the Lismore floodplain until recently when it blocked a new residential subdivision in South Lismore.

- The real pressure on Council has come from the threat of Section 38 of the Coastal Protection Act 1979. If the Section was served on Council the PWD would assume planning control of the designated areas. Insufficient PWD funds and staff as well as the City's announcement of its Flood Plain Development Management Strategy have prevented use of the Section in Lismore. However, even Section 38 has potentially serious shortcomings. To ease administration various types of development may be made exempt from the control process. Those exemptions suggested for Lismore are listed in Table 3.10, they include a number that can only aid incremental floodplain encroachment.

(iii) Floor level regulations:

See Section 3.3.4.3.

Concluding Comment on Regulations

The convincing result that land use regulations as implemented are ineffective is important, as it constitutes strong evidence that local land use restrictions do not override fundamental market forces.
Table 3.10: Section 38 exemptions suggested for South Lismore. These exemptions are made under Section 43 (Coastal Protection Act) so that minor cases are not referred to the Department of Public Works (Data from NSW PWD District Office, Lismore)

(i) Exemptions with minimal effect on the damage potential:
- attachment of signs to building
- rebuilding or alterations without changing plan dimensions or orientation
- maintenance to public roads
- house raising on piers
- laying underground pipe

(ii) Exemptions with minor effects on the damage potential:
- changes of purpose in use of existing buildings
- residential garages and car ports
- domestic laundries and toilets for existing buildings
- addition of less than 20% of the dwelling area

(iii) Exemptions which may allow incremental development of the flood plain:
- building erection if the Minister has given prior unconditional approval to development application
- subdivision of land provided 60% of the land is already built on
- developments or fill by Council of less than 0.2m
Specifically they counter the argument that floodplain regulations result in economic hardship. This argument is often raised in an emotive manner, not only when restrictive regulations are imposed, but also when the risk is publicised.

3.3.3.5 Non-Regulatory Land-Use Control

"Governments can exercise certain control over floodplain development without resorting to ordinances. The direction of development can be encouraged away from floodplains by the wise location of public buildings and public utility provision" (US National Science Foundation, 1980:70), as well as through the use of a wide variety of financial incentives.

Long term planning strategies especially relevant in rapidly developing regions like the Hunter Valley and NSW north coast should ensure that growth is away from high hazard areas. The new planning strategies of Lismore and Singleton for example attempt to avoid floodplains and unstable slopes. Other levels of government can assist in the implementation of such plans by simply withdrawing their normal infrastructure subsidies from high risk areas, or more positively by assisting local councils with the purchase of flood free land necessary for public purposes. "New development in fringe areas depends, to a large extent, on the availability of public services: without it, development could not occur" (UNDRU, 1977(a):39). Frequently local governments provide serviced industrial sites in flood prone areas (South Lismore, Bomaderry, Murwillumbah), and thus ensure development. Government provision of public housing also provides a direct opportunity for disaster prevention. It should go without saying that the provision of public housing in known flood prone areas, where any alternative sites exist, or without adequate flood proofing and warning systems, should not be contemplated on public health and safety grounds.

In addition to the provision of infrastructure and housing there is a wide variety of fiscal incentives useful for flood damage reduction as outlined in Table 3.11. They include tax and subsidy policies on public and private development. Policies can be formulated that effectively discourage encroachment onto high risk areas while at the same time
Table 3.11: Government measures not requiring direct land use control (from UNDRO, 1977(a)).

(a) FISCAL AND FINANCIAL INCENTIVES

(i) Taxation: policies may be negative in the form of a tax on high risk land, or they may be positive in the form of subsidies "usually capital grants for specific types and location of buildings, or interest rate subsidies on land development and buildings. These subsidised loan funds can be used to build outside the disaster areas or to maintain a compatible use for disaster risk land, i.e. for agricultural purposes".

(ii) Non-profit limited dividend companies: mixed public-private companies subject to public control. They enable broad scale largely privately funded development projects to be initiated. As the company is under public control adherence to building and land use regulations can be maintained.

(iii) Government guarantee of development lands: the government can pledge its support to development bonds provided the developer agrees to certain public control, notably over-land use.

(iv) Insurance and mortgage policies: These policies can "encourage the public to adhere to zoning regulations and building codes specifically designed for disaster prevention and mitigation purposes. Conversely, where no controls exist such policies can ensure that loans and investments are safeguarded by requiring the public to develop land which is relatively risk free, and to apply building methods" which will reduce risk. At least as a first step, mortgage institutions should insist that building loans be granted on the condition that the land chosen for development is not obviously located in hazardous areas.

(b) PUBLIC LAND DEVELOPMENT

(i) Provision of infrastructure and housing: "the provision of infrastructure works may be construed as a means for directing growth away from hazardous lands... New Development in fringe areas depends, to a large extent, on the availability of public services: without it, development could not occur... Government intervention into the field of housing could also provide strategies for disaster prevention". Although housing for low income peoples is a particularly sensitive area for planners and policy-makers.

(ii) Secondary centres and new towns: long term planning strategies in rapidly developing regions such as the Hunter Valley and NSW north coast should ensure that growth is away from high risk areas. The strategy plans for Singleton and Lismore for example deliberately avoid flood plain land and unstable slopes.
encouraging development in less disaster prone locations (UNURU, 1977(a): 30). For example mortgage policies can be used to encourage the public to adhere to existing regulations such as minimum floor level elevations, and where controls are considered inadequate or non-existent can ensure that building occurs on land that is relatively risk free (UNURU, 1977:33). Many public facilities provided by local government are eligible for state government subsidies (Appendix G). If the subsidies are made conditional on facility location, as is occurring in NSW, a major incentive may be provided for local governments to plan flood free development.

**Government Policies**

The policy of the NSW government is quite clear as far as the location of its own works and those subsidised by government is concerned. Circular 15 (16/8/77) states:

"As an initial action in this regard, it is required that, wherever there is a flood-free alternative location for a Government or semi-Government structure or Government assisted or subsidised work, the flood-free site is to be used. It is particularly important that no Government, semi-Government or Government assisted work be located within the flood-way. This provision is to apply in all cases, including those where land has already been acquired but not built on, and also where redevelopment of a site is involved."

A potential weakness of this policy is that it does not apply to areas protected to at least the 1:100 level by structural works. In the case of levees especially, such protection ceases to function altogether when floods larger than the design event occur. Thus the state government may still be encouraging and subsidising development in flood-prone areas, while spending large amounts to remove development from adjacent hazardous areas. Where levee protection appears to be the only viable solution subsidies should be conditional on the development and rehearsal of local emergency plans.

**Effectiveness of Non-Regulatory Measures**

That these measures can be effective in hazard land use control is supported by US research and legislation. In recent North American work
by French (1980), "(T)he empirical analysis identified only two contextual factors which were negatively related to (i.e. inhibited) floodplain invasion: the supply of development sites outside the hazard area and direct state regulation of hazard areas" (p.157). French also concludes that it appears "that once the floodplain is invaded by a significant amount of development and provided with necessary public facilities, the legal, political and logical grounds for preventing further invasion are weakened and increased invasion is likely" (p.155).

The US (federal) Coastal Barrier Resources Act 1982, recognises the extent and influence of these government subsidies. The Act "should save taxpayers nearly US$11 billion over the next two decades by prohibiting federal expenditures which tend to encourage construction and growth on underdeveloped barrier islands and beaches" (Chaffee, 1982). The expenditures include normal infrastructure development subsidies, disaster relief, flood insurance and structural works (Sheaffer, 1980). This action was precipitated by the flooding and severe damage caused to the barrier islands by Hurricane Frederic in 1979. At the time there were suggestions that the undeveloped islands, some 71,974 hectares, should be acquired and reserved as public open space and a bill to this effect was put before congress. Generally it was felt that the US$2 billion required was too much, and would provoke considerable negative public reaction. Thus the indirect approach of removing subsidies won favour.

Certainly many of the subsidy costs would be incurred wherever the development took place - though less the amounts for flood insurance, disaster relief, major bridge construction, the extra costs of providing services to the islands, and the very real risk to the lives of the inhabitants. But, the feeling of Congress was that if the investment was to be made, it should be made in a less hazardous site.

Implementation of Non-Regulatory Measures in Lismore

Lismore is the only study site where the NSW policy on development subsidies is significant at present. With the rapid growth of the urban area and consequent increase in demand for various local government services the Lismore City Council plans to build an arts centre, a new swimming pool, a new baby health centre, other public facilities and to
make provision for additional retail and office space. The state and federal governments also intend to expand their office space in Lismore. However, none of this development would receive government support or subsidy if it occurs in the floodplain (Appendix G). When this policy is combined with environmental constraints, such as frequency of flooding and land slope, the choice of location for a major new community/commercial centre is limited to Goonellebah - the area now capturing almost all Lismore's growth (Lismore City Planning Department, 1975).

Despite the apparent economic logic of the Goonellebah plans, there has been considerable opposition from downtown interests represented by the Chamber of Commerce, and from the owners of the proposed town centre site. As well, an arm of the federal government, Telecom, has been less than helpful.

The Chamber of Commerce sees it as an attempt to relocate the city centre. "The radical action aimed at moving the main centre of business from here to somewhere else is just ridiculous" (Patch, 1981-I). A group of city businessmen even threatened to seek an injunction restraining the Council from proceeding on the grounds that the Goonellebah land purchase was a misuse of public funds and would cripple existing businesses (Northern Star 14/3/81). There is also concern that the new site will fragment the city centre. But, this is unlikely to occur for many years as the city area contains most of the tourist, government and commercial/industrial premises. According to government officials there is no intention of moving the centre of business, rather it is seen by the Council, as "giving people in the commercial sector an opportunity to move to a flood free site" (Blair, then Mayor, 1981-I), and because the city had "an obligation to the people who have moved up there to provide the services they require" (Wade, 1981-I).

The Public Works Department is more inclined to see the new site in terms of long term flood damage reduction, not as a wholesale relocation exercise. The Northern Star (6/4/79) carried a denial "Relocation Claim is Discounted", but the Minister for Public Works confirmed that it was state government policy to discourage the location of new commercial buildings in the high flood risk zones of Lismore. Furthermore, the state government agreed to subsidize the purchase of the Goonellebah land by treating the
interest component of the loan as a flood mitigation activity within the scope of the 20:40:40 (local: state:federal) flood mitigation funding agreement (Section 3.2.), and promised that the new regional state office block would be located there.

The other major objection to the Goonellebah site came from the land owners. Political and administrative officials of Lismore Council agree that the purchase process has been "fumbled all the way along" (Blair, 1981-1). Originally, in the late 1970s, a price of $490,000 was settled on, and then in mid 1981 the owners were asking for $750,000. Council was given resumption approval for the land on 17/11/81 following the breakdown of negotiations with the owners (Northern Star 19/11/81). At this time the Town Clerk indicated that the resumption could cost over $1 million. In March 1982 a compensation claim of the order of $1.25 million was formally submitted by the owners. They bought the land 14 years ago for $40,000 (1969$) on their retirement from farming, and the resumption excludes their house and grounds (Wade, 1981-1; Northern Star 20/11/81). Notwithstanding the comments in Section 7.2 it is clear that occasionally property owners stand to make massive gains from the resumption of their land.

Resistance to implementing the NSW policy on the location of government works also comes from agencies of the Commonwealth and NSW governments. In the mid 1970s Telecom Australia (the telecommunications utility) decided to build a new regional administrative office block near Lismore's flood prone business district. Development of this type contravenes the state's policy on flood prone lands and is just the sort of construction being sought for Goonellebah. Although the Fraser federal government had expressed support for the NSW policy, local member and then Deputy Prime Minister, Doug Anthony supported Telecom (Northern Star 26/6/79), and a major paper war commenced. Eventually Telecom shelved its plans, apparently not because of state and local pressure but because of a capital shortage, and instead intends to lease additional space.

The Lismore TAFE (Technical and Further Education College) is located on the floodplain. The Council and District Office of the Public Works Department (PWD) would have liked to see proposed major extensions constructed in a flood free area. However, the TAFE considered that there
was too much investment in the floodplain site and that in any case "split" facilities were not viable. The situation was complicated by the fact that the extension architects were from the NSW Government Architects Office which is part of the Public Works Department - the Department trying to administer the state's flood prone lands policy.

3.3.3.6 Relationship of Land-Use Management to Acquisition

Both regulatory and non-regulatory land use control measures are desirable components of a flood damage reduction program based on acquisition. Some form of regulatory measure is essential in the post-acquisition phase and highly desirable during the program. Where stringent land use restrictions exist acquisition may be desirable as compensation from equity, and occasionally legal viewpoints.

During an acquisition program appropriate land-use measures will:

(i) ensure a coordinated approach to floodplain management. If regulations are applied on a floodplain basis they should prevent the Lismore type situation - clearance of one area with use intensification of an adjacent area. Although the risk to life is reduced by the removal of dwellings, commercial and industrial use may lead to an increase in average annual damages.

(ii) prevent use intensification and rising property values which would make acquisition more expensive and therefore difficult.

After acquisition, regulations are required to ensure that the land remains in a flood compatible state. Non-regulatory measures can to a certain extent surplant regulations designed to complement an ongoing program, but regulations binding all three levels of government are essential to guarantee the long term success of acquisition.

Finally it should be restated that it is often the failure of regulatory and non-regulatory land use control which precipitates the need for acquisition.

3.3.3.7 Concluding Comments on Land-Use Management

In general regulatory and non-regulatory measures which act to
discourage development, as opposed to measures that influence the type and height of construction, will reduce the rate of increase of the disaster potential compared to the "do nothing" situation. Only the most stringent measures rigorously applied, will cause average annual flood damages, (up to the regulatory flood) to actually fall. Their precise effect on damages will depend on:

(i) the height of the MPF above the regulatory flood,

(ii) the existence of appropriate complementary measures, in particular flood forecasting warning services and suitable emergency plans for areas up to the MPF.

If the difference between the regulatory flood and MPF is small then land use measures may be quite effective in reducing the rate of increase of the disaster potential. The converse applies - land use measures may be ineffective in preventing an escalation of the disaster potential if the difference is large and more especially if emergency planning for the flood prone area above that regulated is ignored.

Furthermore, many land use control measures are not rigorously enforced. Typically the case by case assessment of development applications leads to an escalating disaster (and occasionally average annual damage) potential as incremental floodplain encroachment occurs.

3.3.4 Individual Adjustments by Flood Area Residents

3.3.4.1 Introduction

Where individual hazard adjustments have been examined, work has often taken the form of little more than lists of adjustments adopted (Waddell, 1977). Studies that contain useful information on individual flood damage reduction measures include Sheaffer (1960), Williamson (1975), US-FIA (1976), Johnson (1978), and US-FEMA (1979). In the study sites, especially Lismore, the author noted many small individual adjustments or procedures which were designed to reduce tangible flood losses. Some examples are: walking around the house as flood water recedes (generally very rapid in Lismore) to stir up the mud and reduce the amount of cleaning
up; extra large ceiling manholes enabling easy storage and removal of goods; putting crockery in the bath tub to minimise the risk of breakage, and so on. Although each small action may appear trivial, together they may have a substantial impact on overall flood damages. The extent of losses avoided is examined in Section 3.3.4.7.

The sections immediately following are concerned with the more obvious adjustments of house raising in Lismore, and the construction of small levees in Echuca West; actions typical of those undertaken in flood prone areas throughout Australia.

3.3.4.2 House Raising as a Response to the Australian Environment

In parts of NSW and throughout Queensland raising has traditionally been part of the local building style for environmental reasons other than floods (Boyd 1978; Sumner & Oliver 1978). Freeland (1972:207) sums up the development of this aspect of Australian vernacular architecture:

"Economic and material conditions gave rise to the exposed timber frame. Climatic conditions gave rise to other important changes with which it was combined. The framework was lifted one foot six inches above the ground on timber stumps to produce better ventilation below the floor and thereby help to cool the building. As had been accidentally found by the Port Essington settlers (in 1839, Clark 1981:14) it was also the best answer to the depredations of white ants. With this discovery Queensland buildings became stilted on thick whole tree-trunk columns. Gradually the height was increased. By the turn of the century it was six to nine feet and had percolated into the city where the Brisbane Queen Anne houses sat high on stilts and used the undercroft for a variety of secondary but useful purposes from drying clothes to play areas for noisy children".

Boyd lists essentially similar reasons for the original decision to elevate dwellings in Brisbane, but adds that "(T)he pioneers....raised their houses above flood danger" (1978:212).

3.3.4.3 House Raising as a Response to Flooding in Lismore

The most obvious and effective response to flooding in Lismore is
Figure 3.3: Raised housing on the Lismore floodplain. These dwellings have since been acquired.

Figure 3.4: Previously raised house blown off its supports. During the December 1979 windstorm the house collapsed, crushing the car parked under it (foreground). The property was acquired under the Lismore scheme.
house raising. Some 87% of the 1900 houses on the Lismore floodplain (1:100) are raised 1m or more above ground level (Figure 3.3). Individual property owners have made the decision to lift their dwellings and financed the raising without any official encouragement or sponsorship, apart from a low interest loan available from the NSW State Bank. The conditions for this loan are such that very few qualify, and the scheme has probably had no real impact.

A regulation providing that floors in new dwellings had to be above the highest flood was introduced immediately after the 1954 flood, but most of the residential floodplain development had already occurred. In addition effective implementation required a site survey survey and the political will to enforce the regulation. Neither requirement appears to have been satisfied prior to 1974. In 1970 the Lismore City Health Committee even recommended that Council abandon the floor level ordinance. This view was summed up by alderman Habib (Northern Star, 30/3/70). "If the builder is satisfied that water won't enter it is up to him. It's his building. This (regulation) is preventing development". Council adopted a motion that "where the builder was not prepared to build above the 1954 flood level the application be referred to the Health Committee, where each would be dealt with on its merits" (Northern Star, 30/3/70) - effectively abandoning the requirement. This decision was reversed after the 1974 flood. Another problem was that initially the regulation assumed that the flood water surface level was the same from one end of Lismore to the other. Whereas during the 1974 flood the level fell by about 1.5 m as the water went through the city, making the regulation less effective upstream.

There is little doubt that the primary reason for house raising in Lismore is flooding. Houses outside the floodplain are generally not raised, and raising premises has long been seen locally as an effective way of reducing flood damage. Following severe flooding in 1893 the Northern Star, Lismore's daily newspaper, carried this editorial (15/2/1893):

"Ordinary prudence demands that if people have a choice they should reside beyond the possible reach of floods, failing that they should build to provide accommodation considerably above the rise of any known flood... and we would strongly recommend all having business premises, and storing valuable stocks, to be provided with lofts or second stories"; and on 25/2/1908, "In Lismore there have been a number of dwellings built in
flooded areas, where no precautions have been taken to raise the floors even above the level of a moderate flood”.

In many cases houses have been raised subsequent to construction following periods of reported severe flooding. Evidence comes from a number of sources. Old photographs of Lismore show that houses were generally not raised early this century. Today many of the same houses are elevated, and occasionally adjacent dwellings of similar age have floor levels differing by two or more metres. An examination of council building applications to raise property since 1964 (when applications were first required), shows the influence of floods: most applications in the 1964-1980 period were received in the three years after the 1974 flood.

Dexter (1978) has examined the transfer of flood proofing technology to floodplain residents within an innovation diffusion framework. He identifies a number of factors important in successful diffusion which appear to apply in Lismore. Most importantly the flood hazard must be recognised as severe enough to warrant response. Certainly, this is satisfied in Lismore where 96% regard flooding as a nuisance or problem.

Among other adjustment attributes Dexter identified as significant in adjustment adoption were the "observability" of the adjustment and its effectiveness. It is impossible not to notice that virtually all the houses in the Lismore floodplain are raised and that this would reduce the risk of water entering the dwelling. Responses to the Munro survey (Munro et al, 1980; Smith and Handmer, 1983) indicate that people draw a sharp distinction between floods which actually enter their homes, and those that simply inundate their land. While interviewees would tolerate quite frequent underfloor flooding, water inside the home, even if very shallow and infrequent, was unacceptable. An aspect of adjustment effectiveness relates to the short warning time available in Lismore. This places a practical limit on the emergency relocation of goods, and emergency levee construction as at Echuca. Raising eliminates the need to move goods for frequent smaller floods, and provides more time for emergency relocation when a major flood is forecast.
Other aspects of dwelling elevation likely to increase its rate of adoption include: the measure's relatively low cost; its normality, for while largely confined to the floodplain, many officials, builders and residents see raising as much a local building style as a response to floods; its economic viability in cost-benefit terms; and the creation of underfloor space useful for a variety of purposes not related to flood damage reduction. The economic and use issues are explored in the following section. Finally the extensive post-construction lifting has been possible only because over 90% of the floodplain dwellings are wood or fibro single storey detached structures, unlike most of the commercial buildings which are predominantly brick or stone and cannot be raised economically.

Evaluation

Smith and Penning-Rowsell (1981) have examined the Lismore house raising from a cost-benefit perspective. Results are particularly sensitive to the discount rate selected, to the definition of damage avoided by house raising, for example direct or direct plus indirect, and to the value assigned to the underhouse space. Nevertheless (for a discount rate of 10%) they show that for houses with an initial floor height below 10.9 m (corresponding to a 1:4 flood) direct flood damages are high enough to outweigh the costs of raising. From the houseowner's perspective, the economic case for lifting is greatly strengthened if an allowance is made for the value of the underfloor space and for the fact that about half the cost of raising can be recouped through an increase in house value. As most (70%) of the houses are raised 2 m or more the underfloor space is widely employed for storage, recreation, garaging and as a laundry or drying area (Table 3.12). The overall effect on flood damages of house raising in Lismore is shown by Table 3.13. Here actual damages based on those experienced in 1974 are compared with damages that would be expected if all houses were placed 0.5 m above ground level at their present addresses. At the 10 year flood level (12m) raising has reduced flood damages by over 80%. Even at the estimated MPF level damage reduction is significant at 18%. Nevertheless the limits of the measure are apparent.

The benefits and disadvantages of raised housing are not limited to those readily quantifiable in dollar terms nor to those connected with
Table 3.12: Use of underhouse space on the Lismore floodplain. Figures are the percent of houses with each use. Number of houses are in brackets (total N = 332). Up to 2 uses per house were coded.

<table>
<thead>
<tr>
<th>USE</th>
<th>FREQUENCY IN PERCENT</th>
<th>(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not used</td>
<td>10</td>
<td>(33)</td>
</tr>
<tr>
<td>Garage/car port</td>
<td>61</td>
<td>(202)</td>
</tr>
<tr>
<td>Storage</td>
<td>36</td>
<td>(120)</td>
</tr>
<tr>
<td>Laundry</td>
<td>19</td>
<td>(64)</td>
</tr>
<tr>
<td>Workshop</td>
<td>10</td>
<td>(34)</td>
</tr>
<tr>
<td>Business</td>
<td>3.6</td>
<td>(12)</td>
</tr>
<tr>
<td>Nursery (plants)</td>
<td>3.6</td>
<td>(12)</td>
</tr>
<tr>
<td>Organised play room area</td>
<td>2.7</td>
<td>(9)</td>
</tr>
<tr>
<td>Habitable rooms</td>
<td>2.7</td>
<td>(9)</td>
</tr>
</tbody>
</table>

Based on acquisition area plus a random sample of the rest of the flood plain (Section 2.) (N = 332).

Table 3.13: Effect of house raising on residential direct flood damages in Lismore. To estimate the effect of house raising actual damages are compared with those damages that would be experienced if all houses were 0.5m above ground. Calculations were performed by the "ANUFLOOD" computer flood damage assessment package (Smith et al, 1983).

<table>
<thead>
<tr>
<th>DIRECT RESIDENTIAL DAMAGES (1974 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Gauge Height</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>10m</td>
</tr>
<tr>
<td>11m</td>
</tr>
<tr>
<td>12m</td>
</tr>
<tr>
<td>12.5</td>
</tr>
<tr>
<td>13m</td>
</tr>
<tr>
<td>14.5</td>
</tr>
</tbody>
</table>
flooding. Many of the 80% of interviewees who felt that the main advantage was that the house was free or relatively free from flooding stressed intangible benefits of elevated housing: "peace of mind", "saved sleepless nights", avoided the possibility of "frights at night" a reference to the 1976 flood, and that they had more time because the house took longer to flood. Other benefits were the uses that the space could be put to, that the house was thought to be cooler, and to offer more privacy (Table 3.14). The major disadvantage was seen to be the steps (Table 3.15) with nearly all respondents from the worst flood areas mentioning this as a serious problem, made worse by the need to ensure that the under house space is clear during flooding. Another problem is the stability of these houses in strong winds. That this concern is justified is shown by the collapse of six houses off their supports during the December 1979 windstorm (Figure 3.4). Additional concerns were that the houses are difficult and more expensive to maintain, and that the residents are isolated during flooding, often in very deep water.

As a comparison it is interesting to review the results of the only other research the author is aware of concerning the advantages of raised houses. Avoidance of floods was not considered important by respondents to this 1944 Queensland survey. Rather, they valued use of the underfloor space for laundry and drying, and as children's play areas, and stressed climatic advantages such as greater coolness (Boyd, 1978).

A more general benefit of raised houses is the reduction of afflux, (the increase in flood level caused by obstruction to water flow), as a result of a less restricted floodplain. That the older raised houses where the understorey is left open or simply covered with a lattice, present less of an obstacle is quite clear. But the trend to brick-in or otherwise fully enclose the underhouse space will eliminate this advantage, and will tend to reduce the flood damage reduction presently achieved by raising due to the increased value of goods and fittings in the ground storey.

Relationship to Acquisition

Floodproofing is a useful adjunct to acquisition. High hazard areas (as defined in Chapter 4) should be acquired, but a variety of
Table 3.14: Perceived advantages of a raised house. Figures are the percentage of respondents volunteering that reason. Figures in brackets are the number of respondents for each reason (Total N = 183). Each respondent could nominate up to 3 reasons.

<table>
<thead>
<tr>
<th>ADVANTAGE</th>
<th>FREQUENCY IN PERCENT</th>
<th>(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood free</td>
<td>42</td>
<td>(77)</td>
</tr>
<tr>
<td>Avoids small floods</td>
<td>42</td>
<td>(76)</td>
</tr>
<tr>
<td>Space/play area/workshop</td>
<td>22</td>
<td>(41)</td>
</tr>
<tr>
<td>Storage space</td>
<td>19</td>
<td>(34)</td>
</tr>
<tr>
<td>House cooler</td>
<td>14</td>
<td>(26)</td>
</tr>
<tr>
<td>Laundry/drying area</td>
<td>10</td>
<td>(18)</td>
</tr>
<tr>
<td>Garage</td>
<td>8</td>
<td>(15)</td>
</tr>
<tr>
<td>Used for work or habitable rooms</td>
<td>3</td>
<td>(5)</td>
</tr>
<tr>
<td>Privacy</td>
<td>2</td>
<td>(4)</td>
</tr>
</tbody>
</table>

Table 3.15: Perceived disadvantages of a raised house. Figures are the percentage of respondents volunteering that reason. Figures in brackets are the number of respondents for each reason (Total N = 186). Each respondent could nominate up to 3 reasons.

<table>
<thead>
<tr>
<th>DISADVANTAGE</th>
<th>FREQUENCY IN PERCENT</th>
<th>(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps for old or ill people</td>
<td>70</td>
<td>(130)</td>
</tr>
<tr>
<td>Steps for young children</td>
<td>48</td>
<td>(89)</td>
</tr>
<tr>
<td>Steps unspecified</td>
<td>17</td>
<td>(31)</td>
</tr>
<tr>
<td>House unstable</td>
<td>8</td>
<td>(14)</td>
</tr>
<tr>
<td>House cold</td>
<td>3</td>
<td>(5)</td>
</tr>
<tr>
<td>House hard/expensive to maintain</td>
<td>1</td>
<td>(2)</td>
</tr>
<tr>
<td>Junk accumulates underneath</td>
<td>1</td>
<td>(2)</td>
</tr>
</tbody>
</table>
approaches including flood proofing may be employed in the surrounding flood prone areas. Many of the comments made for levees in Section 3.3.3.2 are applicable here—house raising is particularly appropriate in areas of shallow and backwater flooding.

3.3.4.4 Small Levees in Echuca

At the time of survey, September 1981, individual flood adjustments were evident at about two thirds of the dwellings in Echuca West (Table 3.16).

A few houses are raised slightly, but most are protected by small levees or walls, and the use of pumps to remove seepage and domestic effluent is widespread. Many of these embankments were upgraded during the severe floods of 1974/75 and 1981. A number of the levees constructed by the original residents of Echuca West (Chinese market gardeners) still exist, but are in disrepair and no longer function.

The levees are generally less than 1m in height and formed from uncompacted earth fill and/or sandbags, and plastic sheeting. Interviewees who had erected or upgraded levees were generally not prepared to put a cost on the work. Typical responses were "It cost about $100", "it took time, not money", "my relatives (friends) did it—just a load of fill"—the fill it appears was often diverted from other destinations. Johnson (1978) calculated construction costs for small levees of the type found in Echuca West, and came up with a figure of US$800, using a professional contractor or US$2050 if a sump pump and sewer gate valve were included (Table 3.17).

The relatively slow and shallow flooding experienced locally makes such works feasible, though they do fail occasionally. About one quarter (N=7) of those who had themselves built or extended levees had experienced failures. In addition the embankments around a number of houses, vacant at the time of interviewing during the 1981 flood, had been breached or overtopped. Apart from the risk of failure, not catastrophic under recent Campaspe/Murray flood conditions, the main problem with levees was seen to be the need to pump seepage and domestic effluent out over the embankment. Echuca West is not sewered and the high water table caused by floods
Table 3.16: Private levees and house raising in Echuca West. The table shows the percentage of houses in the acquisition area with the indicated adjustments.

<table>
<thead>
<tr>
<th></th>
<th>Not leveed or raised</th>
<th>Leveed(^1)</th>
<th>Concrete flood wall around house</th>
<th>House/yard raised on fill (&gt;60cm)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of houses</td>
<td>36</td>
<td>48</td>
<td>3</td>
<td>13</td>
<td>100%</td>
</tr>
<tr>
<td>(N=63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Generally the whole yard is leveed.

Table 3.17: Estimated cost to protect a residential property with a small wall or levee using a professional contractor (Johnson, 1978:33) (1978 US$).

<table>
<thead>
<tr>
<th></th>
<th>WALL</th>
<th>LEVEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>0.9m</td>
<td>1.5m</td>
</tr>
<tr>
<td>Construction</td>
<td>$3220</td>
<td>$4900</td>
</tr>
<tr>
<td>Sump pump</td>
<td>950</td>
<td>950</td>
</tr>
<tr>
<td>Sewer gate valve</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>TOTAL FIRST COST</td>
<td>$4470</td>
<td>$6150</td>
</tr>
</tbody>
</table>
prevents the use of most septic systems.

Many interviewees commented that "In Echuca West you get flooded in, not flooded out". The water may remain high for weeks or months and considerable personal adjustment is required in the form of levee maintenance, the use of boats, and so on. Nevertheless, the levees enable people to remain in their homes during floods of long duration thus minimising the disruption to their normal routine. Any conventional benefit/cost analysis, which normally includes only tangible damages, will fail to allow for this most important benefit of levees. Even so Johnson's (1978:34) "comparison of minimum cost (of construction) and (tangible) damages reduced", shows small levees (90 cm and 150 cm) to be economically feasible for all flood hazard factors, all locations on the 1:100 floodplain and all types of residential structures except a 2 story, no basement dwelling.

Comments made earlier concerning the adoption of house raising in Lismore also apply to private levees in Echuca: there is a long history of widespread adoption; the measure and its effectiveness is easily observed; it is economically rational; and there has been even less government encouragement or assistance in that no loan or grant schemes, or regulations exist. In fact, following proclamation of the area in 1980 levee construction became illegal, though in the words of one resident "there's no law against top-dressing".

Given the circumstances of Echuca West small levees are a more appropriate flood adjustment than Lismore style house raising. Echuca West residents were the poorest group interviewed (Section 6.2.3), so the very low financial outlay required is critical. The type of flooding is equally important, its long duration would completely destroy gardens, while its relatively slow and shallow nature permits wading and the safe use of boats.

3.3.4.5 Disaster Potential of House Raising and Small Levees

In Lismore house raising is quite effective in reducing flood damages and has some influence on the disaster potential. The disaster potential is reduced because many houses (578, or 30.5%) would still be
substantially out of flood water in the MPF (14.5m Lismore gauge height), with less than 1m of water over their floors. But the damage analysis of Table 3.12 does not make any special allowance for the 453 houses (23.9%) that would have more than 2m of water over their floors, and which if located in a flow zone are liable to be swept away (Section 4.3.3.2). Furthermore, occupants of raised houses may delay evacuation and become trapped in an unstable house in deep water, endangering their own lives and those of rescue personnel.

The levees of Echuca West would generally be considered potentially more dangerous than raised houses, because once the embankments are breached or overtopped they cease to provide any flood protection (Section 3.3.3.2). The danger to life this characteristic poses in Echuca however, is probably low due to the slow rate of river rise and ease of access. Nevertheless, ultimately the safety of both the Lismore and Echuca floodplain populations depends on the government or community provision of an effective flood forecast, warning and evacuation system.

The critical issue is the difference in elevation between the commencement of flood damage and the regulatory flood, or ideally the MPF. If large, then raising, and more especially small levees, are of limited benefit for disaster-potential reduction. On the other hand in places where the difference is small, for example areas of shallow "sheet" flooding, houses may be easily raised above the MPF level, and levees may provide protection from the regulatory flood. In such areas, in particular where development is scattered, individual measures are likely to prove cost effective methods of flood damage reduction.

3.3.4.6 Comments on Raising and Levees

The lack of individual action in North Wagga is in marked contrast to the extent and effectiveness of private response at the other sites. This probably reflects: the apparent absence of a tradition of individual response; the strict regulations effectively prohibiting private initiative; the enduring optimism among residents that the government will provide a levee; and the fact that the flood problem is not as severe as the other acquisition study sites. Work by Smith and Tobin (1979) in England provides some evidence for these hypotheses, in particular that
individual response is more likely to occur in the absence of government action, and where flooding is serious.

Finally, major advantages of both measures in areas of relatively shallow low velocity flooding are: that floodplain development is permitted, except in particularly hazardous areas; and that reasonably effective damage reducing action is taken, at no financial cost to government and at a net benefit to the householder who bears the cost.

3.3.4.7 Individual Response to Flood Warning

Introduction

It should be clear from the review so far that whatever adjustments are adopted the flood forecast and warning system must not be neglected. For a warning system to be fully effective, all the components in the system must be adequately recognised by both the issuer and recipient of the warning. A commonly accepted system division following A.C.D.C. (1981), Mileti (1975) and Murray (1980) is:

(i) collection, collation and evaluation of flood related data,
(ii) dissemination and receipt of a prediction,
(iii) evaluation and understanding of the warning,
(iv) acceptance of and response to the warning.

These can be conveniently grouped as technical aspects, (i) above; and social aspects, (ii) to (iv) above. The social aspects, as they apply to individuals rather than to commercial or government organisations, are the focus of this section.

Predictions for major floods in Lismore, with the exception of the 1976 event, have been technically accurate. But, the effectiveness of any warning system in reducing flood damage depends on the dissemination and receipt of the warning and on the reaction of the recipients. "Flood warnings on their own do not reduce damage. Rather they provide the opportunity for other activities to be put in train" (Higgins and Robinson, 1981:12). This aspect of the warning process has, until recently, been almost totally ignored by authorities in the UK (Smith & Tobin, 1979),
USA (White, 1975:82), Australia (Cameron, 1981) and elsewhere (Schware, 1981). The whole question is reviewed by Mileti (1975) and Murray (1980).

Appropriate warning response, consisting principally of moving house contents, is much more likely to occur in an experienced and well prepared community like Lismore than in an inexperienced community such as Brisbane. The concept is discussed by Higgins and Robinson (1981), and Penning-Rossell and Chatterton (1977), and is developed further by Sinclair, Knight & Partners et al (1982), who take as an index of preparedness the proportion of residents living in the area at the time of the last major flood. This index may be readily constructed from census and mortality data, and is considered a reasonable surrogate for the proportion of residents who have experienced flooding at their present addresses.

As part of the general community orientation towards social issues, many authorities have come to recognise that reaction to warnings constitutes a critical part of the warning process, and that preparedness is the key to appropriate response. In some areas, but not the study sites, attempts have been made to raise preparedness through public education/information programs. Unfortunately these have generally not lived-up to expectations, see Sections 6.1 and 7.7.5.3 for a discussion of the problem.

Evaluation of Individual Response

The difference between actual and potential damages represents the damage reduction achieved by the given population acting on a flood warning. Smith (1981) calculated the extent of this reduction for Lismore empirically. Actual damage consisted of 52.4, 23.5 and 6.1 percent of the potential damage for the residential, commercial and industrial sectors of Lismore respectively. The overall saving is very substantial representing $626,700 1974 dollars or 28.5% of direct damages for a 1:100 event (Table 3.18). A similar picture is expected in the frequently flooded areas (non-leveed) of the other study sites.

By way of contrast actual damage was calculated theoretically as approximately equal to potential damage for Brisbane's 1974 flood using the
Table 3.18: The effect of preparedness on residential flood damages in Lismore. Data from Smith (1981).

<table>
<thead>
<tr>
<th>FLOOD HEIGHT (risk)</th>
<th>DAMAGES (Residential direct 1974$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACTUAL</td>
</tr>
<tr>
<td>11m (1:4)</td>
<td>74,000</td>
</tr>
<tr>
<td>13m (approx. 1:100)</td>
<td>1,118,900</td>
</tr>
</tbody>
</table>
method developed by Sinclair, Knight & Partners et al (1982:Al.8). In this method the conversion factor is a function of preparedness and warning time.

Relationship to Acquisition

If the highest risk areas are maintained as open space through acquisition it may be possible to have a less extensive forecasting and warning system (Ralf M. Field & Ass., 1981). However, where a flash flooding potential exists care must be exercised to ensure that the system is adequate. Post acquisition use will determine the need but generally if settlements or dwellings are removed from such areas the type of warning system needed will be much less intensive. The Canberra Woodan valley flood of 1971 shows the dangers of failing to provide a warning system for open space uses. In this event seven lives were lost as vehicles were swept from an urban transportation parkway. A forecasting and warning system has since been instituted.

Disaster Potential

A flood forecasting and warning system will normally continue to be of some benefit up to the maximum probable flood. However, the effectiveness of preparedness declines for floods greater than those previously experienced. The extent of this decline depends on the difference between the magnitude of experienced events and the flood in question. Where a large difference exists many of the adjustments normally successful such as placing household contents on tables, in lofts etc. will fail totally, though others such as moving cars to high ground will continue to function. It is the observation of the author and other workers in Lismore that items are moved to be just above the forecast flood height - however the MPF, at least 1.5m higher than the 1954 and 1974 record events, would preclude many people, especially in the low areas, from taking action. Table 2.3 showing floor heights, illustrates the problem; in the MPF, water would be more than 1m deep in nearly 70% of dwellings and more than 2m deep in 24%.
3.3.5 Adjustment Compatibility and Interaction

3.3.5.1 Adjustment Interaction

Any detailed assessment of individual flood adjustment measures should consider the dynamic nature of adjustment interaction, specifically:

(i) The effects of adjustments on all elements of flood damage including disaster potential and social disruption.

(ii) The likely effects of adjustments on flood damages over time (dynamics), and

(iii) interaction between adjustments. "Action taken with respect to one adjustment...may have a profound effect on the kind of response which society makes to any one of the other adjustments" (White & Haas, 1975:66).

The extent to which adjustment interaction and dynamics are understood is poor. But some general trends emerge from the literature and the present study; for example the provision of flood protection by levees or other engineered works tends to discourage flood proofing, reduce emergency preparedness at the individual level and weaken community resolve to implement floodplain regulations (White & Haas, 1975; Ericksen, 1976; NSW-PWD & SKP, 1980). Though not as well established, it appears that individual flood mitigation activity may be discouraged by government action in the structural or regulatory areas (Smith & Tobin, 1979). Few comprehensive dynamic assessments have been undertaken. Using scenario analysis Ericksen (1975) and Handmer (1976) examine the effects of various adjustment combinations on flood damages over a twenty year period, and NERBC (1976) developed a catchment-based floodplain management plan. These studies are of a qualitative nature only. A quantitative approach was employed by Higgins and Robinson (1981), but was limited to a search for the "optimal" combination of structural measures.

Thus no established procedure exists for a comprehensive dynamic evaluation of flood adjustments, though the method presented in SKP et al (1982) while still in the developmental stage, is promising. Unavoidably therefore, the discussion of adjustment dynamics and compatibility is in general terms.
3.3.5.2 Components of an Acquisition Program

Measures best suited to complement acquisition will be those that:
(i) individually reduce annual average damages and the disaster potential, and
(ii) are compatible with acquisition and each other, and act in concert to improve public safety.

Effect of Adjustments on Flood Damages

The effects of adjustments on average annual flood damages and the disaster potential, based on the discussions in this chapter and supplemented by material from Ericksen (1975), are summarised in Figure 3.5. A general caveat applies to the presentation. The actual effect of adjustments will depend on the design limit of each measure: typically ordinances do not apply to development in the area between the 1:100 and MPF flood levels, and if development intensifies on the unregulated part of the floodplain the disaster potential may increase, even under the strictest regulations. However, on floodplains well defined by steep topography (eg. Lismore), the additional area inundated by the MPF is likely to be small. Occasionally it may be possible to provide structural protection from the MPF. In theory this would eliminate average annual damages altogether, apart from a small allowance for failure of the works (Mark & Stuart-Alexander, 1977), but would lead to an escalation of the disaster potential.

Generally, non-structural measures are less likely to increase the disaster potential than structural and over time both will reduce average annual damages; structures which largely eliminate flooding may increase the disaster potential as population preparedness declines (Table 3.5). Low levees of the type found in Lismore are shown to increase average annual damages as well as the disaster potential. Reliable flood forecasting and warning schemes will tend to reduce both average damages and the disaster potential.

Adjustment Compatibility

The second key issue in formulating a package of measures for an
Figure 3.5: Trends in the effects on average damages and disaster potential of flood damage reduction alternatives.
acquisition program is adjustment compatibility. Compatibility seeks to illustrate where implementation effort should be directed to produce a workable and effective flood damage relocation program, in this case focussed on acquisition.

The discussion in the "Relationship to Acquisition" Sections and work by Ericksen (1975, 1976) are used to produce a matrix of adjustment compatibility (Figure 3.6). Some form of regulations to prevent land use intensification and redevelopment within the acquisition area while the program is operating is considered essential. Adjacent severely flood prone locations should be subject to development controls as well to ensure that property purchase and regulation does not appear to be arbitrary. After the land comes into public ownership regulations or agreements ideally binding on all levels of government are essential to maintain the area in a flood compatible use. Non-regulatory land use control measures, which in effect simply remove for hazardous zones the normal development subsidies provided by government, are a logical and in many cases effective approach to land use management. The use of these measures should reduce the opposition to regulations and acquisition by making the area less attractive to private investment.

An effective flood forecasting and warning system should be maintained after the acquisition scheme is complete, though it will often be possible to have a less extensive warning system if the area is maintained as open space. If acquisition is part of a scheme involving levees and/or flood proofing then more resources may need to be devoted to flood forecasting and warning for those areas not maintained as open space. In all cases the forecast and warning system should be able to cope with the MPF to minimise the risk to public safety.

Although not generally recommended situations exist where levees and/or flood proofing do not substantially increase the disaster potential, and may provide an acceptable and economical adjunct to the acquisition of more hazardous locations. Suitable areas for these measures are those subject to shallow, low velocity flooding (defined in Chapter 4).
3.4 CONCLUSIONS

3.4.1 Implementing Flood Strategies

Greatest resistance to new policy or programs generally occurs when they are seen as new and non-incremental, or revolutionary, in nature (Pressman and Wildavsky, 1973). Unfortunately even though many non-structural flood damage reduction measures have been well established in some jurisdictions and in the research literature for decades, their effective and widespread implementation is often seen as novel.
Four factors have been identified as important in the failure of all levels of government to implement land use measures including acquisition. Three of these factors are under the control of the federal and state governments: funding arrangements which favour structural works; doubt about the legislative basis to strict land use control; and the fragmentation of functional and geographic jurisdictions through numerous authorities, which inhibits watershed based management. The fourth issue concerns the self-serving nature of organisations. Organisations with a construction mission and staffed with engineers may be slow to accept institutional and individual flood damage reduction adjustments.

Now, in some states and at the federal level the political-administrative environment has become favourable for the implementation of land use measures through the announcement of policies, the enactment of legislation and a review of funding procedures. Changes in the direction of flood policy have parallels throughout the Australian water industry, which is moving from an era of resource development to one of resource management (AWRC, 1982). Underlying the changes are fundamental shifts in community and political attitudes emphasising public safety, and consumer and environmental protection. Unfortunately, organisations used to structural solutions may not be well placed to implement non-structural procedures. In addition, funding for land use measures is still limited and uncertain. This area deserves special attention as Bingham (1976), in his US study, found funding to be the most important factor behind the adoption of innovative programs by local governments.

Further problems remain at the local government level, where councils are subject to a range of pressures for and against enforcement of floodplain land-use management. In general pressure for regulation now comes from state government instrumentalities, while pressure against originates locally in the councils' electorates. In any case, land and development interests are frequently represented directly on councils, and local governments have not been held responsible for flood damages to development which they have permitted or encouraged, though much legal uncertainty remains. Occasionally certain state and federal authorities complicate the situation by overriding local land use restrictions.
Reasons why pressure against land use measures is so great relates to this lack of local accountability for land use decisions, and to the basic nature of institutional adjustments. They seek to control or influence people, unlike structural works which control water. Land use measures in particular, place restrictions on development and therefore incur the opposition of development and business interests, the main sources of power and wealth in a community. The argument often advanced against regulation, that commercial ventures locate where it is economically rational to do so, may be in error. Numerous subsidies encourage use of all land, especially floodplains through: disaster relief, insurance (where applicable), extra costs of infrastructure provision and repair, and lost tax revenue because of disruption and other losses to commercial enterprises.

The ability of local councils to resist these pressures and to implement land use measures is related to a range of issues, some within and some outside the control of local government. Clearly the success of any non-structural measure depends on the cooperation of the affected population. This central issue is the subject of later Chapters. Another potentially important factor in the implementation ability of local governments is the lack of technical knowledge and expertise mentioned by Higgins and Robinson (1981), leading for example to an inability to produce local flood maps. Although this has probably been an important problem in many areas, it is a poor excuse for inaction in many others, where residential development has been taking place in locations where sophisticated delineation procedures are not needed to establish that a serious flood risk exists.

Apart from the funding question a lack of local political resolve to direct the development of flood prone areas is evident. Increasing the legal liability of councils for their development decisions may raise local awareness of the problems. An alternative approach is direct state government control of certain high risk areas. This approach appears to be working well in Victoria and the US.

3.4.2 Flood Adjustment Characteristics

That institutional flood adjustments emphasise human safety and environmental concerns is clear from Figure 3.7. The figure summarises
<table>
<thead>
<tr>
<th>AUTHORITARIAN</th>
<th>ENGINEERING</th>
<th>INSTITUTIONAL</th>
<th>INDIVIDUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dams</td>
<td>Leves</td>
<td>Acquisition</td>
</tr>
<tr>
<td><strong>SAFETY:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- disaster potential</td>
<td>++</td>
<td>++</td>
<td>--</td>
</tr>
<tr>
<td><strong>ECONOMICS:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- econ. viability</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>- support by development interests</td>
<td>++</td>
<td>++</td>
<td>--</td>
</tr>
<tr>
<td>- long-term commitment of</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>maintenance funds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- economic use of land</td>
<td>--</td>
<td>--</td>
<td>++</td>
</tr>
<tr>
<td>for agriculture mining(sand/gravel)</td>
<td></td>
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</tr>
<tr>
<td><strong>ENVIRONMENTAL:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- environmental impact</td>
<td>++</td>
<td>+</td>
<td>--</td>
</tr>
<tr>
<td>- reversibility</td>
<td>--</td>
<td>--</td>
<td>++</td>
</tr>
<tr>
<td><strong>FLOODPLAIN MANAGEMENT:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- relative importance in</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>floodplain management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- funding availability</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>COMMUNITY ASPECTS:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- potential for community</td>
<td>+</td>
<td>++</td>
<td>--</td>
</tr>
<tr>
<td>revivalisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- public acceptance</td>
<td>+</td>
<td>++</td>
<td>?</td>
</tr>
<tr>
<td>- recreation potential</td>
<td>++</td>
<td>--</td>
<td>++</td>
</tr>
</tbody>
</table>

Figure 3.7: Selected impacts of flood adjustments. Key to impact severity: very high = ++; high = +; very low = --; low = --.
chapter material on flood strategy characteristics. In contrast to engineering solutions, acquisition and other land-use measures possess positive safety and environmental impacts, avoidance of an irreversible commitment of resources (including the retaining of the potential for sand and gravel mining, and agriculture), and a relatively small long term commitment of maintenance funds. The viability of the individual measures of house raising and small levees is also highlighted.

The strategy which emerges from Figure 3.7 as the most beneficial in any flood damage reduction program is that of forecasts and warnings. This is also clear from the discussion on flood adjustment compatibility summarised in Figure 3.6. Whatever adjustments are adopted attention must be paid to warning systems, although it should be possible to have a less intensive (and cheaper) system following acquisition - depending on the ultimate land use.

3.4.3 Role of Acquisition

Evidently no strategy acting alone can be expected to substantially reduce flood damages, with the two obvious exceptions of the wholesale relocation of existing development and the avoidance of flood prone areas by new development. Where feasible, avoidance should be the rule, but this leaves the problem of existing development. Large scale relocation is unlikely given political and financial reality, though it has been used in the past following major disasters. Much existing settlement can be protected with levees or through house raising. In other cases, especially where risk to life is low, it may be economically sensible to allow some flood damage to occur. Where residential property is particularly flood prone, however, the only solution may be acquisition. The study now turns to the precise definition of such areas.
CHAPTER 4

PHYSICAL CRITERIA FOR ACQUISITION

4.1 INTRODUCTION

The previous chapter showed that acquisition and other land use measures have an increasingly important role to play in flood damage reduction. This trend was itself found to be a reflection of societal concern with public safety and welfare. However, despite a greatly improved implementation environment, effective land use management is still hampered by political vacillation, and by a lack of definite operational criteria.

The apparent uniformity of protection endowed by the widespread use of the 1:100 level to define flood prone land is illusionary, as occurrence probability is but one aspect of the flood hazard. Furthermore the level of risk considered acceptable varies greatly between local jurisdictions, and is reflected in the way floodplain regulations are applied. This is hardly surprising as councils have quite different physical flood problems, and will be subject to different development pressures. It is not unreasonable that a council with very limited land resources and under pressure to permit development would allow building on flood prone land.

Unfortunately, all too often development is occurring in areas which are demonstrably highly dangerous. The main issue is not the adoption of the 1:100 flood, though this standard certainly has its problems, but the application of land use controls in areas liable to frequent and severe flooding.

Resolution of this fundamental problem requires two steps: first, reform of the legal context local governments operates within to clarify local responsibilities, and to ensure that councils bear some liability for their actions; and second, concepts concerning safety and other flood policy issues need to be put on a less discretionary basis. Legislative reform, with respect to floodplain management, is underway throughout most of Australia. This chapter attempts to set out a quantitative basis for safety.
Safety or "acceptable risk" decisions are almost always political. The shortcomings of this approach, as far as floodplain management is concerned, have been documented in Chapter 3. It would be ideal if criteria for floodplain regulation could be established which went beyond politics and which were universally recognised as providing a sound basis for decisions. Unfortunately this is not considered possible, not only because of political realities, but also because flood problems vary greatly from place to place.

Nevertheless, it may prove feasible to set absolute safety limits, which, regardless of local circumstances, are sufficiently solidly based in physical data to be irrefutable. If this is the case political considerations would continue to be important in determining the type and degree of regulation above the set limit. Below the limit major land use decisions would be outside local, and ideally other levels of politics. In this high risk zone new residential development (and perhaps other construction) would be prohibited, while the fate of existing development would depend on local flood conditions, though in many cases acquisition would be the most desirable solution.

The adoption of this type of procedure would remove one of the major contradictions in the implementation of comprehensive flood damage reduction policy, whereby some high risk areas are developed while adjacent locations are subject to strict regulations to the 1:100 level.

4.2 CURRENT CRITERIA FOR THE ACQUISITION OF FLOOD PRONE LAND IN NSW AND VICTORIA

Most Australian states, including the Northern Territory, have undertaken or considered undertaking flood prone property acquisition. However, as with the rest of the report this section deals only with the states where the case study sites are located: NSW and Victoria. Both states have announced policies of a very general nature for the acquisition of flood prone land.

The Report Flood Plain Management in Victoria (Victorian Water Resources Council, 1978:54) identified criteria for the conversion of flood
prone land to public ownership:

(a) "the land should already be zoned for urban purposes or where no planning scheme exists, is already within an area of urban development and capable under all other regulations and requirements to be so developed but would not be permitted by the F.P.M.A. (Flood Plain Management Authority, synonymous with the Drainage Authorites of Table 3.1, Section 3.2.4.1) to be so developed.

(b) the land should have no other reasonable use compatible with its location in the flood plain.

(c) The F.P.M.A. considers that no structural solutions to relevant flooding problems are, or will become, feasible;

(d) the F.P.M.A. determines that at some time in the future the land should be in the public ownership".

These criteria simply give full discretionary power to the F.P.M.A. They do little to ensure consistency in the selection of acquisition sites, and in each case the decision to acquire remains essentially political.

Unlike Victoria, NSW has not set out any explicit criteria for floodplain acquisition. Various NSW government planning circulars state in general terms the desirability of removing urban development from floodways (Section 3.2.4.1, Table 3.1). At present floodways in NSW are defined by 1:20 flood levels which generally delimit areas far too large to form a basis for acquisition. In many towns, including Lismore, the 1:20 zone encompasses a substantial proportion of the built-up area including the business district.

In the absence of formal criteria, informal or unofficial reasons for the relocation of residential development were obtained from interviews with NSW government officials. Their responses fall into three main categories:

(i) When protection is desirable but is not feasible through structural measures,

(ii) Safety issues; situations where the safety of both the inhabitants and rescuers is endangered, especially where warning times are short and where the area becomes isolated at early stages of flooding
(iii) Equity issues; in particular the case of remnant areas left unprotected by major flood mitigation schemes. Here acquisition is seen as a way of "helping people get out of areas that should never have been developed" (Hogan/Parr, 1980-1).

In both states the formal or informal criteria do little more than acknowledge that acquisition is an appropriate strategy under some circumstances. Specification of these circumstances is vague and leaves the acquisition decision firmly in the political arena, though in Victoria local politics plays a relatively minor role, in that the state government may acquire land directly, see Section 3.3.4.7. The detailed floodway delineation procedures, which exist in Victoria and are under development in NSW, are of potentially greater interest. These could be used to select areas for acquisition, and are discussed in the following sections.

4.3. RISK AND HAZARD ANALYSIS

4.3.1. Introduction

Accurate delineation of flood prone areas is a primary step in the implementation of any hazard mitigation or avoidance measure (Burton, 1965; Hopkins, 1968; Baker and McPhee, 1975; USGS, 1978; Askew and Pilgrim, 1979). Without flood maps it is difficult - if not impossible - to assess the flood damage potential and threat to life, and hence benefits of any mitigation measure.

There are generally two levels of delineation for floodplain management: the boundaries of the legal or statutory floodplain, and the floodway. While a great deal of attention is devoted to the floodplain boundary by behavioural hazard studies in geography, floodways are generally of far greater importance for regulation and acquisition, as they constitute areas of relatively severe and frequent flooding. Both levels of delineation attempt to define zones of potential flood damage and danger. But, this requires more than the straightforward application of data on the physical components of flood risk. To properly assess the degree of hazard the physical elements must be combined with information on the tangible and intangible flood damage susceptibility of selected human activities, including the risk posed to life. This combination should lead
to the development of guidelines for assessing and mapping the flood vulnerability of urban residential development; or put another way guidelines for determining the suitability of an area for residential development.

A variety of approaches have been employed to map the vulnerability or susceptibility of urban areas to flood damage, with the major efforts directed towards third world countries. Tag-Eldeen (1981) developed a methodology for mapping the flood vulnerability of communities in Egypt and Tunisia as part of the national flood strategies of those countries. The process was taken a step further in the assessment and mapping of all natural hazards in Manilla (UNDRU, 1977(b)), and Kingston, Jamaica (Naughton, 1981). To estimate vulnerability all three studies combined aspects of the physical flood risk (or other hazards) with census type data on the built environment and population, such as structure type and density, population density, the position of regionally important production and strategic elements and so on. Socio-economic factors are either ignored or treated in terms of the damage susceptibility of different dwelling types. This oversight is particularly unfortunate in the third world setting where factors like income, savings, age, health, and family size, may be the most important indicators of peoples' ability to absorb loss or indeed to simply survive disaster (Westgate, 1979). Other work, again primarily in developing countries, has explored the socio-economic and political components of vulnerability (Jeffery, 1981; Lewis, 1979, 1981). These issues are relevant to the social questions surrounding relocation in some Australian communities, and are discussed in Chapter 6.

Another method of vulnerability assessment involves the use of scenario models, "which allow a researcher to consider elements of a social system 'as if' they really function in the described manner" (Munn, 1979: 89). The models produce forecasts resting on an empirical base of social and physical science data augmented by political and historical material. Each scenario is a logically constructed model of a potential future, or past, "for which the 'degrees of confidence' as to progression and outcome remain unchanged" (Ericksen, 1975). The method has been used to graphically demonstrate the effects on flood damages and loss of life various different hazard management strategies would have on historic floods, eg. the catastrophic 1972 Rapid City flood (Ericksen, 1975), and
hypothetical events (Sheaffer and Roland, 1981).

The reviewed procedures for vulnerability assessment are all felt to be unduly complex for the purposes of the present study. As this work is concerned with areas of extreme flood risk it should be possible to develop a relatively simple technique to delimit zones in which all residential development is prohibited. Furthermore, government authorities are likely to employ simple procedures and reject as impractical complex and time consuming methods.

4.3.2 Flood Risk Delineation Criteria

A review of the physical components of flood damage and danger to the public is basic to examining the efficiency of existing criteria for flood risk delineation, and to establishing new criteria. The major non-physical components are the flood preparedness of the floodplain population, and the public response to flood warnings, as discussed in the previous chapter. The physical contributors to flood damage are:

(i) Water depth,
(ii) Water velocity,
(iii) Debris, sediments and pollutants carried by the water,
(iv) Flood duration, of varying importance in urban flood damage, but critical for rural damages. In both urban and rural situations long inundation periods (>1 week) greatly increase the intangible costs of flooding (SKP et al, 1982).
(v) Flood warning time, is critical in safety considerations and if very short (<6 hours) may outweigh all other flood damage components. It is also an important factor in contents (as opposed to structure) damage, as a determinant of the amount of contents relocation possible.
(vi) Isolation, the extent to which the area becomes isolated with resultant access difficulties during floods. The importance of this factor is closely associated with warning time.
(vii) Occurrence probability, is necessary when information is required on average annual damages (see Section 5.3.3.2), or overall exposure to hazard.

In general, at urban sites flood velocity and depth are the critical factors for potential damage and risk to life, unless a flash
flood potential exists, i.e. a warning time of less than 6 hours (see Section 4.3.3.3). Ideally flood water depth and velocity should be mapped for the regulatory flood(s) and MPF, and the map should be accompanied by comments on any other locally significant features especially flood warning time and the isolation risk. Flood duration is generally not important for urban damages, and while debris and water-borne pollutants occasionally constitute a health risk they are of a highly unpredictable nature.

Unfortunately, delineation of the flood risk is more often directed by legal requirements than hydrologic and vulnerability arguments, and despite the importance of the various flood risk components most authorities simply map the extent of the regulatory flood(s). Typically these are hypothetical events of particular occurrence frequencies (probabilities). The lowest frequency mapped is commonly the 1:100 (or 1% flood): that flood which has a 1 in 100 chance of occurring every year. Occasionally other approaches may replace, or supplement the use of hypothetical floods of specified probabilities. Historic floods may be used, as was the case in Victoria; theoretical events without return periods, such as the Standard Project Flood of the US Army Corps of Engineers (Dalrymple, 1964), or the Ontario Regional Storm concept where the record regional storm is transposed to the study site (Ontario-MNR and MOH, 1976); or very rarely the maximum probable flood (MPF), as specified in Northern Territory policy (Section 3.2). Occasionally water depths and major flow paths are indicated on flood maps. But, this is not done in a systematic fashion, and there is usually no attempt to show the probable maximum extent of flooding or other important local factors.

Floodways, on the other hand, are generally not delineated by return period. Instead they are usually defined by an afflux limit, which refers to the increase in flood height caused by obstructions to flow (see Victorian Water Resources Council, 1978:37). An exception is NSW where the 1:20 flood is employed to delimit floodways. However, it is expected that NSW will soon abandon this procedure in favour of depth/velocity criteria, with the emphasis on public safety especially where residential subdivisions are concerned. "Through investigations, experiences and development pressures it has become apparent that the (1:20 floodway) definition is not applicable to an increasing number of situations" (Russell, 1982).
It is apparent that a fundamental limitation to any flood damage reduction measure is the need to nominate a design or regulatory flood. Selection of the regulatory flood is a political-administrative decision, and the almost universal adoption of the 1:100 level as a standard is without any sound hydrologic or economic basis, but may be regarded as a reasonable compromise. If the regulatory flood was selected on economic grounds it is generally thought that the level would be considerably lower (Higgins & Robinson, 1981; Howell, 1980; although Arnold, 1981, argues that it would be higher), while on safety and flood damage reduction grounds the adopted level would approach that of the MPF.

Although events larger than the 1:100 flood occur rarely by definition, their effect may be especially devastating. A substantial area, legally classified as flood free may be inundated, also the regulatory floodplain could be subject to water of extra depth and velocity. With respect to tangible damages the distribution of losses by flood probability is instructive. Floods of larger magnitude than the 1:100 level are reported to have caused 61% of flood damages in the U.S. between 1959 and 1975 (Sheaffer and Roland, 1981:21). Although most of this damage would probably occur in the area within the boundaries of the 1:100 flood, the importance of larger events is clear. The problem becomes one of how to cope with the extra area inundated by the MPF and with the extra flood depth within the regulatory floodplain. The severity of the additional risk in terms of tangible and intangible flood damages is related to the difference in flood depth between the 1:100 and MPF levels, and to the issues of warning time and population preparedness. In the study sites the flood depth difference is moderate at between one and two metres.

The comments regarding warning time and preparedness apply particularly to locations with an isolation risk. Areas that are not totally isolated or that appear as "safe" islands in the regulatory flood may become death traps in the event of an extreme flood if warning or preparedness are deficient. Information on potential isolation is of particular interest to State Emergency Service (SES) personnel, who are responsible for the evacuation and flood related safety of floodplain residents.
In many cases it would be socially, as well as economically and administratively, undesirable to regulate strictly the entire MPF area. Nevertheless the area should be treated as flood prone in land use and emergency planning.

4.3.3 Guidelines For Hazard Assessment
4.3.3.1 General

Guidelines should be based on the critical factors identified above, and should pay special attention to the depth and extent of the MPF. At this point a comment should be made about the Flood Hazard Factor (FHF), which is the difference in depth between the 1:10 and 1:100 floods. The factor is often used as a measure of flood damage susceptibility, especially in the US where it underlies insurance premium calculations. The relationship between the FHF and damages is explored in the next chapter, but in general the greater the FHF the greater the potential damage. As the FHFs in the three study sites are virtually identical no detailed assessment of the measure was undertaken. However, examination of a representative selection of Australian FHFs showed no systematic spatial variation, for example between inland and coastal rivers (Table 4.1).

The assessment of residential flood damage susceptibility is for only one structure type, a single story timber dwelling, though in fact the final data are averages representing the performance of different structure types. In their manual for flood damage assessment in the UK Penning-Rowsell and Chatterton (1977) identify 80 different residential stage damage curves. These are based on 21 types of dwelling classified by architectural style and structure age, subdivided by the socio-economic status of the occupants. Such detail is considered unwarranted in the present study because: there is a lack of suitable Australian data; most floodplain houses are of one type, single story, detached; and there is evidence that construction material makes little difference to structural flood damage, (Smith et al, 1983).
Table 4.1: Flood hazard factors (FHF). Both the FHF, the height difference between the 1:10 and 1:100 floods, and the difference between the 1:5 and 1:100 levels are shown for a selection of Australian sites.

<table>
<thead>
<tr>
<th>SITE</th>
<th>HEIGHT DIFFERENCE (metres)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:10 - 1:100 (FHF)</td>
<td>1:5 - 1:100</td>
<td></td>
</tr>
<tr>
<td>Forbes</td>
<td>0.5</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Ingham</td>
<td>0.6</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Murwillumbah</td>
<td>0.7</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Lismore</td>
<td>0.8</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Georges River</td>
<td>1</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Cootamundra</td>
<td>1</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Gunnedah</td>
<td>1.2</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Cooma</td>
<td>1.2</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>Narrabri</td>
<td>1.2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Moree</td>
<td>1.2</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Echuca</td>
<td>1.3</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Nowra</td>
<td>1.5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Wagga Wagga</td>
<td>1.5</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Bathurst</td>
<td>1.8</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Casino</td>
<td>1.8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Denman</td>
<td>1.8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Singleton</td>
<td>1.8</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Bega</td>
<td>1.95</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Camden</td>
<td>2.4</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Gundagai</td>
<td>2.5</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Aberdeen</td>
<td>2.6</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Muswellbrook</td>
<td>2.9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Penrith</td>
<td>3.6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Queanbeyan</td>
<td>3.7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Bingara</td>
<td>4</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Brisbane</td>
<td>5.8</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Dubbo</td>
<td>6.2</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>
4.3.3.2 Water Depth and Velocity

A number of attempts have been made to systematically incorporate water depth and velocity into flood risk analysis (Bonham and Hatersley, 1967; Foster and Cox, 1973; Sangrey et al 1975), but the most comprehensive work appears to be that by Sinclair Knight and Partners in conjunction with the NSW Public Works Department (Mathlin, 1983; Russell, 1982). Their model combines water depth and velocity to produce a series of flood risk categories and forms the basis of the recommended flood risk analysis procedure. The model is based on: other studies; practice, for example floodways declared under the Hunter Valley Flood Mitigation Act; and experience in terms of flood damage to structures in NSW and elsewhere; all modified in the light of expert opinion. The main data sources and their contributions are illustrated in Figure 4.1.

Two American data sources are of particular relevance to the present report. The Corps of Engineers' empirically derived damage criterion "states that any combination of water flow velocity and depth which exceeds a value of nine in a multiplied product is beyond damage limits for light single story dwellings": ie. \( V \) (feet/second) \( D \) (feet) < 9, where \( V \) equals velocity and \( D \) depth (quoted in Sangrey et al 1975:19); Figure 4.1). However, when compared with the results of Sangrey et al's own study, these results appear to be very conservative, even for light housing. As part of an attempt to improve the prediction of the effects of floods on structures these researchers undertook a case study of structure damage following a severe flood. Results of the case study were graphed in a non-dimentionalised form representing the hydraulic loading on structures. "Presented in this form there is a clear and general separation between the destroyed and surviving structures" (p.15). Converted to a depth/velocity relationship this result is shown on Figure 4.1.

Australian experience as shown in Figure 4.1 is very variable compared to Sangrey et al's model. Water depths of only one metre have proven sufficient to destroy or badly damage dwellings even when associated with only moderate velocities of about 1.5 metres per second. Nevertheless, this is still a substantially greater force than that calculated by the Corps of Engineers damage criterion. That the results are different to those of Sangrey et al should not be surprising. The
Figure 4.1: Main data sources for guideline construction. Sources: Russell (1982), Mathlin (1983).
Figure 4.2: Guidelines for floodplain management, based on water depth and velocity during the regulatory flood. Sources: Russell (1982), and Mathlin (1983).
American study examined a large number of buildings at one site and its final figures constitute an average. In contrast the Australian data are individual examples, some of which represent substandard structures in poor condition.

An interesting aspect of Sangrey et al's results is the relative unimportance of water velocity over the range examined (up to 3m/second). Instead depth appears to be the critical factor. From the line plotted in Figure 4.1 it is evident that in water exceeding 2m in depth unraised dwellings are likely to be destroyed or lifted off their foundations by hydraulic loading or buoyancy. This result in no way affects conclusions regarding the danger of flowing water to individuals. These dangers are demonstrated by two Australian studies which examined the stability of cars and people in flood flow to establish criteria for the safe design of submersible causeways. Results are in the form of graphs indicating the limiting conditions in terms of water depth and velocity for vehicles (Bonham and Hattersley, 1967) and children (Foster and Cox, 1973)(Fig 4.1).

Despite the evidence of dwelling vulnerability, practice in floodway management in Australia is very variable. Many developed floodways in NSW coastal settlements fall well above the Sangrey et al depth limit and are subject to high flow velocities as well. Only areas delimited by the Victorian "flood fringe" criteria are within all the damage and safety limits marked on Figure 4.1, including those for children, and vehicles. The Victorian criterion specify that "the flood fringe should not include lands where: the depth of the designated flood level above natural surface exceeds 0.5 metres.(and) The velocity of the flow exceeds 1 metre per second" (Victoria, WRC, 1978:42). Application of this standard to exclude residential development from undeveloped areas might be feasible. But, it is of little use as a delimiter of areas for acquisition, as far too large an area and number of dwellings would be involved. In view of the extent of encroachment into high flood risk areas a more realistic standard is that of Sangrey et al, combined with velocity data from Australian examples of dwelling destruction. This combination limits housing to locations subject to water less than 2m deep and/or a velocity of less than 2m per second (Figure 4.2). Lower limits based on the Corps of Engineers criterion and other data are also shown on Figure 4.2.
Unfortunately, precise velocity measurements are generally not available. All that is usually possible is to simply indicate zones of "high flow" as priority areas for exclusionary zoning and clearance if necessary.

Thus a flood depth of 2 metres is the recommended key measurement. Apart from its ease of application, the recommended measure has a strong logical basis, as for practical purposes it alone represents the survival limit for typical unraised dwellings. The major issue remaining is the selection of a flood level against which to measure the depth and velocity criteria. Ideally the maximum probable flood should be employed. In practice, use of the regulatory 1:100 level is more likely.

4.3.3.3 Isolation and Warning Time

General

Data with respect to appropriate warning times present widely varying results, and no quantitative material on isolation risk is available, or appears likely to become available. The case study sites provide some information on both factors. On the basis of this information combined with that available from the literature, guidelines for assessing the importance of isolation risk and warning times were prepared. These were discussed with workers in the field, and as modified are presented in the following sections (Table 4.3).

Regardless of the broad generalisations contained in the guidelines, the effectiveness of warning times and the importance of isolation depends on the preparedness of the affected population. Prior flood experience is a major component of preparedness, but age, health, income and other socio-economic variables may also affect response (Chapter 6).

Isolation

At the present level of knowledge the decision as to what constitutes dangerous isolation (lack of access during floods) is somewhat arbitrary and subjective. The decision should consider the safety of both the property occupiers and emergency service personnel, and the provision
of access at very short notice for emergency facilities such as ambulance, police and the fire brigade. Some guidelines are offered:

(i) Flood free access for both residents and emergency service personnel is most important in areas where warning times for the regulatory event are limited (6 hours or less), or virtually non-existent (flash flood). "Flood free access" means that the presence of flood water should not make access to a dwelling dangerous. Water depth and velocity should be within the zone marked "low hazard" in Figure 4.2.

(ii) Particularly dangerous are areas that are flood free and isolated at low flood levels and thus appear to be safe "islands", but which become completely inundated at higher flood levels.

Warning Time

The minimum desirable warning time is closely associated with the isolation factor. Clearly the threat and danger of occupying a site prone to isolation is related to the available warning time: a short warning period requires substantially better flood free access to maintain the same degree of safety as a site with a lengthy warning time.

In this context warning time refers not to the technically feasible length of warning, but to that available to the population to act on, the "effective warning period". Estimates of adequate community warning times must take into account: that the warning takes much longer to reach some than others; that some individuals respond poorly; that the effectiveness of response at the community level is largely a function of community flood experience; and that various environmental factors might inhibit response, for example the flood might occur at night, or there may be phone or power failures.

Evidence from other work on flood damages suggests that, unless the community is well prepared, the amount of damage reduction is very much smaller than that theoretically possible. In 1974 Brisbane residents had little or no flood experience. Actual 1974 flood damages are estimated to have been very close to potential damage, in other words there was little damage reduction as a result of the official flood warning, though many lives may have been saved (Sinclair, Knight & Ptns et al, 1982). By contrast, Smith (1981) found that in Lismore an experienced and well
prepared population, acting on a 6-12 hour warning, suffered actual losses equal to half (48%) the potential loss for the 1974 flood. This degree of damage reduction is approximately the same as the theoretically estimated maximum feasible reduction of 40% given a four hour warning (Penning-Rossell and Chatterton, 1977). Also the upper limit of the normally available warning time in Lismore of 6-12 hours is the same as that regarded by Mileti (1975) as the minimum requirement for maximum effective damage reduction. Differences between the Lismore and Mileti figures, and Penning-Rossell and Chatterton's results are a reflection of the assumptions underlying the two theoretical studies. The results and assumptions of these and other studies are set out in Table 4.2.

On the available evidence only a rough classification of warning times is justified. The preliminary classification developed and recommended in this report to assist in site safety evaluation is set out in Table 4.3. The most important class is probably the first, which defines "flash floods". The warning time for these events is too limited to be able to guarantee safe evacuation, or substantial damage reduction, given the factors affecting response to warnings. Although a number of studies estimate that substantial savings are theoretically possible with warnings as short as 30 minutes, the US National Science Foundation (1977) and National Weather Service (Mileti, 1975) regard six hours as the limit of effective warning. Furthermore, in practice the main thrust of flash flood warnings is personal safety rather than flood damage reduction, apart from those savings possible from halting transportation, and shutting off utilities such as gas and power. Researchers have devoted less attention to very long warning periods. However, lengthy lead times of the order of two days or more may enable special types of response, such as the construction of private levees in Echuca West (Section 3.3.4.5), and are therefore included as a separate category.

Thus a particularly hazardous situation exists where, for the regulatory flood, warning time is short (<6 hours), isolation occurs rapidly, and where low population preparedness reduces the effective warning time still further. Conversely a relatively safe situation is where the rate of river rise is slow and isolation occurs gradually, warning time is long (>36 hours), and the population has prior flood experience. A preliminary qualitative index of warning time and isolation
TABLE 4.2: Results of studies into flood warning times, for occupiers of urban residential development.

<table>
<thead>
<tr>
<th>STUDY</th>
<th>LENGTH OF WARNING</th>
<th>DAMAGE REDUCTION</th>
<th>ASSUMPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penning-Rowsell &amp; Chatterton, 1977; (Bussell, 1976)</td>
<td>1 hour</td>
<td>3% of property value per hour up to 4 hours</td>
<td>Time is from individual receipt of warning. No allowance for night etc. Assumes 80% react appropriately.</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
<td>75% contents</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% total property</td>
<td>(exact figures depend on depth)</td>
</tr>
<tr>
<td>Mileti, 1975</td>
<td>40 hours</td>
<td>Maximum damage reduction occurs at 40 hours lead time, and is about 20%.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 hours</td>
<td>12 hours warning maximum effectiveness</td>
<td>Well prepared small community.</td>
</tr>
<tr>
<td>U.S. National Science</td>
<td>6-12 hours</td>
<td>Limited warning</td>
<td></td>
</tr>
<tr>
<td>Foundation, 1980</td>
<td>12-24 hours</td>
<td>Maximum practical evacuation. Damage reduction 25 - 33%.</td>
<td></td>
</tr>
<tr>
<td>Downing, 1977</td>
<td></td>
<td>flood frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1:25</td>
<td>1:50</td>
<td>1:100</td>
</tr>
<tr>
<td></td>
<td>30 minutes</td>
<td>7%</td>
<td>18% 23%</td>
</tr>
<tr>
<td></td>
<td>45 minutes</td>
<td>19%</td>
<td>28% 33%</td>
</tr>
<tr>
<td></td>
<td>60 minutes</td>
<td>29%</td>
<td>38% 43%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assumes total response. Maximum probable reduction to contents. (Actual reduction to contents damage would probably be half these estimates).</td>
<td></td>
</tr>
<tr>
<td>Loss reduction for cars</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 minutes</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45 minutes</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 minutes</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.3: Qualitative indices of warning time and isolation risk. Indices are based on case study sites and other data. Scale from 1 to 5 with decreasing danger.

### WARNING TIME

<table>
<thead>
<tr>
<th>Study site</th>
<th>Time (hours)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Lismore</td>
<td>6 - 12</td>
<td>2</td>
</tr>
<tr>
<td>-</td>
<td>12 - 24</td>
<td>3</td>
</tr>
<tr>
<td>Wagga</td>
<td>32 - 50</td>
<td>4</td>
</tr>
<tr>
<td>Echuca</td>
<td>36 - 120</td>
<td>5</td>
</tr>
</tbody>
</table>

### ISOLATION

(Speed and degree of isolation)

<table>
<thead>
<tr>
<th>Study site</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond River (Cabbage Tree Island)</td>
<td>1</td>
</tr>
<tr>
<td>(Newry Island, Urunga)</td>
<td>2</td>
</tr>
<tr>
<td>South Lismore</td>
<td>3</td>
</tr>
<tr>
<td>North Wagga</td>
<td>4</td>
</tr>
<tr>
<td>-</td>
<td>5</td>
</tr>
</tbody>
</table>
risk based on the three study sites is set out in Table 4.3.

4.3.4 Application to Study Sites

To illustrate the recommended procedures for hazard assessment they were applied to the case study sites as illustrated in Figures 4.3 to 4.7. (The Figures are found at the end of the Chapter).

For all three sites the depths, and where the information was available, areas of high water velocity, were mapped for the 1:100 flood, representing the regulatory event. In addition, estimated water depths during the MPF were mapped for Echuca West and Lismore. No MPF data were available for Wagga. Depths are mapped in 1 metre increments up to 3m; the categories are <1m, 1-<2m, 2-<3m, and 3m or more. Ideally velocity should also be mapped quantitatively. However the information is simply not available. Fortunately as already mentioned in Section 4.3.3.2 depth appears to be the critical variable where structural integrity is concerned, at least over the range of velocities examined.

Depths for the 1:100 flood were obtained by mapping the difference between ground height and available information on flood water surface levels. In this way flood slope or gradient was incorporated into the analysis, though the data quality varied between sites, and was only available for one major recent flood at each site. These floods were not 1:100 events, but were very close to that magnitude in Lismore and Wagga, so that for Lismore the record 1974 flood was mapped as the 1:100 flood and only 0.17 of a metre was added to the surface of the 1974 Wagga flood. Echuca West depths were mapped using 1:100 flood level information provided by the Victorian State Rivers and Water Supply Commission as part of their Echuca Flood Study (1979). Details of information sources accompany the maps. The MPF flood slope is assumed to be identical to the 1:100 slope; an inadequate assumption, but the best presently possible given the limited data. It might be feasible to provide improved estimates of MPF flood slope using computer backwater programs, but this is beyond the scope of the present study.

Following the criteria established above, ideally no new residential development should be permitted in areas which are inundated
to depths of 2m or over in the MPF, and any other urban development in such areas should be subject to the development safety criteria set out in Chapter 8. Dwellings in these high risk areas should be acquired, and demolished or relocated, especially if the areas rank high on short warning time and isolation dangers. However, setting standards on the basis of the MPF is probably a somewhat utopian exercise given the serious nature of the flood problem in the study sites.

On the basis of the MPF depth maps (Figures 4.5 and 4.7) almost all of Echuca West and the Lismore floodplain would be inundated with over 3m of water, except for South Lismore where the water would be between 2 and 3m deep. Also, the MPF maps alone disguise the fact that substantial areas would be subject to very much greater depths than these, especially in Lismore. Use of the 1:100 flood maps adds extra information. In Lismore areas inundated to over 3m at the 1:100 level would be covered by more than 4.5m of water during the MPF.1

A more realistic starting point might be the 1:100 flood, especially as this constitutes the official regulatory flood under NSW and Victorian government policy. It is clear from the maps (Figures 4.3 to 4.9) that a substantial proportion of each site is under more than 2m of water at the 1:100 flood level. In Lismore this includes virtually the entire floodplain apart from much of South Lismore. Here the greater than 3m depth category acts as an aid in setting acquisition priorities. There is considerable residential development in some of these extremely dangerous areas, including much of North Lismore, and in Lismore Basin around Little Keen/Zadoc/Dawson Streets and the Victoria/Parkes Streets areas. From Figure 2.2 it is evident that these areas are the City's first priority for acquisition, as they should be.

The situation at the other sites is not as clear cut as Lismore: Although much of Echuca West is under more than 2m of water during the

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1. This section is based on information available at the time of writing. Recent estimates provided by the Lismore office of the PWD suggest that the 1:100 flood level is slightly higher than the 1974 event, and that the MPF would be 2m, rather than 1.5m, higher than the 1974 flood.
1:100 flood most of the houses are in areas inundated to between 1 and 2m. Of course, this is still an unacceptable risk for residential development where alternatives exist especially as the higher areas are isolated by deeper water. An exception to this is the cemetery sand hill area, part of which would probably be flood-free even in the MPF, though it would be unwise to rely on this, and in the event of such a extreme event being forecast the area should be evacuated. It should be noted that the residents of Echuca West, although experienced with floods, have not experienced floods even approaching the estimated depths of the 1:100, and for most houses their normal mitigation measures of private levees etc would be quite inadequate.

At first sight on straight depth/velocity grounds North Wagga appears to have the least serious flood problem, nevertheless much of the development is in the "greater than 2m" zone at the 1:100 flood level.

Application of a isolation factor substantially alters the degree of hazard in North Wagga. The qualitative isolation factor described above was applied in two stages. First the degree of isolation was assessed by examining at what flood severity the area is cut off, whether it is inundated by the 1:100 and MPF and if so how deep the water is over the isolated area. Results are shown in Table 4.3. From an isolation perspective Echuca West is by far the safest site, followed by North Wagga and then Lismore. Second, the apparent isolation danger is modified to take account of the warning times. This has the effect of increasing the risk in Lismore where the warning time is short, and the rate of river rise rapid, and of decreasing it substantially in Echuca where rate of rise is slow and warning time long. Thus the relative danger of the three sites remains the same: with Lismore the worst because of its short warning time and the isolation of South Lismore, followed by North Wagga and Echuca West.

An important point is the lack of MPF data for Wagga. A MPF height substantially greater than the 1:100 level would increase the danger associated with isolation of the village.

In addition to its role in site safety evaluations the mapping of the MPF serves a number of purposes. Information on the height and extent
of the MPF is a prerequisite for most economic analyses in flood damage reduction assessment (Section 5.3.3.2). Its absence for Wagga reduces the value of average annual damage estimates for that area. As well the MPF maps for Echuca and Lismore illustrate the probable worst flood situation, and emphasises the need for emergency planners to develop contingency plans for these extreme events rather than planning up to the regulatory event only as is usually the case.

### 4.4 LIMITATIONS OF THE RECOMMENDED METHOD

#### 4.4.1 General

The recommended method has been successfully applied to the case study sites, but major limitations are apparent. These are of two types: political, which concerns selection of the regulatory flood (Section 4.3.2); and those of a technical nature, principally problems inherent in flood risk delineation.

#### 4.4.2 Uncertainty in Flood Risk Delineation

##### 4.4.2.1 Introduction

The apparent precision of depth criteria based on a standard regulatory flood of specified probability is illusionary. Every step in the preparation of flood frequency/magnitude estimates and delineation of the flood risk introduces substantial error or uncertainty into the calculations. Uncertainty is inherent in both hydrologic/hydraulic work and the topographic mapping: "wide confidence intervals are unavoidably associated with even the most elaborate and expensive delineation techniques" (Dingman and Platt, 1977; also see Thomas, 1978).

In planning terms, the importance of this zone of uncertainty depends on the extent of the zone, and the costs of development forgone, or development permitted and subsequently flooded. As far as the acquisition criteria developed in this chapter are concerned the critical factor is the uncertainty surrounding the regulatory flood height. Where the zone of uncertainty includes a large area above the regulatory flood line there are
also implications for emergency management. Residents of the unregulated zone may be excluded from emergency plans, and may be lulled into a false sense of security. Similar implications may arise in areas protected by structural works.

Major sources of error and uncertainty associated with the delineation of flood prone areas are:

(i) the flood record; sampling and measurement,
(ii) estimates of flood discharge and frequency,
(iii) hydraulic analysis, in particular for overbank flow,
(iv) local inflow, availability of natural water storages, that the floodway assumed by the analysis is not blocked, and other local factors,
(v) errors in topographic maps.

4.4.2.2 The Flood Record

Sampling

In general the single major limiting factor with streamflow data is the length of record. This is because any river flow record, of for example daily maxima, is only a small sample of the indeterminately long total population of (in this case) daily maximum flows. Table 4.4 shows that substantial sampling uncertainty is unavoidable even when the record is over 100 years in length (Burges, 1979; Linsley et al., 1975). The Echuca record illustrates the immense potential error, or area of uncertainty. Here the 1870 flood is estimated to have a return period of 188 years with a lower limit of 60 years and an upper limit of 700 years, within one standard deviation or \( \pm 68\% \) when expressed as a percentage (Victorian State Rivers and Water Supply Commission, 1979; Table 4.5).

These broad confidence limits reflect uncertainty due to sampling errors only. They do not reflect deficiencies in measurement, nor do they take account of changes in streamflow characteristics resulting from human activities or climatic variability. Particularly obvious human activities include alterations due to dam construction and stream channellization.
Table 4.4: Length of record in years required to estimate flood discharges of various probabilities with 95% confidence (Linsley, Kohler & Paulus, 1975).

<table>
<thead>
<tr>
<th>Design Probability</th>
<th>Acceptable Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+10%</td>
</tr>
<tr>
<td>0.1</td>
<td>90</td>
</tr>
<tr>
<td>0.02</td>
<td>110</td>
</tr>
<tr>
<td>0.01</td>
<td>115</td>
</tr>
</tbody>
</table>

Table 4.5: Confidence limits for Echuca flood probabilities. Length of record is 110 years (partial duration series)
Confidence limits are calculated using a method set out in Alexander (1956), and results are for a 68% confidence level (1 standard error) (Victorian SR & WSC, 1979).

<table>
<thead>
<tr>
<th>Flood</th>
<th>Estimated Return Period</th>
<th>Confidence Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Return period in years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Limit</td>
</tr>
<tr>
<td>1970</td>
<td>188</td>
<td>60</td>
</tr>
<tr>
<td>1:100(approx 1867)</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>1975</td>
<td>36</td>
<td>20</td>
</tr>
</tbody>
</table>
Less obvious are the well documented, but frequently overlooked, changes to flooding probabilities on smaller streams due to catchment clearing or urbanisation (Doehring et al., 1975; Hollis, 1975; Lazaro, 1977; Barnard, 1978; Australia-NCDC, 1980).

Changes in streamflow due to climatic variation may radically alter flood frequency/magnitude calculations. The effect of such changes on the Richmond and other North Coast rivers, and their implications for planning are discussed in Section 2.3.2.1. Climatic variability may substantially reduce the value of very long records for 1:20 floodway delineation, cost-benefit work and other analyses over typical planning periods. In contrast, as the observed variability has little effect on less frequent floods (of the order of 1:100), confidence in their estimated probability increases with record length.

Frequently the streamflow record is too short to reliably estimate the design flood, and a variety of methods may be used to extend the record: tree ring data can extend the record back some hundreds of years, but for seasonal flow only (Holmes et al., 1979; Stockton, 1975; Stockton and Boggess, 1979); sedimentary analysis of slackwater deposits, has extended the flood record back 10,000 years for certain rivers of the Balcones Escarpments region of Texas (Costa, 1978(a), 1978(b); Kochel, 1980; Patton, 1977); computer simulation (Burgess, 1979), and regional flood analysis; and in Australia daily rainfall records used as surrogates for streamflow have proven successful when record length is very short (less than ten years) (Boughton, 1976).

**Measurement and Discharge Estimates**

Errors in the streamflow data itself must be added to those due to sampling. Inevitably even the best streamflow record will include missing sections and measurement inaccuracies. A typical set of good discharge data (US Geological Survey standards) will have 95% confidence intervals of ±10%, in other words it is 95% certain that the true values lie within ±10% of the measured values (Dingman and Platt, 1977). A range of potential problems may greatly reduce confidence in the record: artificially induced changes in streamflow, changes in catchment conditions and changes in gauge datums. Most concern however, centres on obtaining good discharge
measurements, because it is usually here that the greatest errors occur. Boyer (1962).

Further errors are inherent in the methods used to construct rating curves and other approaches to discharge estimation. For example, the slope-area method of discharge measurement suffers from channel cross-section problems as well as from the need to determine a Mannings "n" roughness coefficient. Mannings "n" is an estimate of the surface roughness of stream channels and floodplains, and is especially difficult to estimate where overbank or flood flow is involved (Pattison, 1977). Problems in discharge measurement may be avoided by employing river stage records for flood probability calculations, as used by the NSW Public Works Department in Lismore and elsewhere.

Hydraulic Analysis

Mannings "n" is also a critical component in the calculation of backwater curves, which are a necessary part of flood mapping. Small errors in "n" may result in large errors in discharge estimates. The channel slope, size, shape, and relative roughness affect the coefficient. Typical values for "n" range from 0.010 for smooth surfaces such as glass or plastic, to 0.050 for mountain streams with vegetated rocky beds. In addition estimates made for alluvial streams are complicated by the behaviour of the bed material. Mannings "n" values increase by nearly 50% as the sand waves vary from a plane bed to antidunes. In summary, "Mannings Roughness Coefficient (n) is extremely difficult to estimate reliably for a natural stream, particularly at high discharges when over-bank flow occurs" (Pattison, 1977: 71).

4.4.2.3 Errors in Mapping

Further error is introduced when transferring the flood-risk information to a map. Here the principal problem is the inherent vertical and horizontal inaccuracy of topographic maps.

Topographic map standards typically specify that 90% of the map points tested should have an elevation within one half of the contour interval (Canadian Federal flood-map standards; Royal Australian Survey
Table 4.6: Ninety percent confidence intervals for the Location of a contour line, (with standard contour map precision) (Dingman & Platt, 1977).

<table>
<thead>
<tr>
<th>Land Slope (Tangent)</th>
<th>Contour Interval in metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>2500</td>
</tr>
</tbody>
</table>

190% confidence interval for horizontal position = 1 x contour interval/2 x slope tangent

Corps standards; U.S. Geological Survey mapping standards). Thus theoretically, on a map with 2 metre contour intervals 10% of all points may have a vertical error of greater than 1m, while for 90% of the points the actual elevation will lie within a 2m range. The significance in practical terms of this error source will depend largely on the shape and slope of the valley cross section. On a gently sloping floodplain this zone of uncertainty represents an enormous area which may be included or excluded from land use control, emergency plans and so on (Table 4.6).

Horizontal mapping error is introduced by: compilation tolerances typically of the order of 1/2mm (including errors in the photogrammetric compilation process); by the width of lines and size of symbols drawn on the map, and by line "edge growth" resulting from overinking. At scales used by the NSW Water Resources Commission (WRC), 1:12672 for the Forbes flood map, uncertainty introduced by line width and cartographic tolerances is small compared to other sources. On this map major streets are shown by lines 0.5mm wide representing about 6m on the ground. However, the 1:25000 scale of some preliminary floodplain maps is such that the compilation error alone represents 12m on the ground. At this scale inherent cartographic tolerances may make determination of the flood risk of individual sub-division plots virtually impossible as the error may exceed property size.
The extent of errors due to the overinking of greytone symbols is not discussed here as most published flood maps do not use greytone symbols. Nevertheless it is worth noting the potential magnitude of this problem: "results indicate that printing is at least as significant a potential source of error in cartographic communication as perception" (of the size and density of greytone symbols) (Monmonier, 1980).

4.4.2.4 Other Factors

The real significance of these errors, in terms of area on the ground will depend on the importance of valley slope and morphology, especially in cross section (Table 4.5)(Wolman, 1971), and other local factors influencing flood levels (Handmer, 1976). Local factors include: natural levees; rainfall and antecedent water levels in swamps and depressions; tributary inflow; wind and wave set-up, especially in coastal settings either on the floodplain or at the outlet to the sea; high sea levels due to tidal phase or storm surge; and in some areas, for example the Shoalhaven River, the condition of the entrance bar may be critical (Handmer, 1976). These variables frequently defy quantification in ways that would enable their inclusion in flood risk calculations, yet may overshadow all other sources of uncertainty.

In summary, error is most likely to be significant when the regulatory flood is a hypothetical event with a specified occurrence probability; the flood record is short (say less than 60 years (Burges, 1979), contains suspect data, or the local rainfall, run-off or channel characteristics have changed as a result of human activities or natural causes; the main channel gradient is low (up to about 1:2000 (Burges, 1979) or the floodplain slope to the river is small (less than 1:300); and in situations such as occur on certain coastal floodplains where a range of factors for which only limited or no data exist.

Methods of coping with this uncertainty include: eliminating errors associated with mapping by using ground survey whenever precise flood height information is required; using airphotomaps to eliminate horizontal mapping errors for flat areas; showing the estimated flood limit as a zone (of uncertainty) rather than a line; the use of an economic approach suggested by Hughes (1980), which essentially ignores the
uncertainty above the lowest (highest probability) estimate; and depending on the degree of local flood risk in terms of depth and velocity, the enforcement of flood proofing regulations up to the most conservative, or lowest probability flood estimates.

Flood "losses are not likely to decrease, however, if we continue to make decisions from map data while ignoring inherent map error" (Vitek and Richards, 1978). Uncertainty about the exact location of regulatory floods, however, must not be used as an excuse for inaction in checking floodplain encroachment. The fact is that although hydrological and cartographic uncertainty may be very significant from a technical and legal perspective the practical problems in many jurisdictions do not occur in zones of uncertainty; rather development has been (and is being) permitted in areas which are clearly flooded more frequently that the 1:20 floodway limit of the NSW government, and where the potential for catastrophic losses is undeniable. Ultimately the importance of uncertainty may be decided in the courts. American experience suggests that the legal system will uphold delineations reached on the basis of established engineering practise.

4.5 CONCLUSIONS

Safety standards based on physical science data have been developed and applied to the three study sites. The criteria delimit areas of exceptionally high flood risk and should be regarded as absolute limits. During the regulatory flood dwellings in these areas are likely to be destroyed or severely damaged by floatation or water pressure. Damage to contents and risk to life are also likely to be high.

The main criteria, water depth and velocity, are drawn from a model developed by Sinclair, Knight and Partners and the NSW Public Works Department. A number of other physical factors were found to be important in determining the degree of flood hazard, but their systematic application is restricted by lack of data. However, enough information exists for the construction of a preliminary index of warning time. Because of its importance in safety considerations a preliminary qualitative index of isolation risk was also developed.
A number of depth/velocity risk zones are shown on Figure 4.2, but as far as acquisition is concerned the areas of greatest interest are those inundated by two metres or more during the regulatory flood. New development should be prohibited in these locations, and consideration should be given to acquiring existing development. The hazard model also contains velocity criteria. However, in general detailed velocity data are not available, though high flow zones will be local knowledge. Fortunately, over the range of velocities examined (up to 3m/second), flood depth appears to be the critical variable as far structure damage is concerned. Nevertheless, current is important in gauging personal risk to residents and State Emergency Service workers, and high flow zones (>2m/second) should not be used for residential development.

Where the warning time for the regulatory flood is less than six hours the area is considered to have a "flash flood" potential, and special attention should be paid to warning dissemination. Ideally areas where flood warnings are less than six hours or are unreliable should be acquired or remain undeveloped, especially if other physical flood hazard acquisition criteria are met or approached. This is particularly important in locations with a high isolation risk. Such locations may become death traps in the event of a major flood occurring with little warning. Unfortunately, (given its importance), the isolation "index" presented in this chapter is of a subjective nature and not transferable to other sites. Considerably more work is needed to put the isolation factor on a quantitative basis. All other physical criteria would also benefit from further research.

The criteria were mapped for the three case study sites. Lismore has the highest overall risk because of water depth (and velocity), its short warning time, and isolation of South Lismore. North Wagga follows with a very high isolation risk, while Echuca West is less dangerous with a long warning time, and minimal isolation risk, but with the potential for very deep flooding. As recommended the extents and depths of the maximum probable floods were also mapped for Echuca and Lismore. These maps show the probable worst flood situation and are essential for comprehensive emergency planning. With each study site flood warning times and flood duration do not vary spatially, and were therefore not mapped. However, the variation may be substantial at sites such as Adelaide which experience
both major riverine flooding and flash floods from small urban creeks.

The procedures do not provide entirely apolitical acquisition criteria as they are based on the regulatory flood (though they could be tied to the MPF). Other limitations include the errors inherent in any flood risk delineation based on flood probabilities, and the apparent bias of the procedures towards coastal settlements. Compared to inland rivers, in general coastal areas are subject to deeper and faster flood flows, have much shorter warning times, and greater isolation risks. Any state-wide assessment of flood damage reduction priorities will therefore tend to direct resources to coastal areas. However, political decisions can and will be made to distribute flood mitigation funds on a regional basis, in which case the recommended procedures are useful in setting within region priorities.

Use of a probability based regulatory flood is a potentially important limitation of the method. The main deficiency of this approach is the variable residual risk, that is flood risk between the 1:100 and MPF expressed in terms of depth, velocity, isolation and so on. This additional risk, which varies greatly between sites, is ignored unless the recommended criteria are mapped for the MPF. Ideally, the MPF should be used as the basis for floodplain regulations. However, given the extent of floodplain development this is generally not feasible. Nevertheless, a flood hazard analysis is not complete without reference to the MPF.

While the physically based criteria provide a useful avenue for the delineation of potential acquisition areas, other avenues should be explored, which may assist in putting the decision to acquire on a more consistent and apolitical basis.
Figure 4.3: Flood depths and flow pattern in North Wagga during the 1:100 flood. Sources: base map, ground contours and flood water surface level from City of Wagga Wagga (n.d.), 1" to 4 chains map of "Topography and traditional flow pattern..."; 1:100 flood height from Sinclair, Knight & Ptns (1979).
Figure 4.4: Flood depths in Echuca West during the 1:100 flood. Sources: map base, ground height data and 1:100 flood surface levels from Victorian SR & WRC (1981).
Figure 4.5: Flood depths in Echuca West during the maximum probable flood. MPF estimate from Victorian SR & WRC (1979) is 97.25m AHD.
Figure 4.6: Flood depths in Lismore during the 1:100 flood.

Sources:
- Base map, "City of Lismore" tourist map, Lismore City Council.
- Ground surface contours, Orthophoto 1:4000 series.

1. Information now available from PWD, Lismore, suggests that the 1:100 level may be slightly higher.
Figure 4.7: Flood depths in Lismore during the MPF.

CHAPTER 5

ECONOMIC CRITERIA FOR ACQUISITION

5.1 INTRODUCTION

The safety criteria developed in Chapter 4 are solidly based, but it is recognised that other approaches may provide complementary standards, which may be more acceptable and more easily applied under existing administrative arrangements and legislation. Economic procedures have been used widely for the evaluation of structural flood damage reduction measures. In fact in the past many jurisdictions employed economic analysis as virtually the sole criterion for the feasibility of structural works. Although at first sight economic procedures might appear to provide a workable complementary approach to area selection based on physical criteria, a number of potential problems exist. The first of these concerns the difficulties in applying to land use management the economic procedures traditionally used for structural works. The apparent inapplicability of the funding procedures is generally thought to have been an important reason for the lack of political interest in non-structural measures (Section 3.2). Second, evaluative procedures have not been applied in a uniform fashion, and analyses have been subject to political and administrative manipulation. Measurement and procedural uncertainties, in particular with respect to how, and indeed whether, to include intangible costs and benefits, appear to have facilitated this manipulation.

Hence the rationale for a detailed examination of the tangible and intangible costs and benefits of acquisition is broadly similar to that for the previous chapter on physical criteria: that is to try to establish universally applicable standard procedures, with special effort devoted to intangibles, as part of the attempt to improve the floodplain management decision-making process. A major aim of this improvement is to provide criteria which may make decisions more consistent and less subject to local politics.

An economic approach to flood damage reduction requires examination of the benefits, in terms of flood damages avoided, and of the costs of implementing the strategy. Also a technique for comparing costs and benefits must be selected. Innovative procedures for assessing flood
damages, including intangibles, will be presented, and techniques for the economic evaluation of flood adjustments are to be reviewed. The recommended procedure for flood damage assessment was developed by Sinclair Knight and Partners (Consulting Engineers) in conjunction with the author, D.I. Smith (CRES, ANU), and T. Lustig (Environmental Management, consultants).

The economic viability of acquisition in the study sites will be assessed in two ways: first, using criteria developed in North America, and secondly by applying the recommended procedures for evaluating the costs and benefits of acquisition to Lismore. Finally, if there is reasonable agreement between the overseas data and the present study on the economic grounds for acquisition, it should be possible to confidently recommend criteria.

5.2 FLOOD DAMAGE ASSESSMENT

5.2.1 Types of Damage

Flood losses are referred to as direct when damage is caused by the physical contact of property with flood water or debris, and indirect when the losses result from the disruption of normal economic and social activities. Indirect damages may occur during or after the flood, and may include disruption to schooling, transport, trade, production, tourism, and the cost of flood fighting and cleaning up. These two major categories of loss are further subdivided into tangibles and intangibles according to whether or not the items can be valued in conventional economic terms. Tangible damages can be valued in monetary terms, while intangible losses concern items that are not normally bought and sold and for which market values do not exist. Direct intangible losses would include death from drowning, and the destruction of cultural artefacts. Examples of indirect intangibles are death or ill-health resulting from flood induced stress, and disruption to schooling (Table 5.1).

As stressed in the methodology section of the study only residential damages are considered. Commercial, industrial, infrastructure and cultural losses are not treated, as they are not central to the concern of acquisition with the safety of floodplain dwellers.
Table 5.1: Classification of flood losses.

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>TYPE OF LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIRECT</strong> (physical contact with flood water)</td>
<td><strong>INDIRECT</strong> (flood induced disruption or stress)</td>
</tr>
<tr>
<td>TANGIBLE (monetary values)</td>
<td>Damage to infrastructure, buildings and contents, vehicles, boats, etc.</td>
</tr>
<tr>
<td>INTANGIBLE (non-monetary values)</td>
<td>Death by drowning, loss of items of cultural significance.</td>
</tr>
<tr>
<td></td>
<td>Loss of production, clean up costs</td>
</tr>
<tr>
<td></td>
<td>inconvenience and disruption, esp. to schooling and social life. Stress induced ill-health and mortality.</td>
</tr>
</tbody>
</table>
5.2.2 Tangible Damages: Assessment of Direct Losses

5.2.2.1 Introduction

Both researchers and the responsible government authorities have devoted most attention to the assessment of direct damages, rather than to those of an indirect or intangible nature. Direct losses are defined for structures as the cost of repairs necessary to regain pre-flood condition. Damage to contents is valued as the cost of replacement to pre-flood condition, i.e., replacement cost minus depreciation.

The various approaches used for loss assessment fall into one of two general categories: "historical" or "synthetic". In both categories damages are often presented as stage-damage (depth-damage) curves. These give the average damage sustained by a property in a specified property class, at different depths of overfloor flooding (Figure 5.1). Stage-damage curves enable rough extrapolation of historic damage estimates to different flood heights, and are essential to synthetic damage assessments.

5.2.2.2 Historical Approach

For an historical damage assessment people who have incurred flood losses are interviewed to ascertain the extent of the loss. In its simplest form damages may simply be treated as an aggregate figure, and no attempt is made to differentiate them by type of activity, structure, and contents. Where a substantial number of properties are involved a more sophisticated analysis is usually attempted and stage-damage curves are constructed for different activities. Australian studies employing the latter approach include SMEC's (1975) study of Brisbane, and Smith et al's (1979) work in Lismore. The most comprehensive work based on historical flood damages is that by the US Federal Flood Insurance Administration (US-FIA). Their stage-damage curves are based on flood insurance claims rather than questionnaire surveys. The results are set out in the FIA Standard Rate Tables as a percentage of structure value (US-HUD, FIA, 1970), but unfortunately are considered inappropriate for Australia (SKP et al, 1982).
An important aspect of historical damage assessment is that the results are actual damages: that is losses experienced at one point in time, given the community's preparedness, length of warning and so on. Unfortunately this fact is often neglected when estimates are transposed through time and extrapolated for larger floods.

5.2.2.3. Synthetic Approach

In its purest form synthetic damage assessment involves detailed land use mapping and inventories of property contents for different structure types. Stage-damage curves are synthesized for properties having similar susceptibility to flood damage. The contents component of residential curves is constructed by estimating the flood susceptibility of household items kept at different heights within the dwelling, while structure damage is based on historical experiences. The accuracy of the method depends therefore on the breadth of the data bank. A synthetic approach is widely employed in the UK following the procedures set out by Penning-Rowsell and his co-workers (Penning-Rowsell and Chatterton, 1977). The UK method contains 21 basic categories for residential property subdivided by the social class (income) of occupiers, age of property, and flood duration to give 80 different residential stage damage curves. Unlike the historical damage evaluation, a synthetic assessment results in potential damage, where no account is taken in the initial calculation of warning time, population preparedness and emergency action. Hence a major issue in the use of a synthetic approach is the conversion of potential into actual damages, ie into those damages that might reasonably be expected in the community under study.

5.2.2.4 Recommended Method

Various combinations of the two general approaches have recently been used in Australia. A major shortcoming of historical assessment appears when damage estimates are required for an area that has not been flooded for a long time, or where floodplain encroachment has occurred since the last flood. Thus SMEC (1981) used an essentially synthetic approach in their Adelaide (Torrens River) study. A detailed land use study was combined with their Brisbane (SMEC, 1975) stage-damage curves. Given the short warning time and the total lack of flood preparedness
Figure 5.1: Recommended residential stage damage curve. Depth over floor by damage per dwelling. All values in January 1983 dollars.
potential flood damages were assumed to equal actual losses. Higgins and Robinson (1981) go further and attempt to develop stage-damage curves applicable throughout Australia based on their flood damage case study of Forbes, NSW, and other local data.

However, for most circumstances the standardised synthetic approach as set out in SKP et al (1982) is recommended. The stage damage curve shown in Figure 5.1 is the basis of the recommended procedure and is used for damage calculations throughout this report. This curve combines information from a number of studies, and essentially has the shape of that calculated by Penning-Rowsell and Chatterton (1977) for a typical bungalow, with values from Australian historical and synthetic damage data.

The curve does not include an allowance for underfloor and garden damages, clean-up costs or losses to vehicles, boats and caravans. Guidelines for assessment of these damages are contained in the SKP et al manual. The complete synthetic damage assessment procedure (apart from vehicular damages) is also available as an interactive computer package "ANUFLOOD", from CRES, ANU, described in Smith (1983) and Smith et al (1983). In this form very substantial time and hence money savings are attained in damage assessment. No questionnaire surveys are required for residential areas (though they are still needed for industrial and large commercial enterprises). A detailed land use survey is required, but this can be completed quickly.

Other major advantages of a synthetic approach are that:

- damages can be calculated for any flood in any community on a standardised basis. This is valuable where a flood has not occurred or where the last flood is beyond the reliable memory of most inhabitants.

- there is a consistent appraisal of flood damages, especially important in setting priorities between schemes, also scheme benefits are less likely to be exaggerated

- other advantages concern problems inherent in questionnaire surveying (see Section 2.2, and Appendix C).

Two major disadvantages are apparent:

- the first has already been mentioned and concerns the difficulties in determining actual damages from the estimated potential losses. A prototype methodology is
contained in the SKP et al (1982) manual, and is outlined in Chapter 3 of this study.

- the other problem is that by its nature as a standard methodology it is probably never totally appropriate to local conditions. It is felt that this is not a serious shortcoming except where "flash flooding" situations exist. In these events structure damage is often very high, "Nearly 75% of all buildings are destroyed during flash floods" (White, 1975:28).

A related issue is that the method, again because it is standardised, tends to redistribute losses away from extremes. This averaging mechanism may have considerable merit, given that the costs and benefits of flood damage reduction measures are usually assessed over a long period of up to 50 years, and the uncertainty surrounding future land use. Also the redistribution may be seen as socially desirable, because flood damages to low value property will be assessed at a higher level making mitigation action more feasible.

5.2.2.5 Other Types of Residential Direct Damage

Caravan Parks
Caravan parks are frequently excluded from flood damage evaluations, but deserve special mention. Many Australian caravan parks, including at least one in each study site, are located in very flood prone locations. The Lismore Council park for instance at 6.5 m (AHD) is subject to annual flooding. Even though such parks frequently have adequate evacuation plans, if only rehearsed due to constant flooding, the disruption and anxiety caused to residents would greatly increase indirect and intangible damages. Caravan parks with less experience, where a proportion of vans are typically immobile, are not organised for rapid evacuation and substantial direct damage may result.

Vehicles
Vehicle damage may be large as most Australian households own at least one car, truck etc. The extent of these losses is shown by the experiences of Brisbane and Florence, and the Adelaide potential flood-loss estimates. Vehicle damage in the 1974 Brisbane flood amounted to 6% of total direct residential and public utility damage (SMEC, 1975), while 15,000 cars were destroyed by the 1966 Florence flood (Clark, 1983). In the Adelaide potential flood-loss study, car damage was typically assessed
at between $1,500-$2,000, and occasionally exceeded that to residential contents (SMEC, 1980). As with losses to household contents vehicle damage is likely to be especially high where the population is inexperienced and warning time limited.

5.2.3 Tangible Damages; Assessment of Indirect Damages

Estimation of indirect damages has proven difficult. Calculations are hampered by lack of data and uncertainty about the transferability of damage estimates from site to site. It is not always clear how indirect damages are defined by the different flood studies, or how the data were collected, and no attempts have been made to control for different flood types. A long slow flood with ample warning time for instance may cause little direct damage, but result in substantially higher indirect costs through prolonged interruption to normal community activities. Type of community and time of year might also be important (Penning-Krowsell & Chatterton, 1977). A coastal tourist town flooded during its peak season would suffer heavy economic losses (Handmer, 1976), while damage from an off-season flood or the inundation of a retirement settlement would be relatively small. Rural communities isolated by flood waters for long periods may incur particularly heavy losses. In view of these factors it is not surprising that indirect damage estimates range widely up to 75% of direct losses (Table 5.2).

It is fairly clear that the size and type of indirect loss is site specific. However, because of the difficulties in obtaining data the usual practice is to treat indirect damages as a fixed proportion of actual direct damage, following the recommendations of Kates (1965). There are some severely limiting assumptions underlying this approach, for example the relationship between direct and indirect damage is presumed to remain constant as flood stage increases and for different types of flooding, length of warning and so on. Also the extent to which indirect losses are a function of potential rather than actual damages is unclear.

Nevertheless, in keeping with the recommendations of the NSW Department of Environment and Planning report on the Evaluation of Flood Damages ... (SKP et al 1982), and on the basis that the recommended procedure will almost certainly yield a conservative estimate, an indirect
Table 5.2: Estimates of indirect residential flood damage as a percentage of actual direct damages.

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>ESTIMATE (% of actual direct damage)</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane (SMEC, 1975)</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Lismore (Smith et al 1979)</td>
<td>39%</td>
<td>Includes clean-up</td>
</tr>
<tr>
<td>Maitland (McColl et al 1975)</td>
<td>30-40%</td>
<td>Includes commercial transport and storage costs, and imputed rent</td>
</tr>
<tr>
<td>Lehigh Valley, USA (Kates, 1965)</td>
<td>15%</td>
<td>Most widely quoted study</td>
</tr>
<tr>
<td>Toronto, Ontario (Ontario MTRCA, 1959)</td>
<td>75%</td>
<td>Average figure for residential, commercial and industrial.</td>
</tr>
<tr>
<td>USA Army Corps of Engineers Department of Agriculture</td>
<td>15%</td>
<td>Quoted in Ontario</td>
</tr>
<tr>
<td>RECOMMENDED VALUE</td>
<td>15%</td>
<td>MNR and MOH (1977)</td>
</tr>
</tbody>
</table>
residential loss figure of 15% of actual direct damage is suggested. It should be noted that as far as the post flood clean-up is concerned this figure covers only paid clean-up labour, it does not include voluntary work. The adopted approach is inadequate, but the best approximation possible given the present level of knowledge, and the difficulties in collecting case by case damage data. Research presently underway in England should lead to an improved understanding of indirect losses (Green et al, 1983).

5.2.4 Intangible Damages
5.2.4.1 Background and Extent

Throughout this report the importance of considering public safety and welfare has been stressed. Fundamental to such consideration is an assessment of intangible flood damages. Until recently intangibles were largely ignored and in fact there is still considerable debate over their extent, and in the case of health effects, their very existence (see Smith et al, 1980). However, increasingly government authorities require that intangibles be considered.

To demonstrate in a general way the extent of indirect intangible flood damages two illustrative examples are presented. They require little explanation. The first, from the records of the Queensland Disaster Welfare Committee (1976) concerns the pre- and post-flood needs of those inundated by the 1974 Brisbane floods (Table 5.3). (The Committee had made contact with most of the flooded households, 6007 out of 7500). Data in Figure 5.2 constitute the second example, the information is from the records of the US Department of Housing and Urban Development for the year before and year after the 1972 Pennsylvanian floods (Poulshock et al 1975). The US data refer to older people but show a similar pattern. In both cases there was a doubling in the number of medical problems (when flood-aggravated needs are included in the case of Brisbane). If emotional needs are included, the combined demand for social workers and medical facilities more than triples. As Raphael (1979) and others have observed, if these emotional needs are not catered for long term recovery is impeded, and there is likely to be a substantial increase in clinical symptoms. This in turn may lead to a sustained requirement for increased medical and welfare services. Also of interest is the high proportion of those flooded experiencing material
Table 5.3: Needs recorded in Brisbane 1 February 1974 to 28 May 1974
(From Queensland Council of Social Services 1976).

<table>
<thead>
<tr>
<th>NATURE</th>
<th>PRE-FLOOD</th>
<th>FLOOD CAUSED</th>
<th>FLOOD AGGRAVATED</th>
<th>TOTAL FLOOD RELATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional</td>
<td>408</td>
<td>1,623</td>
<td>315</td>
<td>1,938</td>
</tr>
<tr>
<td>Health</td>
<td>826</td>
<td>307</td>
<td>447</td>
<td>754</td>
</tr>
<tr>
<td>Material</td>
<td>103</td>
<td>8,804</td>
<td>102</td>
<td>8,906</td>
</tr>
<tr>
<td>Other</td>
<td>165</td>
<td>1,068</td>
<td>65</td>
<td>1,133</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,502</td>
<td>11,802</td>
<td>929</td>
<td>12,731</td>
</tr>
</tbody>
</table>

a Number of households = 6,007.
b Financial, social security benefit, furniture, difficulty with house repairs.
c Language difficulty, need for information or referral.
d Totals in this column flood caused needs + flood aggravated needs.
Figure 5.2: Major types of services received by respondents in contact with agencies prior to, and one year after, the 1972 Pennsylvania flood (Poulshock & Cohen, 1975).
(financial) difficulties, as abrupt negative changes in financial status are themselves well correlated with increased stress and disease risk (Smith et al., 1980).

It should be noted that not all the effects of disasters are negative. Disasters may be beneficial at both the community and individual levels. For example, at the individual level, while some family groups may break up, others may be greatly strengthened (Raphael, 1979; Drabek et al., 1973). For the community, crime rates in the affected areas may fall (Siman, 1977).

The community may solidify and provide support to its members, the "therapeutic community", though usually this only functions until aid arrives (Fritz, 1961; Bates et al., 1963). Occasionally under certain circumstances, not yet clearly identified (Quarantelli and Dynes, 1977), the community may remain, or become, closely united and may actually prosper after the disaster in a way not thought possible before. This is known as the "amplified rebound" effect. The small community of Aberfan, Wales, victim of a coal mine tailings-heap collapse in 1966 which killed 116 children and 28 adults, provides an extraordinary example of post-disaster community prosperity (Williams and Murray-Parkes, 1975; Nossiter, 1973).

The following assessment of intangibles is concerned primarily with indirect losses as a result of flood induced stress. Damages are examined under the headings of health effects, disruption, and deaths. These categories constitute the main types of intangible losses in the study sites and similar flood prone towns throughout Australia. Occasionally other forms of intangible damage will be important, for example the destruction of cultural artefacts during the 1966 Florence flood (Clark, 1983).

Flood related stress may be reflected in ways other than health effects, disruption and deaths, though these are the major categories. For example disaster stress may precipitate family problems and even breakup, but probably only where the situation was unstable already (Queensland Council of Social Services, 1976). Major health issues surrounding family breakdown are reviewed by Francke et al (1980). The degree of personal
suffering in the post-disaster period, the clean up, and the incidence of ill-health and emotional problems, may be reflected not only in increased strain on all types of facilities, but also by increased work absenteeism, school truancy, alcohol consumption, use of non prescription drugs (Ohlsen et al 1980), and related crime rates.

The author has prepared a detailed literature review and discussion of health effects and deaths, which is published separately in Smith et al (1980). The review includes an examination of the methodological problems in assessing intangibles including the issues of care seeking and under-reporting.

5.2.4.2 Assessment of Indirect Intangible Damages: General

Previous attempts at assessing intangible damages have been on a site by site actual damage basis and have either assigned a monetary value to the intangibles (Mallette, 1975), or incorporated them into the decision making process through a ranking or matrix procedure (Ontario, MNR and MOH, 1977; SKP and MSJKY, 1979).

Many social scientists, including the author, take the philosophical view that there are a number of non-marketed goods that should not be valued in monetary terms. This viewpoint rests on two premises. First, that accurate valuation of such goods is difficult, if not impossible, and actual values may vary greatly from case to case; and second, that increasingly many people see certain goods as basic non-negotiable rights and will refuse to accept any monetary valuation whatsoever, examples here include 'safe' drinking water, or the assumption that major engineering works will not fail. Quantifying items, through for example shadow pricing, that are not quantifiable in conventional economic terms may achieve little more than to give essentially political decisions an unwarranted technical accuracy.

While taking this ideological stance, the author recognizes that decision-makers are often confronted with the need to allocate resources between competing programs on a cash basis. To many economists these allocations imply a monetary value for human life and suffering even if
nothing is stated explicitly. Often, however, a political decision is made, which sets the physical limits of acceptable risk, eg. floodway limits, and the task of the responsible authority may simply be to find the most cost-effective way of achieving the goal (Section 5.3.2). The case for the monetary valuation of social cost is put by Pearce (1978), and Pearce and Nash (1981), and from an engineering point of view by Cordery and Pilgrim (1979). Adams (1974) puts the case against (also see Arnold, 1976, 1981).

At least one attempt has been made to assess intangibles using the same procedure as that recommended for indirect damages: as a percentage of actual direct damages. In a floodplain relocation study in Atlanta, Georgia, Mallette (1975) asked interviewees to estimate intangible losses as a proportion of direct damages. The final figure of 94% was an average of floodplain and flood free respondents. These results were used by Johnson N. (1976) in another relocation study. He took the floodplain intangible damage estimate of 112% of direct losses and added a further 15% of direct damages to incorporate indirect losses; resulting in a final total damage figure 227% of direct damages (see Figure 5.9). This approach is considered grossly inadequate for the reasons given above, although it is an improvement over simply ignoring intangible costs altogether.

In contrast to monetary evaluation attempts, ranking and matrix procedures acknowledge the non-quantifiable aspects of intangibles, and simply attempt to show whether the damages are large or small and who they affect. While this is useful for evaluating public policy at one site the approach is of less value for establishing priorities between sites. Furthermore these procedures are similar to monetary evaluations, in that the ranking and relative weighting of intangible effects is a somewhat arbitrary exercise. Final results may appear to have a sound technical basis, yet conceal decisions of an arbitrary or political nature.

During the present study prototype procedures were devised for the assessment of the intangible losses of health and disruption on a synthetic standardised basis. These are described in detail in SKP et al (1982), and are summarised below. They are calculated in terms of lost time. The impact of other tangible and intangible costs and benefits of acquisition are shown in a general way by the matrix in Figure 5.8.
5.2.4.3 Health Effects

A large body of literature attempts to document the linkages between a range of stressful events and disease. This connection has been particularly well established in relation to heart disease (Dohrenwend and Dohrenwend, 1974), and for widows and widowers, who show significantly increased morbidity and mortality rates, compared to control subjects, in the year following bereavement (Madison and Viola, 1968; Parkes et al 1969; Stein and Susser, 1969). Other examples are provided by Rahe (1972) and Dohrenwend & Dohrenwend, (1974). Rabkin and Streuening (1976) critically review the methodology typically employed by these "life events" studies, and point out the numerous deficiencies.

However, they accept that, although the cause and effect process remains obscure and a clear physiological explanation has yet to be provided, "it is becoming recognised that stress can be one of the components of any disease, not just of those designated as psychosomatic ..." (Rabkin and Streuning, 1976). The effects of stress, at both the individual and community level, depend on a variety of factors which can include event predictability, speed of onset and magnitude, degree of preparedness, past experience, perception of the event as stressful, strength of family and broader social support systems, and a range of individual and personality factors.

It would appear reasonable to assume that a major flood or other natural disaster would produce stress which in turn could precipitate a range of health problems. Many workers have examined the effects of disaster on mental health, the studies include Titchener and Kapp (1976), Erikson (1976), Quarantelli and Dynes (1977), Chamberlin (1980), Bromet and Dunn (1981), Ahearn (1981), Gleser et al (1981) and Bolin (1982). Studies on the health effects of flooding, while limited in number, are broad in scope. The described effects range from the increased incidence of headaches and emotional problems (Poulshock and Cohen, 1975), to substantial rises in the levels of leukemia, lymphoma and spontaneous abortion (Janerich et al 1981), and mortality (Lorraine, 1954; Bennet, 1970). Three studies of particular interest to any investigation into the general health effects of flooding in Australia are those of Bennet (1970), Abrahams et al (1976), and Handmer & Smith (1983) (also see Smith et al, 1980).
Bennet's study of the 1968 Bristol, UK, floods is the most widely quoted. Certainly his study appears to be the most rigorous research in the field, with its use of multiple data sources and a well controlled sample. His results demonstrated that the Bristol flood had a major impact on health (Table 5.4). "There was a 50% increase in the number of deaths among those whose homes had been flooded, with a conspicuous rise in deaths from cancer. Surgery attendances rose by 53%, referrals to hospital and hospital admissions more than doubled. In all respects the men appeared less well able to cope with the experiences of disaster than the women".

Abrahams et al (1976) set out to test whether Bennet's results held for Brisbane following the serious flooding of 1974. The sole data source was a set of interviews administered to a sample of flooded and non-flooded people, contacted some months after the flood and again approximately one year later. Results show that "the number of visits to general practitioners, hospitals, and specialists were all significantly increased for flooded persons in the year following the flood".

The Bennet and Abrahams et al studies demonstrate the negative impact on health of severe floods in inexperienced communities. In an attempt to check the degree to which their results held for an experienced population Handmer and Smith (1983) examined the effects of major flooding on hospital admissions rates and mortality in Lismore. The major findings are that while the flood does not appear to have increased the number of hospital admissions or deaths, in an area well adjusted to floods, it has affected the pattern of admissions. Among those who had more than 1m of water through their homes, the number of male admissions doubled and the number of female admissions halved. Similar effects, though not as marked as in Lismore, were also found by Bennet (1970) and Abrahams et al (1976). This well documented impact of floods on health is puzzling, and a satisfactory explanation has not been forthcoming.

In addition to these major studies, useful site-specific information has been collected as part of Australian flood damage studies in Lismore (Smith et al 1979), Shepparton-Mooooroopna (Kinhill Pty. Ltd., 1981), Wangaratta (Finlayson and McKay, 1980), and Brisbane (Queensland Council of Social Services, 1976).
Table 5.4: Hospital admissions following the Bristol flood (Bennet, 1970).

<table>
<thead>
<tr>
<th></th>
<th>Flooded N = 209</th>
<th>Not flooded N = 238</th>
<th>Flooded and not flooded compared</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 July 1967 to 10 July 1968</td>
<td>3 (actual)</td>
<td>10 (hypothetical value)</td>
<td>11 Using actual value P = 0.046</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Using hypothetical value, N.S.</td>
</tr>
</tbody>
</table>

11 July 1968 to 10 July 1969

<table>
<thead>
<tr>
<th></th>
<th>23</th>
<th>12</th>
<th>x² = 4.69* p &gt; 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Using actual value</td>
<td>p &lt; 0.001</td>
<td>N.S.</td>
</tr>
<tr>
<td>Before and after compared</td>
<td>Using hypothetical value</td>
<td>x² = 4.74* p &lt; 0.05</td>
<td></td>
</tr>
</tbody>
</table>

# Fisher's exact probability.

// This value is the admission rate for the not-flooded group applied to flooded group. The calculation was made because the admission rate of the flooded group was very low before the flood. Using this value the difference in the admission rate before and after the flood is still significant.

* Chi squared values.
Assessment

Unfortunately, many studies are not strictly comparable to the degree required to develop a predictive model. The method of investigation, position, and types of controls vary greatly. Some work makes no attempt to examine or control for the predisposing/mediating variables found to be important in other stress research. However a reasonable number of Australian studies, while not uniform in terms of methodology or quality, are broadly comparable for self reporting of ill-health. Summary results from these studies are presented in Table 5.5. This data was used by the author to produce a prototype synthetic method for assessing the extent of ill-health induced by the stress associated with severe flooding. The full procedures and examples of its application are contained in SKP et al., (1982). The suggested method has the basic advantages and problems of synthetic direct damage assessment discussed in Section 5.2.2.4.

In brief the procedure is as follows. The data in Table 5.5 are graphed as the percentage of the floodplain population reporting ill health following severe flooding by community flood preparedness (Figure 5.3). Hospital admissions data are also plotted. Preparedness is taken as the percent of the flooded population with prior flood experience at their present address. Information that can be deduced, if necessary, from census material. The proportions of the floodplain population estimated to suffer ill health, and to be admitted to hospital, are converted to the numbers of people involved at the site under investigation. These numbers in turn are multiplied by factors representing average numbers of days lost per person. The final combined figure gives the total number of days "lost" as a result of self reported ill health and hospital admissions. Factors of 7.5 and 3.4 days are conservative figures derived from published Australian Bureau of Statistics data, and refer respectively to average length of hospital stay (ABS 1981(a):64), and the average period a self reported illness was debilitating (ABS, 1981(b)). Disability time is a combination of average length of self perceived disability, average stay in bed and average time off work, weighted for the proportion of time off work or in bed.

5.2.4.4 Disruption

Flood damage studies have tended to ignore intangible damages
Table 5.5: Ill-health following floods (size of sample is indicated in brackets).

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample Size</th>
<th>Self-Reporting of Ill-Health</th>
<th>Hospital Admissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% of Floodplain Population Affected</td>
<td>Preparedness (% with Flood Experience at Present Location)</td>
</tr>
<tr>
<td>Lismore (N=150)</td>
<td></td>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>(Smith et al., 1979)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brisbane (N=6007)</td>
<td></td>
<td>13 (health)</td>
<td>15</td>
</tr>
<tr>
<td>(QCSS, 1976)*</td>
<td></td>
<td>32 (health &amp; emotional)</td>
<td></td>
</tr>
<tr>
<td>Wangaratta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Finlayson &amp; McKay, 1976)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Wangaratta (N=118)</td>
<td></td>
<td>17</td>
<td>72</td>
</tr>
<tr>
<td>One Mile Creek (N=360)</td>
<td></td>
<td>32</td>
<td>19</td>
</tr>
<tr>
<td>Shepparton-Mooroopna (N=532)</td>
<td></td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>(Boulevarde sub-area)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Kinhill, 1981)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bristol (UK) (N=197)</td>
<td></td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>(Bennet, 1970)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Queensland Council of Social Services (1976).
Figure 5.3: Effect of preparedness on ill-health following flooding. Calculation of preparedness is described in SKP et al (1982), and Section 3.3.4.7.
resulting from disruption. However, an Australian study by McColl Ptns Pty Ltd (1977) is largely devoted to this type of intangible damage. They found that in rural areas where the flood duration was long, the major issue was the problem of travel and communications, especially the disruption of schooling for children, and isolation of families from neighbours and town services. Where the flood duration was short, clean-up time is relatively more important.

Both issues result in lost time. For example a flood may effectively maroon a family in western NSW for weeks or even months. Although some day-to-day activities would continue, disruption and stress would be substantial. Some limited data has been obtained from the Lismore and Echuca questionnaire surveys which asked the question, "For how long does a flood disrupt your normal routine?". Lismore, represents coastal, or short duration, flooding; and Echuca, relatively slow inland flooding. Although the data are sparse, some trends can be discerned. For areas with long, slow floods, the people seem not to regard themselves as severely disrupted after the first few days, even though they are surrounded by water. For example, they do not look on having to use a boat or tractor for transport as a major disruption, since they are still able to go about many of their normal activities. Consequently, it is likely that there is an upper bound to the period of disruption, at least for well-prepared communities. For less prepared communities, it is judged that the period of disruption would be greater, but no information on this has been collected.

For settlements subject to long periods of inundation, the warning times would themselves have been long, so that even if a community was initially unprepared, it should have improved its readiness by the time the flood arrived. Hence, for long durations of flooding, the time lost through disruption may be relatively independent of the initial preparedness.

Assessment Method

An attempt by the author to develop a synthetic method for assessing the duration of flood caused disruption is presented in SKP et al (1982), based on material from the Echuca and Lismore surveys. The
Figure 5.4: Disruption (time lost) by duration of flooding. Results shown for both prepared and unprepared communities. Calculation of preparedness is reviewed in SKP et al, summarised in Section 3.3.4.7. Data from the Lismore and Echuca surveys.
disruption in days obtained from the questionnaires is divided by three to represent productive time lost. Time lost is plotted against duration of flooding (Figure 5.4). Minimum loss of time for a severe flood is taken as one day (ie three disrupted days) per adult floodplain resident, and increases with flood duration. The figure thus obtained must be adjusted according to the preparedness of the community under study. Development of the procedure has been hampered by lack of data and the outlined method should be treated as a preliminary suggestion only.

5.2.4.5 Deaths

Deaths due to flooding may be a result of drowning or flood induced stress.

Deaths from drowning

Deaths directly attributable to flooding in Australia over the last 25 years have been rare. When deaths have occurred they have been as a result of severe flash flooding of transportation routes, such as the Woden Valley flood of 1971 (7 deaths); or of a major flood affecting an inexperienced and unprepared population, eg Brisbane 1974 (12 deaths). Even in these cases mortality has been small compared with flood disasters elsewhere. There is no Australian trend towards increasing numbers of flood related deaths as is evident in North America (Natural Hazards Observer, June 1978:4)

Key factors in maintaining this situation are the identification of potential flood disaster sites, avoidance of high risk (especially coastal) areas, and the development of effective warning systems. Typically the greatest risks are associated with: the sudden flooding of transportation routes, flash flooding of urban creeks, or sudden levee collapse.

Mortality increase from flood related stress

That mortality may increase substantially after flood disasters has been well established.
"There were a large number of deaths (sic) in Luzerne and Wyoming Counties after the flood (Hurricane Agnes). Statistics compiled showed a dramatic rise in the number of deaths over comparable periods for the past three years, primarily due to heart disease. Such data suggest that severe emotional trauma, which carries with it a sense of hopelessness and despair, speeds one's trajectory toward the grave" (McGee and Heffron, quoted in O'Malley, 1978:19).

The most convincing work is that by two British researchers, Bennet (1970) and Lorraine (1954). Bennet found a greatly increased mortality rate for areas of Bristol flooded in 1968: a rise of 50% in the year following flooding (Table 5.5). There was effectively no change for the rest of Bristol over the same period making the increase significant for Chi-square at the 0.02 level. In his study of the Canvey Island flood disaster Lorraine found a similar, though at 24% a less marked, increase in mortality for the year following flooding. As stress is expected to precipitate rather than actually cause death (Rabkin and Struening, 1976), a decrease in mortality rates should be observed during the second year after flooding. No figures are available for Bristol's floodplain, but the hypothesis is clearly demonstrated by Lorraine's (1954) study for which Bennet obtained 1954 mortality figures. Table 5.6 shows that in 1954, the second year after the Canvey Island flood disaster mortality was substantially less than normal.

Attempts to obtain similar results following severe floods in Australia have not been successful. The fact that there was no overall increase in mortality in Lismore following the 1974 flood is not altogether surprising (Handmer & Smith, 1983; Smith et al, 1980), given the community's exceptionally high level of flood experience and preparedness. Experience and adequate preparedness act to mediate the effects of stressful events (Smith et al, 1980). Also such mediating factors may affect individual perception of flooding. Perception of the event as stressful by the affected individual has been found to be a key factor in determining the effect of stress (Dohrenwend and Dohrenwend, 1974; Rabkin and Struening, 1976). Unlike Lismore the Brisbane community was inexperienced and largely unprepared for the severe 1974 floods. Hence a significant number of stress induced deaths could reasonably be expected. However, Abrahams et al (1976) failed to find any evidence of increased mortality in the year
Table 5.6: Numbers of deaths in Bristol and Canvey Island before and after flooding. (Data from Bennet, 1970). Those who drowned during the floods are excluded from the calculations.

**BRISTOL***

<table>
<thead>
<tr>
<th>Year before flood</th>
<th>Year after flood</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooded</td>
<td>58</td>
<td>87</td>
</tr>
<tr>
<td>Non-flooded</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Change significant at 0.02 level (chi-squared = 5.64, D.F. = 1)

**CANVEY ISLAND***

<table>
<thead>
<tr>
<th>Before flood</th>
<th>After flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>1952</td>
</tr>
<tr>
<td>Flooded and non-flooded</td>
<td>151</td>
</tr>
</tbody>
</table>

* Change significant at P < 0.001 (chi-squared = 18.60, D.F. = 1)
following flooding. But the number of deaths, a total of 15 in both their flooded and non-flooded sample groups, is considered too small for firm conclusions. Unlike the other three post-flood mortality studies Abrahams et al did not consult death certificates, instead they relied on deaths within their survey samples - hence the small number and sampling uncertainty surrounding the results.

Assuming that the results of Abrahams et al (1976) accurately reflect the Brisbane situation a number of factors may be responsible for the mortality figures of the English studies. Climate differences may be important in increasing stress. Certainly Canvey Island in mid-winter and even summer in Bristol is very different from Brisbane's subtropical climate. For Bristol the higher proportion of older people in the floodplain area may be significant in comparisons with Brisbane. Older people tend to be more prone to disaster-induced stress (Dodge and Martin, 1970; Price, 1978), especially if evacuated for substantial periods (Edwards, 1976; Raphael, 1979). Another potentially important factor for post-flood mortality in events directly responsible for a large number of deaths, such as the Canvey Island flood where 58 drowned, is the increased risk of death among the bereaved in the year following the disaster (Parkes et al, 1969).

Valuing Loss of Life

No procedures are recommended. Instead human safety should be paramount in planning decisions. To ensure the incorporation of safety issues, economic assessments should be undertaken within some comprehensive planning evaluation framework such as multi objective planning, and the physical safety criteria of Chapter 4 should be applied.

Detailed discussions on valuing human life are found in Cordery and Pilgrim (1979), Mishan (1971), and Mooney (1978), with economic models being the focus of the last two references. A range of values for life is reproduced in Cordery and Pilgrim (1979) and Smith et al (1980). Values are derived from court awards, expected earnings, and amounts spent by various industries and authorities to reduce individual risk. Generally the most commonly-used value (by economists) is some multiple of the individual's expected annual earnings. An average value for earnings is
employed, otherwise results show enormous variation in peoples' worth, while those on various forms of social welfare have no value at all.

On the other hand, using this same procedure, a severe disability may cost society rather more than death, as to lost earnings must be added the cost of extra support payments; thereby enabling a strong case to be made for rehabilitation (Australia, Commonwealth Department of Health, 1979).

5.3 FLOOD DAMAGE REDUCTION STRATEGY ASSESSMENT

5.3.1 Introduction

A selection of flood mitigation measures were assessed in Chapter 3 in terms of a wide range of criteria including their effectiveness in reducing direct and intangible flood damages, their effect on the disaster potential, and their compatibility with acquisition. Other commonly employed assessment techniques seek to compare flood mitigation options in terms of the costs of effecting benefits. Features of the principal techniques are summarised in the following sections, and the main problems encountered in economic analyses are reviewed as a prelude to the economic assessment of acquisition viability in the study sites.

Benefits are usually estimated as flood damages avoided by the mitigation measure.

Costs are typically assessed as those expenses incurred in implementing the measure: the costs of levee construction, setting up a flood warning system, and so on. Costs of land use control are harder to determine, but a potentially major expense is the foregone use of the land. According to the theory of land value analysis this will be reflected by a drop in land value. In the absence of regulation and any other encumbrances floodplain land values are expected to mirror flood damages.

As land value analysis is often suggested as an appropriate method for assessing the costs of land use regulation two points deserve further emphasis in the context of the present Chapter. The first is that the real costs and benefits of using land are often obscure and unknown to those
trading in real estate. There are numerous government and philanthropic subsidies encouraging use of all land (Appendix 6), in particular flood prone land through disaster relief to local governments and individuals: and while direct damages can be estimated with some confidence, indirect, and more especially intangible, damage assessment remains problematic. The second point is related to the first and may be seen as a special case of benefits. It appears that many floodplain residents have little choice in their residential location for a variety of socio-economic reasons as detailed in Chapter 6. The critical factor in the location decisions of these people is that floodplain land is substantially cheaper than flood free land, not that the difference in price accurately reflects flood damages.

5.3.2 **Economic Assessment Procedures for Flood Mitigation Strategies**

5.3.2.1 **General**

Methods used to assess flood damage reduction strategies from an economic perspective include: fixed cost, benefit-cost, cost-effectiveness and its variation fixed-effectiveness, and special provisions in the US federal Flood Insurance Act.

The typical Australian approach in recent years has been to seek the least-cost solution to solve a specific problem or need (AWRC, 1978). This has generally involved meeting a politically determined level of flood protection which constitutes the fixed-effectiveness approach. However, works constructed under the Commonwealth-NSW coastal flood mitigation agreements have been subject to a benefit-cost requirement since the late 1960s. In addition environmental impact studies (EIS) are undertaken. The benefit-cost and EIS conditions have not been applied to funds released for acquisition.

Any economic assessment will have shortcomings and one common to all methods is the limited range of costs and benefits considered, in particular their failure to take account of social issues, for example equity, reinforcing the need to conduct the analysis within a broader evaluation framework such as that provided by multi-objective planning.
Key aspects of the various assessment measures are summarised below.

5.3.2.2 Fixed-cost

Fixed-cost is not really an assessment technique, rather it simply sets a budgetary position by specifying the total amount of funds authorities are prepared to make available for that purpose. According to SKP et al (1982) this is often very close to the actual assessment process for Australian works. The procedure used alone has no economic merit.

5.3.2.3 Benefit-cost

This method is used extensively overseas: in the US where it is enshrined in the 1936 Flood Control Act, and in the U.K. (Penning-Rowsell and Chatterton, 1977). It has not been so widely employed for flood mitigation assessment in Australia, apart from the requirements of the NSW Coastal Rivers Flood Mitigation Works program.

Ideally the approach tallies all the benefits and costs of each proposed flood mitigation option, and evaluates the proposals according to predetermined criteria. In theory this permits money to be allocated efficiently in economic terms not only between competing flood mitigation proposals but also between other calls on public funds. An important limitation concerns the definition of economic efficiency employed in most flood studies, including the present research. Economic efficiency is assessed by comparing only the costs and benefits, relating directly to the floodplain inhabitants and their property. Following usual practice these are treated in isolation to the Australian economy, for example the analysis excludes benefits to builders and others involved in post-flood reconstruction. Using an input-output analysis Higgins (1979) attempts to trace these wider effects of flooding through the regional economy of Forbes, NSW. However, at present the detailed data required to operationalise the technique severely limits its applicability. Also the criteria used to assess economic efficiency are far from perfect, and another obvious problem is that of identifying and incorporating all benefits and costs. The treatment of different benefits and costs is the subject of several sections of this report, and an overview of the problem
is presented in the following Section. For more detail readers are referred to SKP et al (1982).

For a project to be viable benefits must exceed costs when both costs and benefits are reduced to some common base for comparison. Comparisons are generally performed according to one of five criteria: benefit-cost ratio, internal rate of return, net present worth, marginal benefit-cost ratio, and marginal net present worth. But only two, the benefit-cost ratio and net present worth (or its variation net annual worth) are widely used in flood studies.

For the net present worth criterion to be satisfied the present value of benefits must exceed the present value of costs. Costs for flood mitigation strategies are frequently calculated at their present value and need no further adjustment. Benefits however are typically spread over the expected life of the project as a series of annual damages avoided. This series of benefits (and where necessary costs) is converted to a present value by the formula:

\[
\text{Present value} = \frac{A}{i} \left[ 1 - \left( \frac{1}{1+i} \right)^N \right] \quad \text{(Formula 5.1)}
\]

where \( A \) equals the average annual benefit, \( i \) is the discount rate and \( N \) the expected project life (Penning-Rowsell and Chatterton, 1977). Where benefits (or costs) are not a steady series but change over time, for example where the implementation of a flood mitigation scheme takes place over a number of years or where in the case of acquisition some extra benefits occur such as rental income, then the present value may be calculated for individual years employing the formula:

\[
\text{Present Value at year } N = \frac{A}{(1+i)^N} \quad \text{(Formula 5.2)}
\]

Clearly the discount rate, \( i \), constitutes a particularly sensitive part of the calculation. The problems surrounding rate selection are examined in following section (5.3.3.4).
5.3.2.4 Cost-effectiveness

The cost-effectiveness method seeks the strategies returning the greatest improvement for a unit of expenditure. The fixed effectiveness procedure is a widely used variation of this method. In many jurisdictions including NSW and Victoria the desirable level of flood protection has been politically determined as the 1:100 or 1% flood. It is then the responsibility of the relevant authorities to find the most cost effective way of achieving this level of protection - ideally also acting within the safety and social constraints discussed elsewhere in this report.

There are a number of problems with a fixed-effectiveness approach, in particular the implicit assumption that mitigation based on a uniform flood probability confers uniform protection is false. As discussed in Chapter 3 and 4 the height of the maximum probable flood above the regulatory event may vary greatly and thus residual damages will also vary. In any case length of warning, population preparedness, and flood type will generally have a much greater influence on damages and safety than flood probability. Inflexible application of the assessment procedure would also lead to severe losses in economic efficiency unless the full range of mitigation options was considered including that of allowing flood damages to continue.

On the other hand the fixed-effectiveness criterion is easy to incorporate into policy. Largely because of this characteristic it has received regular endorsement through its incorporation into policy in Australia and overseas, and at the 1:100 level was approved by the 1980 AWRC Floodplain Management Conference discussion group on "The Desirable Level of Flood Protection".

5.3.2.5 Procedures Used by the US Flood Insurance Administration

The US federal flood insurance scheme includes a number of measures designed to prevent further residential floodplain encroachment. Section 1362 of the Insurance Act provides for the acquisition of dwellings under certain conditions. Essentially property may be acquired where it would clearly be cheaper to acquire than to continue insurance payouts, as when the structure is damaged "substantially beyond repair" (ie when
repairs would equal or exceed 50% of the structure's market value), or where direct flood damage has equalled or exceeded 25% of the structure's value three or more times in the previous five years; or when the property has for one reason or another lost its economic value, for example where local ordinances prohibit reconstruction in the floodplain, or make rebuilding substantially more expensive.

The details of the acquisition criteria are complex, and are set out in the US Federal Register (1980). It should be noted that acquisition is voluntary and in theory property is bought at "fair market value".

5.3.3 Some Problems in Economic Assessment

5.3.3.1 Introduction

A fundamental problem with any economic analysis is the apparent ease with which the results are subject to political interference. While the same comments may apply to any form of evaluation, economic procedures are of greater importance in a policy context as they have been used as the sole means of justifying numerous public works projects of dubious economic and social merit. Details of many such projects are set out in Kollmorgen (1954), Leopold and Maddock (1954), Peterson (1954) and Arnold (1976,1981). Decisions have been made to suit political ends but have been given a frequently undeserved technical validity through the widely accepted benefit-cost procedure outlined in the previous section.

These problems are examined in the following section. The sensitivity of benefit-cost analysis to the discount rate is clear from formula 5.1 (Section 5.3.2.3), and is explored further here. The issues of average annual flood damage calculation, and of which variables are included or excluded in the assessment may be important factors in every form of economic analysis. Questions of appropriate discount rate selection and variable inclusion/exclusion are of particular interest as they may be central in determining analysis outcome and are readily subject to politically inspired manipulation.
5.3.3.2 Average Annual Damage Estimates

Flood damages are typically expressed in terms of average annual losses. This figure is obtained by summing for all floods the products of flood damage by flood probability, more generally expressed as the integral of the area under a flood damage by probability curve. Unfortunately, all too frequently losses are only calculated up to the regulatory flood, usually the 1:100 event. This may exclude a substantial proportion of the average annual damages. The diagram in Figure 5.5, representing the flood damages by probability curve for a hypothetical town, illustrates the point. For Lismore the average annual residential damage calculated to the MPF level is approximately 13% greater than that calculated to the 1:100 level. The difference between damages estimated to the two heights may be substantially greater in other towns, or if commercial damages are included in the analysis. At Forbes, NSW, for example, average annual losses to the residential and commercial sectors combined are approximately one third greater if calculated to the MPF rather than 1:100 level (SKP et al 1982:A1.10). Moreover both these examples exclude that development lying between the 1:100 and MPF levels.

Frequently MPF height information is not available and in its absence accurate average annual damage estimates cannot be obtained. In such cases a conservative estimate should be applied; failing that some of the additional damages may be included by assuming that the MPF is the same height as the 1:100 event. It is clear from Figure 5.5 that whatever the real height of the MPF, the area bounded by the height of the 1:100 event and the probabilities of the 1:100 and MPF is part of the average annual damage. However, the area may contain relatively little of the extra loss. This is because flood depths remain at the 1:100 level, and this same water depth is being integrated over very low probabilities.

5.3.3.3 Flood Hazard Factor

The flood hazard factor (FHF) is the difference in flood height between the 1:10 and 1:100 events (Section 4.3.3.1). The measure is widely used in the US but to date has seen little application in Australia. It is difficult to make any generalizations about the measure as its effect on
Figure 5.5: Flood damage by probability curve for a hypothetical town. Flood damages are those expected from an event of specified probability. The area under the curve equals the average annual flood damage.
flood damages is dependent on structure type, and the floor height in terms of flood risk.

When employing economic analysis the FHF may be critical in determining the viability of various strategies. This is particularly the case where the FHF is between zero and three metres. Outside this range variations in the factor have little effect on average annual flood damages. The sensitivity of acquisition to the factor in a cost-benefit framework is shown in Figure 5.10.

5.3.3.4 Discount Rates

The discount rate is the rate chosen in benefit-cost analysis, to convert future annual series of benefits, or costs, to a present value. In this way costs and benefits are converted to a common point in time for comparison.

Results of benefit-cost analysis are generally extremely sensitive to the discount rate chosen (Figure 5.6), and there is no doubt that on occasions a rate has been selected solely because it made the project under consideration appear desirable. The problem of appropriate rate selection is exacerbated by the existence of two main schools of thought on rate calculation, which produce opposing estimates: the social time preference approach, and the opportunity cost method. It is important to note that results of the present value computations are relatively insensitive to the length of time the discount rate is applied over. Figure 5.7 shows that for a rate of 10% results vary little once the time period exceeds 30 years. When project life is very short, or where low discount rates are employed and the limiting value is not reached until the time period is very long, the period chosen will affect results, but still only in a minor way compared to variations in the discount rate.

"The opportunity cost stand holds that government should act to improve the efficiency of the national economy. Therefore no public investment should displace an alternative project which produces a greater return. Consequently the discount rate should be equivalent to... opportunity costs in the private sector (SKP et al, 1982:A8.1). Within this basic definition a number of concepts exist, but all recommend rates..."
Figure 5.6: Sensitivity of Present Value Calculation to the discount rate. Time period is 30 years. Average annual damage = $2724.

Figure 5.7: Sensitivity of Present Value Calculation to the time period chosen. Discount rate is 10%. Average annual damage = $2724.
similar to the prevailing interest rates and return on private investment as modified by taxation. This suggests rates of the order of 10%.

On the other hand the social-time-preference advocates prefer a low discount figure of about 4%. They argue that market interest rates do not take future generations into account. High rates make capital expensive and reduce the present value of streams of future benefits. Thus reliance on opportunity-cost rates would effectively rule out many major public projects, and encourage expenditure on projects with a rapid payoff to the detriment of future generations. The low discount rates advocated by the social-time-preference supporters increase the economic viability of acquisition because the benefits, in terms of flood damages avoided, extend indefinitely into the future. To benefit fully from the low interest rates the present value calculation must be applied over a long period. From Figure 5.7 the present value at 4% calculated over 30 years is $47,000. If the same annual amount of $2724 is discounted at 4% over 150 years the present value increases substantially to $68,000.

Figure 5.7 illustrates the effect of a range of discount rates from 2% to 20% calculated over 30 years, on the present value of average annual damages for Lismore dwellings with floor levels below the 1:2.5 flood height. It is clear that even a small variation in the discount rate will have a major impact on the results.

Rate selection is further complicated by the fact that streams of future costs and benefits are generally expressed in constant dollars; or using US FIA terminology 10% of structure value today is the same as 10% of structure value in 30 years time. For comparison with market rates of interest the discount figure must be added to the prevailing and expected inflation rates. With inflation currently at about 10% per annum, a 10% discount results in a true rate of 20%, which is equivalent to the cost of some private loan capital, but is substantially higher than the cost of general real estate loans or the yield on government bonds. Clearly the source of funds may become an important aspect of discount rate selection. Further discussion is considered beyond the scope of this study and readers are referred to Pearce and Nash (1981) or other texts on the subject.
As a general rule it is suggested that a discount rate should be selected between the two extremes and then a sensitivity analysis should be performed for other discount rate values. Over the last few years a number of major flood studies have employed a discount rate of 10% (SKP & MSJKY, 1979; SMEC, 1980; Smith and Penning-Rosswell, 1981). The present study follows this practise and uses a rate of 10% applied over an infinite period.

5.3.3.5 Inclusion and Exclusion of Important Variables

Inclusion or exclusion of a wide range of factors can radically alter the results of any economic analysis. As all costs and benefits are simply not known it is obviously impossible to include them all in the calculations, but it is possible and desirable to identify all major types of costs and benefits and to practice consistency in assessment methodology. The types of benefits and costs that should be included in any analysis of acquisition or relocation are listed and reviewed in Section 5.3.4. Broad differences in approach between US work and previous Australian studies in terms of accounting practice and factor inclusion/exclusion are examined in the same section. This section briefly reviews the changing fortunes of the economic analysis of the North Wagga relocation proposal. Table 5.7 summarises the various relocation costings for the village.

Following the 1950s floods the relocation option was seriously examined by Wagga Council. Estimates were prepared which compared the costs of relocating North Wagga to those of bringing the village up to new subdivision standard including leveeing. As Table 5.7 shows the balance was in favour of relocation. However, the relocation of only just over half the houses was actually considered, the balance being brick or too rundown to survive movement, and it was assumed that the new land would be purchased at rural values. Clearly this offered only a partial solution to the problem. On the other side of the ledger no allowance appears to have been made for residual flood damages after leveeing, land needed for levee construction, and levee maintenance.

By 1971 there was considerably less interest and unanimity in Council over relocation, and the cost balance had shifted in favour of
Table 5.7: Cost estimates for acquisition in North Wagga. All costs in dollars at dates indicated. 1958 and 1971 estimates were provided by the Engineering section of Wagga City Council. 1979 figures are from SKP & MSJ KY (1979), and the 1983 estimates came from the NSW Department of Environment & Planning.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>1958</th>
<th>1971</th>
<th>1979</th>
<th>1983</th>
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<tr>
<td><strong>VILLAGE TO REMAIN</strong></td>
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<tr>
<td>Levee</td>
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</tr>
<tr>
<td>Land</td>
<td>-</td>
<td>-</td>
<td>1:20</td>
<td>220,000</td>
</tr>
<tr>
<td>construction</td>
<td>26,000</td>
<td>?</td>
<td>1:100</td>
<td>505,000</td>
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<tr>
<td>maintenance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>760,000</td>
</tr>
<tr>
<td>isolation danger</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>landscaping</td>
<td>-</td>
<td>4,080</td>
<td>(+2% p. a. maintenance)</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<tr>
<td><strong>Upgrade Village standards</strong></td>
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<tr>
<td>kerbs and gutters</td>
<td>50,000</td>
<td></td>
<td>103,783</td>
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<tr>
<td>seal roads</td>
<td>42,300</td>
<td></td>
<td>?</td>
<td>?</td>
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<tr>
<td>drainage</td>
<td>14,000</td>
<td></td>
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<tr>
<td>sewer reticulation</td>
<td>87,760</td>
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<td>106,500</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<tr>
<td><strong>VILLAGE TO GO</strong></td>
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<tr>
<td>Relocation costs</td>
<td></td>
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</tr>
<tr>
<td>Land</td>
<td>15,000(50ac)</td>
<td>29,500(70ac)</td>
<td>248,000</td>
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<tr>
<td>kerbs, gutters, roads,</td>
<td>50,000</td>
<td>176,983</td>
<td>517,500</td>
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<tr>
<td>drainage</td>
<td>46,000</td>
<td>45,185</td>
<td>172,300</td>
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<td>water</td>
<td>20,000</td>
<td>51,250</td>
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<td>electricity</td>
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<tr>
<td>residual value of services</td>
<td>33,000</td>
<td></td>
<td>16,000</td>
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<tr>
<td>telephone</td>
<td>61,000</td>
<td></td>
<td>103,000</td>
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<tr>
<td>street lighting</td>
<td>1,920</td>
<td></td>
<td>3,200</td>
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<td>landscaping</td>
<td>22,093</td>
<td></td>
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<tr>
<td>dwelling relocation</td>
<td>72,000</td>
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<tr>
<td>(120 houses)</td>
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<tr>
<td>dwelling purchase</td>
<td></td>
<td></td>
<td>2,280,000 dwellings</td>
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<td></td>
<td></td>
<td></td>
<td>616,000 others</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>203,000</td>
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<td>5,100,000</td>
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leaving the village alone (Table 5.7). Curiously the costs of bringing North Wagga up to contemporary subdivision standard remained much the same as the earlier estimates, and no allowance appears to have been made for levee construction. On the other hand the costs of relocation had risen considerably. For example the cost of roads and drainage had increased by three and a half times for a new village site, but inexplicably had actually fallen slightly for the existing village. The expense of landscaping and telephone installation, and the residual value of the abandoned water reticulation system were also debited to relocation.

The most recent benefit-cost estimates, prepared in 1976, do not consider raising the standard of public utilities in North Wagga, yet charge to the relocation option the full cost of street lighting, sewerage, roads and drainage for the new village. In addition telephone installation, and the residual value of existing services are debited to relocation (SKP & MSJKY, 1979). When the costs of permanent evacuation are calculated in this manner and then compared with the cost of a levee, naturally levee protection appears to be the only economically sensible alternative.

However, the 1976 estimates could be recalculated quite reasonably to produce somewhat different results. The costs of purchasing land for the levee should be included. To the extent that the expense of sewerage and gas provision and a substantial proportion of the cost of roads and drainage would probably be incurred anyway if the village remains, the costs of these utilities should not be included on the project balance sheet. Furthermore, it was argued at the AWRC Conference on Floodplain Management "Syndicate for Acquisition" that the costs of provision of basic utilities such as sewerage, water, electricity and telephone are recouped through rates or other charges and therefore do not constitute a legitimate charge to acquisition.

Attention has been drawn to the erratic nature of past economic assessments, and the importance of considering all potential project costs and benefits. None of the three "relocation cost" accounts prepared for North Wagga during the last 25 years cover all the major cost areas listed in Section 5.3.4. It would be unreasonable to expect them to, but it is important that every item be considered, and then weighted according to the nature of the particular site.
5.3.4 Benefits and Costs of Acquisition and Relocation

5.3.4.1 General

Acquisition programs impact specific sectors of the community quite differently. A cost to one sector may be a benefit to another. In general the program’s dollar costs are shared between the various levels of government, or put another way all Australian taxpayers foot the acquisition bill. Nevertheless, this truism should not be allowed to disguise the fact that very often substantial dollar losses are borne by relocatees when they are forced to upgrade their accommodation, or where living costs are greater in their new locations (Chapter 7). Both intangible costs and benefits are incurred by relocatees, the net loss or gain depending on individual circumstances, while the community at large stands to gain substantial intangible advantages from acquisition. The identified impacts of acquisition are set out in Figure 5.8, according to their effects on different groups, and whether they are tangible or intangible.

5.3.4.2 Benefits

In the economic evaluation of flood damage reduction measures flood losses avoided are usually the primary (if not the only) benefits considered. As relocation removes flood susceptible development and keeps the land in a use compatible with flooding, there should be virtually no residual damages in the scheme area; though of course damages outside the relocation scheme’s boundaries will be largely unaffected. These characteristics are in contrast to the benefits of other flood mitigation measures which generally leave the protected area or structure with residual damages, and in many cases such as dams, forecasts and warnings and so on, confer equal protection (in terms of probabilities) on the whole floodplain.

Many of the costs of flooding and thus the benefits of flood mitigation are properly classified as intangible. They have usually been ignored in assessments of flood coping strategies because of measurement difficulties even though intangible damages, especially safety issues, may be more important than tangible direct and indirect losses combined.
Figure 5.8: Costs and benefits of acquisition for different groups.
Key to impacts: benefit = +; cost = -.

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<td>- Property purchase</td>
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<td>- flood free replace.</td>
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<td>- Household moving costs.</td>
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<td>- Increased living costs.</td>
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<td>- Site restoration.</td>
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<td>- Residual life of public utilities.</td>
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<td>- Site maintenance.</td>
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<td>- Change in land value.</td>
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<td>- Loss of rates.</td>
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<td><strong>Flood factors</strong></td>
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<td>- Reduced flood damages.</td>
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<td>- Reduced flood disaster payout.</td>
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<td><strong>Other</strong></td>
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<td>- Reduction in amount of low cost accommodation.</td>
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<td><strong>Floods</strong></td>
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<td>- Reduced risk to life.</td>
<td>+</td>
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<td>- Reduced stress/anxiety.</td>
<td>+</td>
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<td><strong>Relocation</strong></td>
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<td>- Stress while waiting.</td>
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<tr>
<td>- Stress from relocation.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Loss of community/friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Improved living conds.</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>- Enhanced recreation opps.</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>- Improved community appearance.</td>
<td>+</td>
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</tbody>
</table>
For many householders relocation may have benefits other than flood damage reduction. These may be both tangible and intangible. Any relocation payments or assistance above the market value of the flood prone property constitute benefits to the property owner according to accounting procedures often followed in the US (see Section 5.3.4.4). Additional intangible gains may arise when, for instance, householders find themselves trapped on the floodplain by their socio-economic circumstances (Chapter 6), but do not consider that floods are a major problem. They may dislike the rundown appearance of the area, the poor council services or their neighbours. Such people may see relocation as an opportunity to better themselves socially and economically.

Other benefits of relocation as a strategy are more diffuse and include generally beneficial environmental impacts (Section 8.2.6), avoidance of an irreversible commitment of resources and a reduction in the potential for catastrophic losses (Section 3.4).

An interesting observation from Figure 5.8, the acquisition impact matrix, is that the majority of acquisition benefits accrue to community members living outside the acquisition areas. These benefits include the provision of additional parkland and recreation space, aesthetic improvement of the settlement, reduction of SES (emergency service) work load, and the financial gains to those businesses involved in dwelling demolition or relocation, landscaping and so on. The provision of new housing for relocatees through a government scheme would be of major benefit to local businesses and employment.

5.3.4.3 Costs

Expenses are incurred in the actual purchase of property and in structure demolition or relocation; in abandoning public utilities with residual value; in maintaining the land in a flood compatible state; and by the householder in having to seek a new residence, and pack up and move. As many of these costs may also constitute benefits to certain sectors of the local community, the accounting procedures assume critical importance in determining strategy viability (Section 5.3.4.4 below). Disruption itself has many components. These are discussed further in Chapter 7 in the context of local reaction to acquisition schemes. Maintaining the land
in a flood compatible state is the subject of Section 8.10, while household moving costs are very site specific.

Most of the work on valuing the intangible aspects of dislocation comes from the literature on compulsory relocation for major public works (Section 7.2). A summary of the various approaches is found in Pearce (1978). This work has attempted to fix compensation for people driven from their homes, and therefore has little application to the voluntary acquisition programs being considered by the present study. One method which has been used in Australia in relation to floodplain management, is the "Consumer Surplus" technique (SKP & MSJKY, 1979). "The householder's (consumer's)surplus, for an owner occupying his residence, is defined as the monetary value of the property to him over and above its market price "

Table 5.8: Neighbourhood value in North Wagga through the consumer surplus approach. (Data from SKP & MSJKY, 1979).

| Percent |
|------------------|-----|
| "If leaving North Wagga is required, what money would be required to make moving acceptable? |
| Market value, plus legal & moving expenses | 8 |
| Replacement value | 1 |
| Market value, plus legal & moving expenses, plus $1,000-$4,000 | 5 |
| " " " " " " " " " " $5,000-$8,000 | 4 |
| " " " " " " " " " " $9,000-$12,000 | 6 |
| " " " " " " " " " " $13,000-$16,000 | 1 |
| " " " " " " " " " " $17,000-$20,000 | 2 |
| " " " " " " " " " " $25,000 | 1 |
| " " " " " " " " " " $30,000 | 1 |
| " " " " " " " " " " $40,000 | 1 |
| " " " " " " " " " " $50,000 | 2 |
| " " " " " " " " " " $100,000 | 1 |
| No answer | 22 |
| No amount of money would be acceptable | 39 |
| Renter | 11 |
| Total | 100 |
| (N=168) |
(Stanley and Rattray, 1978). Assessment of the surplus is made difficult by the fact that in most studies a substantial proportion (sometimes over half) state that no amount of money will compensate them, or are unable to state an amount. Table 5.8 from the SKP & MSJKY North Wagga study illustrates the problem. No attempt is made in this study to place monetary or other values on the stresses of voluntary relocation.

The experiences of a number of US and Australian programs were reviewed to ascertain the tangible costs of acquisition (Tables 5.9, 5.10, & 5.11). All authors deal with the same general cost components: purchase of house and land, demolition and site clean up; or if the dwelling is to be relocated, the purchase and preparation of a new site, moving the structure and reconnecting services. However, actual costs assigned to each component and the accounting procedures employed varied considerably. The figures for Lismore are employed for the benefit-cost analysis in Section 5.5.3.

5.3.4.4 Comments on Accounting Procedures

Accounting procedures may radically alter the results of any economic analysis of flood damage reduction strategies. For example the input-output analysis explored by Higgins (1979) would weigh flood damages by the benefits to local builders and retailers and might well conclude that in terms of the local or regional economy floods were not a problem. Another procedure is set out in the US Federal Flood Control Act (1936), which specifies that costs and benefits are to be counted "to whomever they may accrue". In compulsory US acquisition schemes payments for relocation disruption of up to $15,000 may be made to the property owner. Such payments are assumed to confer a benefit on the householder equal to their cost and are therefore excluded from the economic calculation of scheme costs, though of course relocation payments still form part of the financial costs of the scheme, in that the money must still be found.

Mallette (1975) treats the cost of the acquired land, as opposed to the cost of the structure, in the manner prescribed by the Flood Control Act. He argues that part of the land price reflects its real value to the community for post-acquisition use as open space, agriculture, etc., and the balance represents a benefit to the homeowner. In both cases the costs
Table 5.9: Tangible costs of acquisition. Australian data on cost per dwelling in 1983 dollars. Estimates for Forbes from Higgins and Robinson (1981). For US figures see Tables 5.10 and 5.11.

<table>
<thead>
<tr>
<th>PURCHASE of dwelling and land</th>
<th>Lismore</th>
<th>Echuca</th>
<th>Forbes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase of undeveloped land</td>
<td>$600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(per building block)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dwellings sold for removal</td>
<td>$2000**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELOCATION of dwelling</td>
<td>$4000**</td>
<td>$5000</td>
<td></td>
</tr>
<tr>
<td>(up to 20 kms)</td>
<td></td>
<td>(up to 5kms)</td>
<td></td>
</tr>
<tr>
<td>Extra for brick veneer</td>
<td></td>
<td></td>
<td>$3000</td>
</tr>
<tr>
<td>Connect services from boundary of new site</td>
<td>$1600**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of new site</td>
<td>$2000**</td>
<td>Highly variable and</td>
<td></td>
</tr>
<tr>
<td>(edge of floodplain) site</td>
<td></td>
<td>site specific</td>
<td></td>
</tr>
</tbody>
</table>

POST-ACQUISITION

Value of old site for agriculture etc. No data available

Maintenance of acquired site. " " "

* See note Table 5.13.
# Recent purchases include a $60,000 dwelling which would affect this figure.
equal benefits and are therefore not included in the analysis of economic costs, though they form part of the financial costs of the scheme.

Johnson W. (1978) does not follow Mallette's approach and debits land costs to the project. However, allowance is made for the post-acquisition value of the land demonstrating another difference between Australian and American accounting procedures. In the North Wagga relocation study of SKP & MSJ KY (1979), residual land values are ignored, while land is frequently assigned a substantial salvage value in the US. For example the value of land along Peachtree Creek, Atlanta, for post-acquisition use was estimated at $9,900 (1976US$) per hectare (Johnson N., 1976).

ECONOMIC VIABILITY OF ACQUISITION AS ESTABLISHED BY OTHER STUDIES

5.4.1 Acquisition or Relocation of Developed Residential Property

Various US studies have found that acquisition of flood prone property is feasible on benefit-cost grounds. Other studies have shown that where it is not viable on a benefit-cost basis acquisition may still be the most cost effective solution to serious flood problems. A review of a number of these studies follows.

The first is research by N. Johnson (1976) into acquisition and relocation along Peachtree Creek, Atlanta, Georgia. He uses a benefit-cost approach of the type outlined in Section 5.4.6.2 and obtained benefit-cost ratios as high as 2.5. It is interesting to note that a proposed channellization scheme producing the same 80% reduction in annual damages would cost about ten times as much as relocation. The main components of the acquisition alternatives investigated are set out in Table 5.10. A major factor in favour of relocation is the very high residual value assigned to the cleared land, on the grounds that Atlanta is short of open space. However, in constructing his guidelines Johnson is much more conservative: the land was assumed to have no salvage value, and 5% of structure value was added to the property purchase costs to allow for demolition and removal.
Table 5.10: Alternative Plans for Land-Use Change in Peachtree Creek. (From Johnson N. 1976)

<table>
<thead>
<tr>
<th>Description</th>
<th>Plan 1</th>
<th>Plan II</th>
<th>Plan III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of houses impacted</td>
<td>11</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>Reduction in average annual damage, in dollars</td>
<td>152,000</td>
<td>278,000</td>
<td>338,000</td>
</tr>
<tr>
<td>1975 fair market value of property to be purchased, in dollars</td>
<td>679,000</td>
<td>1,327,000</td>
<td>2,264,000</td>
</tr>
<tr>
<td>Land to be purchased, in acres (square meters)</td>
<td>8.4</td>
<td>15.0</td>
<td>26.4</td>
</tr>
<tr>
<td>Salvage value of land to be transferred to recreational or other use, in dollars</td>
<td>206,000</td>
<td>408,000</td>
<td>701,000</td>
</tr>
<tr>
<td>Benefit/cost ratio&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.53</td>
<td>2.36</td>
<td>1.68</td>
</tr>
<tr>
<td>Percentage of total damages reduced if plan is implemented</td>
<td>37</td>
<td>68</td>
<td>82</td>
</tr>
<tr>
<td>Frequency of flood damage reduced to if plan is implemented, in years</td>
<td>1.5</td>
<td>2.7</td>
<td>5.5</td>
</tr>
</tbody>
</table>

<sup>a</sup>Based on direct damages and interest rate of 8% per year for 30 yr (0.088827).

Note: Plan I - Purchase houses 10 ft (3m) or more below 100-yr flood elevation; Plan II - Purchase houses 8 ft (2.4m) or more below 100-yr flood elevation; Plan III - Purchase houses 6 ft (1.8m) or more below 100-yr flood elevation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition of Existing Structure and Site</td>
<td>$25,500</td>
</tr>
<tr>
<td>Demolition of Existing Structure</td>
<td>5,100</td>
</tr>
<tr>
<td>Moving and Related Expenses</td>
<td>600</td>
</tr>
<tr>
<td>Replacement Housing for Homeowner</td>
<td>1,000</td>
</tr>
<tr>
<td>Costs to Convey Property to Government</td>
<td>400</td>
</tr>
<tr>
<td>Total First Cost</td>
<td>$32,600</td>
</tr>
<tr>
<td>Annual Cost</td>
<td>$2,612</td>
</tr>
<tr>
<td>Annual Cost as Percentage of Structure Value</td>
<td>8.7</td>
</tr>
</tbody>
</table>

1 Costs were estimated assuming a 1600 square foot structure in a flood-free location was valued at $30,000 and land at $5,000.

2 The value of the structure in the flood hazard area was assumed to be $5,000 below market value of structures at flood-free sites and land value was assumed $500.

3 Costs include 25 percent for contractor's bonds, overhead, profit and engineering.

4 Replacement cost is sometimes interpreted as being the additional cost to provide a comparable structure at a flood-free site. Under this interpretation this cost could be over $9,500 since an additional $5,000 would be needed for a comparable structure and $4,500 for flood-free land. This cost item is limited to $15,000 by the Act.

5 Amortized at 7 percent for 30 years.

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Site Purchase and Preparation</td>
<td>$11,950</td>
</tr>
<tr>
<td>Moving Structure to New Site</td>
<td>3,200</td>
</tr>
<tr>
<td>Moving and Related Expenses</td>
<td>600</td>
</tr>
<tr>
<td>Replacement Housing for Homeowner</td>
<td>1,000</td>
</tr>
<tr>
<td>Costs to Convey Property to Government</td>
<td>400</td>
</tr>
<tr>
<td>Total First Cost</td>
<td>$17,160</td>
</tr>
<tr>
<td>Annual Cost</td>
<td>$1,375</td>
</tr>
<tr>
<td>Annual Cost as a Percentage of Structure Value</td>
<td>4.6</td>
</tr>
</tbody>
</table>

1 Estimated for a $30,000, 1600 square foot structure. Land value of a new site was assumed to be $5,000.

2 Costs include 25 percent for contractor's bonds, overhead, profit, and engineering.

3 Amortized at 7 percent for 30 years.
Johnson presents his guidelines in terms of floor level distance below the 1:100 flood level by the costs of funds in percent per year (annual interest rate) (Figure 5.9). Flood probability data from Peachtree Creek has been added. An unusual feature of the work is its attempt to include intangible flood damages. The broken line on the graph in Figure 5.9 represents the additional houses that may be economically acquired if allowance is made for intangibles according to the estimate of Mallette (1975) (see Section 5.3.4.4), as modified by Johnson: i.e. 112% of direct damages for intangibles plus 15% of direct damages for indirect, giving a final damage figure equal to 227% of direct damages. Naturally more than doubling average annual losses has a dramatic effect on acquisition feasibility, lifting the zone from those properties lying below the 1:4 flood to those below the 1:8 level.

More details are available in a US Corps of Engineers study, which considered both acquisition with relocation of the existing structure, and acquisition with demolition (W. Johnson, 1978). Standard FIA stage damage estimates are used to assess benefits. These estimates are given as a percentage of house value in Figure 5.10. Unlike many other US workers W. Johnson does not exclude land costs and relocation allowances from his analysis (Section 5.3.4.4), except that in the case of relocation the flood prone site is assumed to be deeded to the government in exchange for the new site. Details of the costs for both procedures are set out in Table 5.11.

A few observations on W. Johnson's work are in order: the flood prone structure is given a value of $25,000, whereas flood damages are calculated for a $30,000 dwelling (all values in 1978 US$). The reason for this difference is that flood prone structures are assumed to be worth less than equivalent flood free buildings. Once purchased for demolition the structure is assumed to have no salvage value and a cost of $5,000 is allocated for its demolition and removal. This allocation is considered excessive for 2 reasons: structures in reasonable condition can usually be sold for demolition or removal, for example in Lismore such buildings are typically sold for about $2,000 (Robinson, pers.comm. 1981); and second, costs of demolition may be substantially less than $5,000 (1978 US$), in fact as low as $1,000 (1975 US$) (Mallette, 1975). Finally, costs and benefits are compared on an average annual basis. Calculation of average
Figure 5.9: Indifference curve for acquisition (purchase and demolition) within Peachtree Creek study area, Atlanta, Georgia. One storey detached dwellings without basements.

Figure 5.10: Economic feasibility of acquisition (with demolition and structure relocation) estimated for hypothetical properties in areas subject to various flood hazard factors (FHF). FHFs shown in feet with metres in brackets. One storey detached housing without basements. Costs amortized at 7% over 30 yrs.
annual benefits (i.e. flood damage) has been described above, and to obtain the annual cost of implementation the total costs as listed in Table 5.11 were amortised at 7 percent over 30 years.

Final results from W. Johnson (1978) are presented in Figure 5.10. For economically justifiable acquisition and demolition one story detached dwellings without basements must have floor levels lying below the 1:5 flood level. Relocation viability on the other hand is more sensitive to the flood hazard factor. Under the conditions in the study sites, where the flood hazard factor is quite low at less than 1.5 metres, relocation under W. Johnson's criteria is feasible for dwellings with floor levels below the 1:8 flood.

In contrast to the results of N. Johnson and W. Johnson, other North American and Australian studies have reported that acquisition was not justifiable on benefit-cost grounds. However, much of this other work has found that the strategy is still a cost-effective approach to flood damage reduction.

Neither relocation nor a levee was a viable proposition in benefit-cost terms for the town of Soldiers Grove, Wisconsin. But, given that a solution to the flood problem had to be found, relocation was the preferred option. The estimated long term maintenance costs of the levee would have required nearly double the local rate revenue. Furthermore, relocation appeared to satisfy other community aims, in particular the need for community revitalisation, and the reversal of population and property value decline (Becker, n.d.). Relocation is now largely complete.

An Australian example is provided by Grigg's (1981) theoretical study of acquisition in Brisbane. Although earlier work had established that the benefits of acquisition did not exceed the costs (Grigg, 1977), an extension of the analysis established that relocation could be a cost-effective method given certain conditions. He assumed that the desirable level of protection was set politically and that there were only two ways of arriving at that level: acquisition and reservoir air space. As the costs of additional increments of acquisition are constant while those of air space provision increase, at some point it becomes cheaper to acquire than to provide further reservoir protection.
On the whole US work has found that dwellings with floor levels below the 1:5 flood could be economically relocated or acquired and demolished. Under some quite plausible conditions, such as high flood hazard factors or circumstances where the structures may be sold for removal, the level of economic purchase may rise to the 1:8 flood or higher. Acquisition appears to be uneconomic where land or structure values are high, for example where commercial areas are involved or where waterside amenity outweighs flood risk.

5.4.2 Acquisition of Undeveloped Flood Prone Land

Apart from circumstances where land is reserved, vacant areas need not generally be acquired. Exceptions exist where the authorities want to fill in a patchwork of earlier purchases, where environmental protection is important, or where the area is under strong development pressure and the council feels that morally or legally acquisition is necessary. Situations occasionally arise where an area was subdivided for residential development many years ago, but now, due to changes in attitude, development is prohibited and compensation in the form of acquisition may be desirable. Attitudes towards development may change as a result of a flood disaster, new hydrologic data, state government policy, or changed local demand for open space.

A major limitation of the flood adjustment evaluation procedures reviewed above is their reliance on average annual damages computed for existing conditions. Vacant land incurs little flood damage, thus its acquisition is difficult to justify on conventional benefit-cost grounds. Nevertheless, two different future-damages approaches have been used to assess the acquisition viability of undeveloped land.

Concern over the effects of the potential loss of natural valley flood storage led to a proposal to acquire 3410 hectares of undeveloped land in the Charles River watershed. If the area was not acquired it would be gradually developed, leading to the progressive loss of 30% of the total presently available natural valley storage capacity. This loss would result in higher flood peaks, more rapid rates of river rise and increased flood damages. Acquisition benefits were estimated as the difference
between downstream average annual flood damages under present conditions and those damages expected after the projected loss of natural storage area. Acquisition was found to be justifiable, but it appears that no account was taken of the negative impact of acquisition on the income of potential floodplain occupiers (Carson, 1975).

In his review of non-structural measures W. Johnson (1978) suggests a method for assessing the economic feasibility of the purchase of undeveloped land. Acquisition "reduces damages by controlling future use. With acquisition there will, hopefully, be less damageable property exposed to the flood hazard than without. The difference in damage with and without acquisition will measure the damage reduced. The accuracy of this measurement is tied to the accuracy of estimating future land use for both conditions" (W. Johnson, 1978:91). Clearly such estimates can only be prepared on a site by site basis. As very flood prone land sells cheaply, at least for residential use, purchase will almost always be economically justified by Johnson's approach.

5.5 ECONOMIC VIABILITY IN THE CASE STUDY SITES

5.5.1 Introduction

The following sections examine the feasibility of acquisition in the study sites, employing firstly US criteria, and secondly a benefit-cost analysis for Lismore using local data and the flood damage assessment procedures developed above.

For both sets of analyses only developed property is considered, and the critical dwelling variable is floor level. Thus accurate assessment depends (as it does for all residential flood damage evaluations), on detailed floor level data. Such information is available for Lismore but not for the other two sites. Fortunately, floor levels in Echuca West could be estimated from topographical data found on the maps of the Echuca Flood Study (Victoria-SR & WSC, 1979), and North Wagga floor heights in 30cm classes are contained in Livingstone (1975). Floor level data for Lismore are aggregated for the whole floodplain. It is not possible therefore to examine separately dwellings in the priority
acquisition areas. Instead dwellings are categorised and examined according to their floor levels, a reasonable but not perfect surrogate.

5.5.2 Viability According to US Criteria

According to the North American benefit-cost studies acquisition and demolition is viable for dwellings with floor levels at or below the 1:5 flood, and acquisition with structure relocation is feasible when floors lie at or below the 1:8 level. These criteria are based on tangible direct annual average damages. (Mallette's dollar estimate for intangibles is not included in this analysis).

Results of the comparison of dwelling floor levels with the US criteria are set out for each study site in Table 5.12. The table shows clearly that acquisition and demolition or relocation of dwellings in the Lismore priority acquisition areas (see Figure 2.2) is an appropriate action on economic grounds alone. The floor levels of most of the houses (82%) fall below the 1:8 flood level. Acquisition of much of Echuca West can be substantiated as nearly half the dwellings are either just below or just above the 1:8 level, but purchase of the whole area is not justifiable. In contrast virtually all (93%) of North Wagga's dwellings are above the limit and most are well above it, leaving no doubt that on normal benefit-cost grounds alone acquisition or relocation of the village is not feasible.

As an addendum it should be pointed out that the Lismore figures tend to understate the situation when comparisons of this nature are drawn between the 3 sites. This is because houses in Echuca and Wagga are not raised, while almost all those in Lismore are raised substantially to reduce the risk of flood damage (Section 3.3.4.3). The true comparative picture emerges if all houses in the Lismore floodplain, approximately 1900 structures, are lowered to ground level, or to be precise 0.5m above ground surface. (Half a metre was also the assumed average height above ground level of houses in the other sites). When this is done nearly half (861) Lismore's floodplain dwellings have floor levels below the 1:5 flood level, and nearly two thirds (1205) are below the 1:8 level. Two quite different conclusions emerge: first, this appears to be further evidence that much of Lismore's residential development should not be there; and second, it
Table 5.12: Economic viability of acquisition with dwelling demolition and relocation, for the study sites according to US criteria. Only developed property is considered. The criteria are set out in Section 5.5.2. The Table indicates the proportion of dwelling floor levels below the specified flood heights, with numbers of houses in brackets. The 1:10 category is included because a large proportion of dwellings fall between the 1:8 and 1:10 levels where relocation is only marginally uneconomic.

Percentages and numbers of dwellings are cumulated figures.

<table>
<thead>
<tr>
<th>SITE</th>
<th>No. of Houses</th>
<th>Acquisition % below 1:5 flood</th>
<th>Relocation % below 1:8 flood</th>
<th>% below 1:10 flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Wagga</td>
<td>220*</td>
<td>3 (7)</td>
<td>6.8 (15)</td>
<td>15.4 (34)</td>
</tr>
<tr>
<td>Echuca West</td>
<td>64#</td>
<td>-</td>
<td>20.3 (13)</td>
<td>45.3 (29)</td>
</tr>
<tr>
<td>Lismore (Priority Acquisition areas)</td>
<td>295</td>
<td>34 (99)</td>
<td>81 (242)</td>
<td>100 + (328)</td>
</tr>
</tbody>
</table>

* Livingston (1975)
# SR & WSC (1981)
demonstrates how effective the individual adjustment of house raising has been.

5.5.3 Viability in Lismore Using Local Data

Using the procedures recommended in Section 5.2 flood damages were calculated for the Lismore residential areas (Table 5.13). Potential tangible direct average annual damage estimates were prepared for houses exposed to different flood risks, by grouping properties according to floor level in 0.5 metre increments. The resultant damage figures were halved to obtain realistic estimates of actual damage, as Smith (1981) found that due to community preparedness actual residential losses in Lismore attained only about half their potential (Section 3.3.4.7). Indirect damages were assessed at 15% of actual. Thus the total tangible damage figure is 115% of actual direct loss. Intangible losses for the health and disruption categories are also calculated using the recommended procedures.

As Lismore is a very experienced and well prepared community the intangible damage in terms of lost time is low (Table 5.13). However, a few points should be appreciated: concern for personal safety remains high, a disruption "loss" of one day represents three days of calendar time, and that both health and disruption figures are an average, hence losses would be greater in the most flood prone areas. Also, the health of the acquisition area residents is poor and may reflect constant anxiety about flooding.

Under these circumstances the intangible flood damage estimates may well be equalled or exceeded by the intangible costs of relocation. In any case the losses are very small when compared with tangible damage estimates and would have no impact on the analysis. As a result intangibles are excluded from the formal calculations, but they are listed in Figure 5.8. and Table 5.13.

It is stressed that this type of tangible damage assessment may result in a conservative estimate of benefits where acquisition is concerned because public utility and road damage are not included, yet may also be eliminated. Weighed against this in some cases is the residual value of the abandoned services.
<table>
<thead>
<tr>
<th>Floor level of dwelling (metres)</th>
<th>Flood Risk (Recurrence Interval in years)</th>
<th>Number of Dwellings</th>
<th>Potential Direct AAD(^1)</th>
<th>Potential Direct AAD per dwelling</th>
<th>Actual Direct AAD per dwelling (0.5 potential)</th>
<th>Indirect AAD (15% of Actual Direct)</th>
<th>Actual Direct &amp; Indirect AAD</th>
<th>Present Value of AAD (per dwelling) discount rate 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>≈2.5</td>
<td>10</td>
<td>47376</td>
<td>4738</td>
<td>2369</td>
<td>355</td>
<td>2724</td>
<td>27240</td>
</tr>
<tr>
<td>&gt;10-10.5</td>
<td>≈3</td>
<td>9</td>
<td>32602</td>
<td>3622</td>
<td>1811</td>
<td>272</td>
<td>2083</td>
<td>20830</td>
</tr>
<tr>
<td>&gt;10.5-11</td>
<td>≈4</td>
<td>19</td>
<td>49950</td>
<td>2629</td>
<td>1315</td>
<td>197</td>
<td>1512</td>
<td>15120</td>
</tr>
<tr>
<td>&gt;11-11.5</td>
<td>≈5</td>
<td>61</td>
<td>107680</td>
<td>1765</td>
<td>883</td>
<td>132</td>
<td>1015</td>
<td>10150</td>
</tr>
<tr>
<td>&gt;11.5-12</td>
<td>≈8</td>
<td>143</td>
<td>156712</td>
<td>1096</td>
<td>548</td>
<td>82</td>
<td>630</td>
<td>6300</td>
</tr>
<tr>
<td>&gt;12-12.25</td>
<td>≈10</td>
<td>86</td>
<td>62652</td>
<td>729</td>
<td>365</td>
<td>55</td>
<td>420</td>
<td>4200</td>
</tr>
<tr>
<td>&gt;12-12.5</td>
<td>≈40</td>
<td>268</td>
<td>151329</td>
<td>565</td>
<td>283</td>
<td>42</td>
<td>325</td>
<td>3250</td>
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<td>&gt;12.5-13</td>
<td>≈100</td>
<td>422</td>
<td>105002</td>
<td>249</td>
<td>125</td>
<td>19</td>
<td>144</td>
<td>1440</td>
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<td>&gt;13-14</td>
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<td>704</td>
<td>86959</td>
<td>124</td>
<td>62</td>
<td>9</td>
<td>71</td>
<td>710</td>
</tr>
<tr>
<td>&gt;14</td>
<td></td>
<td>271</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Contents: Structure = 79:21. Potential to actual damages = 0.5 of potential from empirical data. Theoretically 0.43 of contents i.e. 55% of total damages (SKP et al., 1982). The empirical coefficient is preferred as it gives a slightly more conservative result.
Table 5.13 continued: INTANGIBLE DAMAGES

<table>
<thead>
<tr>
<th>No of dwellings</th>
<th>No. of Occupants (Ave = 3.2 per dwelling)</th>
<th>ILL HEALTH (days lost)</th>
<th>HEALTH (days lost)</th>
<th>Disruption (productive/enjoyable time lost)</th>
<th>Calendar days lost</th>
<th>Total No. of days lost (effective time) per event</th>
<th>AAD (days lost) 1.9 x flood exceedence probability per dwelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>32</td>
<td>1.9</td>
<td>6.5</td>
<td>21</td>
<td>63</td>
<td>28</td>
<td>.76</td>
</tr>
<tr>
<td>9</td>
<td>28</td>
<td>1.68</td>
<td>5.7</td>
<td>19</td>
<td>57</td>
<td>25</td>
<td>.63</td>
</tr>
<tr>
<td>19</td>
<td>60</td>
<td>3.6</td>
<td>12.2</td>
<td>40</td>
<td>120</td>
<td>52</td>
<td>.48</td>
</tr>
<tr>
<td>61</td>
<td>195</td>
<td>11.7</td>
<td>39.8</td>
<td>131</td>
<td>393</td>
<td>143</td>
<td>.38</td>
</tr>
<tr>
<td>143</td>
<td>457</td>
<td>27.4</td>
<td>93</td>
<td>306</td>
<td>918</td>
<td>399</td>
<td>.24</td>
</tr>
<tr>
<td>86</td>
<td>275</td>
<td>16.5</td>
<td>56</td>
<td>184</td>
<td>552</td>
<td>240</td>
<td>.19</td>
</tr>
<tr>
<td>268</td>
<td>857</td>
<td>51.4</td>
<td>174.8</td>
<td>574</td>
<td>1722</td>
<td></td>
<td>.048</td>
</tr>
<tr>
<td>422</td>
<td>1350</td>
<td>81</td>
<td>275</td>
<td>905</td>
<td>2715</td>
<td></td>
<td>.019</td>
</tr>
<tr>
<td>704</td>
<td>2252</td>
<td>135</td>
<td>459</td>
<td>1509</td>
<td>4527</td>
<td>1968</td>
<td></td>
</tr>
<tr>
<td>271</td>
<td>867</td>
<td>52</td>
<td>176.8</td>
<td>580</td>
<td>1740</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The resultant combined figure representing actual average annual direct and indirect flood damages provides a basis for assessing the benefit-cost ratio of acquisition. The figure could be used directly by amortising the cost of acquisition and comparing the annual loan repayment with the annual benefit, that is the average annual flood damage avoided. However, in keeping with normal Australian practice a comparison of the present values of costs and benefits is preferred. Costs are calculated in todays values and need no further adjustment, while the series of annual benefits are converted to their present value using the formula set out in Section 5.3.2.3 (Formula 5.1). At a discount rate of 10% the formula has a limiting value of ten times the annual benefit, and as, in theory at least, damages to relocated structures are avoided forever this value is employed in the analysis. In any case the calculations are not sensitive to the estimated scheme life once the time period exceeds 35 years or so (Figure 5.7), though the process is very sensitive to the discount rate (Figure 5.6). A rate of 10% is that recommended by this study (Section 5.3.3.4).

The present value of benefits is compared with the current cost of property acquisition. Cost of acquiring individual dwellings and blocks of land in Lismore were obtained from the records of the N.S.W. Public Works Department District Office, details of Echuca West purchases were provided by Echuca City Council. Individual property purchase costs were adjusted to January 1983 dollar values using the housing component of the Australian Consumer Price Index (Australian Bureau of Statistics). No attempt was made to evaluate land purchases though comments on the economic assessment of acquisition of underdeveloped land are contained in Section 5.4.2. Elements considered in the cost of acquisition in Lismore are set out in Table 5.13. No residual value is assigned to the land or structure. Although Lismore City Council generally sells the dwelling for removal no figures are available. A local valuer suggested that typically such structures would bring council some $2,000 (Robinson, 1981 pers.comm.). Consistent with US procedure, the Lismore benefit-cost calculations make no allowance for this residual value, and to this extent the analysis results are conservative.

Within these limits results of the cost-benefit analysis naturally vary according to the assumptions and data sets employed. Using the actual cost of all houses and land purchased under the Lismore scheme up to
Figure 5.11: Economic feasibility of property acquisition in Lismore. Curves show the effects of varying the assumptions regarding discount rates and average annual damage assessment on the present value of flood damages. Horizontal lines show costs of acquisition in Lismore. All properties falling below the selected cost and damage lines may be economically acquired on a benefit-cost basis. Details of calculations are in Table 5.13.
26/4/83, expressed in January 1983 dollars, acquisition and demolition is viable up to approximately the 1:5 year level. Using the actual cost less the 3 properties that cost $30,000 or more, the process is viable up to the 1:8 level. These results are obtained using the cumulated damages (benefits) as opposed to the damages incurred by property in each 0.5 metre floor level increment. If the incremental damages are used, the viability of acquisition and demolition is lowered slightly to the 1:4 and 1:5 year level respectively for the total and modified average dwelling purchase costs. The 1:5 year flood line includes 99 houses, while the 1:8 area includes some 242 dwellings, virtually all the properties in the Lismore priority areas shown in Figure 2.2. Varying the discount rate from the recommended 10% has a substantial impact on the economically viable level of acquisition. The effects of these various assumptions on the results of the cost-benefit analysis are illustrated in Figure 5.11. Overall there is surprisingly close agreement with the results of the Section 5.5.2, where acquisition viability in the study site was assessed according to US criteria (Table 5.12).

Costs of a government sponsored relocation scheme could be slightly lower, but are so highly dependent on land prices that analysis was not worth pursuing. Estimates for the cost components of relocation obtained from a valuer in Lismore are set out in Table 5.9.

5.6 COMPATIBILITY OF ECONOMIC AND PHYSICAL ACQUISITION CRITERIA

A number of researchers assert the irrationality of floodplain regulations in economic terms (Howell, 1980). They argue that floodplain occupiers will not locate where their expected economic losses exceed the expected gains, unless they are either ignorant of the true risk or expect that society will bear part of their losses for them.

This view arises from the "economic man" model. According to the model people make economically rational decisions unconstrained by personal preferences, knowledge or anything else. Safety concerns are implicitly rejected, as are a whole host of other constraints that may operate to restrict locational choice. The operation and importance of these constraints are explored in the next chapter. At issue here is the
compatibility of the recommended economic and safety acquisition criteria.

To examine the relationship between the two sets of criteria, the safety standard, which is the area inundated to a depth of two metres or more during the 1:100 flood, is compared with the economic standard, that area delineated by the 1:5 flood. Evidently the comparison is limited by the focus on the depth criterion, as for simplicity warning time and isolation factors are ignored.

Within these limits agreement between the two quite different types of criteria is close for all three sites. Put another way this means that the height difference between the 1:5 and 1:100 floods is approximately the same at all sites: Lismore, 1.7m, Echuca 2m, Wagga 2m. Small differences appearing between the two types of criteria when mapped for Lismore are in part due to the absence of flood slope data for the 1:5 event.

Unfortunately the close agreement between economic and safety acquisition criteria achieved in the study sites is not a widespread phenomenon. An examination of flood frequency/magnitude data for other Australian towns reveals a wide variation in the 1:5 to 1:100 flood height difference (Table 4.1). From the sample it appears that in general (66%) the 1:5 level is more than two metres below the 1:100 level. Thus the economic criterion would frequently fail to select for acquisition areas considered too dangerous for residential development.

The extent to which this confirms the work of Howell (1980), and others, that floodplain regulations are uneconomic, depends on the weight given to intangibles, in particular safety issues.

5.7 DISCUSSION AND CONCLUSIONS

Efforts to develop standard economic criteria for assessing the viability of acquisition have met with some success, and there is no doubt that procedures used to assess structural measures are, in many circumstances, applicable to the evaluation of land use management. Unlike
the physical safety criteria of the previous chapter these evaluative procedures are often not tied to a politically determined level of flood risk. However, economic analysis of structural measures have in the past been subject to a variety of other political influences. In addition all the procedures have inherent flaws related to data inputs. These deficiencies are particularly apparent where intangible costs and benefits are involved. The problems have occasionally been such that some observers have suggested that benefit-cost analysis is administratively infeasible (Arnold, 1976).

Before the economic analysis of acquisition in Lismore could be undertaken the costs and benefits of acquisition had to be established. Program costs were obtained from local and state government officials. Benefits are flood damages avoided, so it was necessary to review damage evaluation procedures. The recommended method was developed during the course of the study by D.I. Smith, T. Lustig, the author and others. It is based on standardised synthetic stage-damage curves, as opposed to loss estimates based on historical damages, and has a number of major advantages over the more conventional approach. The main advantage is that damages can be calculated for any flood in any community on a standardised basis. This is particularly important where a flood has not occurred for some time, or where information is required for the MPF for example. Special attention has been paid to the extent and assessment of intangible damages, a generally neglected area. Australian data are now sufficient to justify firm confidence in results produced by the method as far as estimates of potential direct damages are concerned. Data for indirect and intangible damages on the other hand, are poor and in need of upgrading. Estimates of these types of damages are therefore not as reliable. The recommended procedures produce potential damage estimates. To convert these figures to estimates of the damage likely to occur, the "actual damage", an allowance must be made for community flood experience.

The Lismore analysis was in reasonable agreement with the results of US studies and firmly demonstrates the economic viability of acquisition: acquisition of developed residential property with floor levels below the 1:5 flood height is justified on cost-benefit grounds alone. Under certain quite plausible circumstances, such as relocation of the dwelling rather than its purchase and demolition, or the inclusion of
intangible damages, the limit may be substantially higher. When many of
the assumptions underlying the calculations are subject to sensitivity
tests, the results confirm those of North American studies into the
economic viability of acquisition. Clearly, the exact floor level below
which it is more economic for society to purchase property than to bear the
losses, will vary from site to site. Nevertheless the consistency of
research results is reassuring, especially as the studies examined employ a
number of different procedures to assess acquisition viability.

In an attempt to determine the compatibility of economic and
safety acquisition criteria, the two standards were compared in the study
sites and a wider sample of towns. Results show that in general the
economic criterion is the stricter and may exclude areas selected on
public safety grounds.

Under the economic criteria the feasibility of acquisition in
Echuca West is marginal, while the North Wagga scheme is not justified.
CHAPTER 6
THE FLOODPLAIN RESIDENTS AND THEIR REASONS FOR LOCATION

6.1 INTRODUCTION

The establishment of social criteria for acquisition is more complicated than was the case for either physical or economic standards, such that it is more realistic to think of guidelines rather than criteria. Difficulties arise because the guidelines would depend entirely on individual responses to acquisition, which in turn is dependent on a host of interrelated individual, community, and political processes. In contrast, economic and safety criteria are only partly dependent on individual response. Another distinguishing feature of social factors is their importance for the implementation of acquisition in areas selected on physical or economic grounds.

The location process is one of the most important socio-economic issues confronting studies of those natural hazards where small spatial variations are important; these include floods, earthquakes, and landslides. Thorough understanding of the location decision may result in interpretations of flood adjustment adoption which may be more appropriate than those normally offered (Section 1.4), besides helping to explain the persistence of occupancy in the study sites. The two preceding chapters show that on both safety and economic grounds large proportions of the acquisition areas should not be occupied by residential development. There is no question that many dwellings, in Lismore especially, are subject to frequent severe flooding compounded by the anxiety associated with a short warning time. Yet occupation of the areas persists, why?

In general the microeconomic location models of urban housing market studies incorporate the classical economic concepts of consumer behaviour, which treat people as "rational animals who know their preferences and attempt to optimize their net benefits in selecting a residential location" (Bourne, 1981:131). In keeping with other models based on these concepts the necessary assumptions are severely limiting: consumer knowledge and market competition are perfect; land use regulations non existent; the existing housing stock is ignored; space has only one dimension-distance from the city centre; and overall
consumption of housing, location cost and all other non-housing goods including leisure, are subject to only one constraint, income, which is constant.

Another approach to location uses behavioural models based on the decision to seek new accommodation, a decision which is generally associated with housing needs at different stages in the life cycle (Bourne, 1981:135), though, in a society with an increasing variety of lifestyles this is less and less the case. Behavioural models examine the relocation and search process by considering households' awareness of alternatives, their aspirations which act to define the extent to which their knowledge of alternatives is utilized, and their behaviour path or search order (Bourne 1981:138). Unfortunately empirical validation of these models has been restricted because of the volume of data required.

The shortcomings of the housing market models also exist in much geographic hazard research (Section 1.4). Research frequently operates implicitly within the broad microeconomic and behavioural theories of the residential location models outlined above. This similarity is particularly apparent in the way hazards work has emphasised individual knowledge and freedom of choice in location decisions and flood mitigation action, and has paid little attention to external limits or constraints to decision making. A further limitation of much hazards work is its determinist nature. Social systems are frequently seen as dependent on the physical environment.

The focus on the physical environment helps ensure that the social, economic and political forces, which may contribute to the development of hazards by constraining location and adjustment choice, will not receive proper attention.

All the models, both microeconomic and behavioural, suffer from three main problems: first, they apply primarily to specific segments of the population, namely the mobile middle class, may obscure social conflict and serve to justify the status quo (Bourne, 1981); second, they generally fail to allow for changes through time (Bourne, 1981); and third, the emphasis is on freedom of choice. Whereas the external forces largely ignored by both the housing location and much hazards research act
essentially as constraints on choice. However, hazard researchers have often assumed that people will make locational choices constrained only by the individual factors of, in the case of floodplains, flood knowledge and perception.

A number of constraints have been identified by Bourne (1981:143), in his study of housing policy. These factors affect peoples' ability to choose their housing and to move from their present dwellings:

- low income.
- discrimination, eg. on racial grounds.
- the psychological stress of leaving familiar environments, especially important for the older long term residents.
- being physically incapable of relocating, through handicaps, medical needs etc.
- lacking the necessary information.
- being residents of housing commission units, who traditionally have a low mobility rate.
- living in an isolated location or a place like Echuca West where relocation would involve a major change in living environment.
- having special needs, eg. very large families, one parent households etc. A large proportion of the Lismore floodplain residents are in this category.

People affected by these constraints are not denied access to housing, but their choice may be restricted to dwellings or areas considered undesirable by the rest of the community. These "undesirable" areas or types of housing frequently constitute housing submarkets. Aborigines, for example, may find that their choice is not only restricted by dwelling price, but also by difficulty in obtaining mortgages, and their effective exclusion from certain areas on racial grounds. According to the "housing policy literature...at least one-third of all households in a competitive housing market have little or no choice and need some form of public sector assistance. These people may be the real working poor, the elderly, the very young, the unemployed, or the transient." (Bourne, 1981:143).
At first sight the acquisition areas appear quite rundown and are therefore likely to comprise housing submarkets. If this is the case the dwellings are probably occupied by the types of people identified by Bourne (above); people who are effectively forced to live in high risk locations. Alternatively, occupancy may be explained by low flood knowledge or perception.

Those who found that they had little choice in their selection of residence, or who now find that moving is financially impossible, would probably be fully aware of the flood problem and would welcome an acquisition scheme, if it provided for their relocation. On the other hand, those who occupy the areas because of low flood knowledge or perception, are unlikely to see any point to the scheme and are not expected to support it.

The first step in examining this hypothesis is a detailed study of the acquisition area residents, followed by scrutiny of their reasons for location. This will form a sound basis for the next chapter, which investigates local reaction to acquisition and develops guidelines to ease implementation.

A detailed knowledge of the acquisition area residents is necessary for a number of other reasons. It would be desirable to establish whether the residents are members of the especially vulnerable groups identified in studies of compulsory relocation, as a first step in determining the extent to which their findings might apply to voluntary programs. Knowledge of the residents' status and location reasons is also of broader significance in the implementation of non structural measures. The absence of choice in location for example, would be expected to reduce the value of public hazard information programs designed to dissuade people from locating in floodplains. Finally the detailed demographics of the questionnaire samples are required so that their representativeness can be established, and also to determine whether any demographic differences exist between the various samples, especially between the Lismore acquisition and flood-free groups (Section 2.2).
6.2  FLOODPLAIN RESIDENTS

6.2.1  Criteria for Poverty Assessment

The Commission of Inquiry into Poverty (Australia-CIP, 1975) constitutes the most extensive Australian examination of socio-economically disadvantaged people. While recognising that poor people do not only lack wealth but also knowledge, power and opportunity, the commissioners based their poverty lines on income; 56.8% of the average weekly earnings for a standard family (CIP, 1975:1). An alternative approach to poverty measurement was employed by a research report on rural poverty in northern NSW (CIP, 1974). Its definition was based on social and economic functioning, on the assumption that lifestyle is more important than income as a determinant of poverty. Housing was selected as the critical variable (p.64); "The most obvious difference between the very poor whites and the rest of the community is their housing..." Other indicators of poverty among white Australians were found to be low levels of health and education and level and type of employment. Another functional approach has been employed by Stubbs (1966) and the Australian Social Welfare Policy Secretariat (SWPS) (1981). Stubbs identified those people most likely to be at economic risk: the aged, widows, single parent families, and socially marginal groups like migrants and aborigines. The SWPS, through a program of consultations with welfare agencies, attempted to locate significant groups in poverty separately to its income level calculations. Groups identified were the unemployed, invalid pension and sickness beneficiaries, those on widow's pensions and supporting parents and their children.

The various Australian poverty studies and reports have all pinpointed the above groups as especially poverty prone, but another group has been found to cut across every one of these categories: women, in particular the large number of fatherless families. The CIP (1975:19) found that 81% of all poor income units were headed by women. "Society has failed to adapt to the needs of a large number of single parents (mainly women) and married women for part-time work and facilities for child care...lack of such opportunities is an important cause of poverty" (CIP, 1975:1).
6.2.2 Urban Environment and Housing

All the acquisition areas are well within 1:20 flood zones, and were severely flooded a number of times during the 1970s. With the exception of North Wagga the areas are also subject to frequent local flooding (at least every year) as a result of poor drainage. The feasibility of structural flood protection varies from non-existent to moderately low (Section 2.3), a major justification for the acquisition schemes.

Because of the flood hazard and the decision to phase out residential development - in the case of North Wagga a decision taken over 25 years ago - the level of council services is low. Conditions vary but public utilities, in particular roads and drainage are rundown. North Wagga and Echuca West are not sewered and streetlighting and footpath provision is minimal. An additional feature of the environment specific to Lismore is the increasing and apparently haphazard location of industry in the floodplain residential area.

Overall the housing stock is rundown and property values are low. Within each area house condition is closely tied to flood risk, with the most flood prone areas having the highest proportion of poor houses. House condition was evaluated externally by the author and an assistant, and independently by Smith et al (1979) (Tables 6.1 and 6.2). Certain factors other than flooding contributing to the poor condition of the housing stock such as the development and maintenance restrictions in North Wagga, are themselves a reflection of the flood problem in the first instance; but, on closer examination may be manifestations of the process by which groups in Australian society remain in poverty (CIP, 1975:1). As the Echuca and Lismore acquisition areas were developed over a long period, house age is not felt to be a critical variable.

In turn the conditions of the physical environment and housing stock are reflected in depressed property values. As the degree of flood hazard is the factor underlying these conditions the extent of the property value discount is closely related to the flood risk of individual sites. Based on Valuer General transaction records and evidence from local real estate agents, the most depressed property values occur in North Lismore.
Table 6.1: House Condition. Percent in Echuca and Lismore, evaluated externally by the author and assistant.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Dwellings</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ECHUCA WEST</td>
<td>62</td>
<td>40.3</td>
<td>35.5</td>
<td>24.2</td>
</tr>
<tr>
<td>LISMORE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORTH LISMORE</td>
<td>166</td>
<td>26.5</td>
<td>51.8</td>
<td>21.</td>
</tr>
<tr>
<td>VICTORIA ST/LT KEEN ST</td>
<td>127</td>
<td>38.6</td>
<td>41.7</td>
<td>19.7</td>
</tr>
<tr>
<td>FLOODPLAIN CONTROL</td>
<td>109</td>
<td>63.3</td>
<td>29.4</td>
<td>7.3</td>
</tr>
<tr>
<td>FLOOD FREE</td>
<td>105</td>
<td>90.5</td>
<td>7.6</td>
<td>1.9</td>
</tr>
</tbody>
</table>

* Includes a number of fairly new houses.

Table 6.2: House Condition on the Lismore Floodplain. Percent in poor condition by flood risk (Data from Smith et al 1979:219)

<table>
<thead>
<tr>
<th>Flood Risk*</th>
<th>1:1.5</th>
<th>1:2</th>
<th>1:2.5</th>
<th>1:4</th>
<th>1:8</th>
<th>1:75-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of only 4 houses poor in each risk class below 7.5m</td>
<td>100%</td>
<td>58%</td>
<td>34%</td>
<td>16%</td>
<td>11%</td>
<td>9%</td>
</tr>
</tbody>
</table>

* Using flood recurrence curve based on post 1945 data.
Table 6.3: Lismore Property Values (January 1983)

<table>
<thead>
<tr>
<th>House and Land Floods</th>
<th>House and land flood free</th>
<th>House is flood free, land floods</th>
<th>South Lismore and Lismore Basin</th>
<th>North Lismore</th>
<th>Acquisition Scheme Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$64,000</td>
<td>$35-50,000</td>
<td>$25-37,000</td>
<td>$20,000</td>
<td>$11,000</td>
</tr>
</tbody>
</table>

(The most flood prone area), where values are less than half those for comparable flood free dwellings. Lismore interviewee self assessment of property value acts to confirm these figures (Munro et al., 1980). Thus a typical North Lismore residence in good condition would market for less than $20,000, and the worst of the flood affected property such as that purchased under the acquisition scheme for about half that figure (Table 6.3).

The property values refer, as far as is possible, to the prices of structures and the land they occupy in flood free and flood prone locations. It is apparent therefore that flood prone land has almost no value. A typical building block in flood free Goonellebah would fetch in excess of $20,000, while flood prone land purchased under the acquisition scheme is valued at some $600 per building block.

Housing in the acquisition areas appears to satisfy the 1974 CIP poverty criteria. As the infrastructure of the areas is also very rundown, or of a very low standard, it seems reasonable to expect that the inhabitants are without the financial or other resources necessary for occupation of less hazardous locations.

6.2.3 Financial Status of Residents

6.2.3.1 Income, Education and Employment

The income and education levels of acquisition area residents are lower than the levels in flood free areas. Employment is generally in blue
collar jobs and unemployment levels are comparatively high. Factors which were identified by the CIP (1974, 1975) as being major contributors to poverty. Data in this section are from the 1976 census.

Acquisition area household incomes are typically in the $4-9000 per annum range (40%), compared with average incomes in the respective cities of between $9-18000 (30-40%). Echuca West is notable for being by far the poorest area on an income criteria with 38.2% of the households earning less than $4000 p.a. (Table 6.4).

Income is closely related to occupation, and in all three study sites acquisition zone residents tended to hold unskilled jobs in the service industries or as labourers or process workers (60% in acquisition areas compared to an average LGA, or citywide, figure of 38%). The very low proportion in white collar jobs is reflected in the virtual absence of high income earners ($>18,000). These low income areas exhibit the highest unemployment levels (Census) with about 12% of household heads or spouses claiming to be unemployed and looking for work. No similar cases were recorded among the flood free sample.

The level of educational achievement is generally similar in all areas on and off the floodplain, with the largest single group of adults (33%) having left school at Intermediate Certificate/School Certificate age (15/16). Echuca West provides an exception: there the most common school leaving age was 13/14. Apart from Echuca, differences between the acquisition and non-acquisition areas are ones of degree, with educational achievement declining as flood risk increases. The questionnaire results emphasise these differences dramatically. They suggest that between 7 and 10% of the acquisition samples have virtually no formal education compared with 2% of the flood free interviewees. These results are expected in part because the acquisition area populations are relatively old, nevertheless they serve to reinforce their low socio-economic status.

Analysis of income confirms the CIP (1974) finding that housing is the most obvious expression of poverty among poor whites in rural NSW. Within the Lismore floodplain those on lower incomes tend to occupy the more flood prone and rundown dwellings. (Lismore was the only site for
Table 6.4: Comparative Income Data (percentages).
1976 Census figures not adjusted for inflation

<table>
<thead>
<tr>
<th>INCOME $</th>
<th>LISMORE</th>
<th></th>
<th>ECHUCA WEST</th>
<th></th>
<th>NORTH WAGGA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North Lismore</td>
<td>Victoria/ Little Keen Sts.</td>
<td>CD</td>
<td>LGA</td>
<td>CD</td>
</tr>
<tr>
<td>4000 or less</td>
<td>22.6</td>
<td>18.2</td>
<td>16.8</td>
<td>38.2</td>
<td>16.8</td>
</tr>
<tr>
<td>&gt;4000-9000</td>
<td>38.2</td>
<td>44.1</td>
<td>29.7</td>
<td>26.4</td>
<td>30.1</td>
</tr>
<tr>
<td>&gt;9000-18,000</td>
<td>27</td>
<td>23.4</td>
<td>34.9</td>
<td>14.7</td>
<td>31.2</td>
</tr>
<tr>
<td>&gt;18000</td>
<td>1.7</td>
<td>1.7</td>
<td>10</td>
<td>2.9</td>
<td>7.8</td>
</tr>
<tr>
<td>No Response</td>
<td>-</td>
<td>15.5</td>
<td>8.6</td>
<td>17.6</td>
<td>13.1</td>
</tr>
<tr>
<td>TOTAL (percent)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

CD's are census collectors districts.
LGA's are local government areas.
which the income of individual households could be matched with dwelling flood risk data).

6.2.3.2 Welfare Recipients and Household Composition

"The majority of the very poor families in Australia are dependant on pensions or benefits" (CIP, 1975:47). Virtually all pensions and benefits are below the CIP poverty lines using figures for 1979-80, (SWPS, 1981).

Some data on numbers of welfare recipients were collected during interviews but the more accurate figures are from the 1976 Census (Table 6.5). The census data show that the acquisition areas contain a very high proportion of people on pensions or benefits of one type or another. On average, the proportion of welfare recipients in these areas is about 1.5 times that found in the flood free areas, though this varies and is twice the proportion in the basin area of Echuca West. These differences would be considerably greater now due to the rise in the number of people on supporting parent pensions (Australia-SWPS) and unemployment benefits since 1976; and because a disproportionately large number of these people will seek accommodation in the cheapest areas. In the study sites the cheapest areas are the most flood prone.

The average figures for welfare recipients though high, disguise a far greater impact on women than men. Some 79% of single pensioners aged 65 years and over are women (Dept. of Social Security, Annual Report 1979-80, SWPS:173), about 80% of single parent families in the study areas are fatherless, and employment opportunities for women in rural areas are minimal.

Two large identifiable groups on welfare in the acquisition areas are the aged and single parent families.

Single Parent (fatherless) Families

Apart from North Wagga, the proportion of single parent families in the acquisition zones is high, varying from 2 to over 3 times (up to 17.5% of Census CD households) that found in the flood free areas. In
Table 6.5: Welfare Recipients - 1976 Census data

<table>
<thead>
<tr>
<th>Lismore North Lismore</th>
<th>Victoria/Little Keen Sts.</th>
<th>Echuca West</th>
<th>Echuca West Basin*</th>
<th>Wagga North Wagga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of area receiving pensions or benefits</td>
<td>39</td>
<td>50.9</td>
<td>30.9</td>
<td>42.2</td>
</tr>
</tbody>
</table>

* Data from Bethune (pers comm. 1981)

Table 6.6: Tenancy by Age on the Lismore Floodplain*

<table>
<thead>
<tr>
<th>Age</th>
<th>Rent</th>
<th>Buy</th>
<th>Own</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30 (N=60)</td>
<td>66</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>30-39 (N=29)</td>
<td>32</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td>40-59 (N=53)</td>
<td>23</td>
<td>28</td>
<td>49</td>
</tr>
<tr>
<td>60+ (N=67)</td>
<td>12</td>
<td>7</td>
<td>81</td>
</tr>
</tbody>
</table>

* Proportion of rented housing in other sites was too small for analysis.
addition about 4% of the Lismore acquisition households consist of parent(s), a daughter and the daughter's child.

According to the Commission of Inquiry into Poverty (1975:220) "One parent families and large 2 parent families were the poorest groups... Fatherless families in particular as a group were in a critical position..." The situation for fatherless families in the area this study is concerned with, i.e. those outside the metropolitan centres, is very much worse than average figures indicate: 41.5% of these families were very poor by the Commission's criteria compared with 28.8% in the Metropolitan areas (p.203). This difference is largely due to the existence of fewer suitable work opportunities in rural areas.

Most of the (one parent) families sampled (66%) rent privately which generally acts to increase their housing costs, and in Lismore, places them at a greater flood risk. One third live in dwellings with floor levels below the 1:20 flood level (12.5m), while only one sixth of two parent families (with children) live at similar flood risks.

The Aged

All three acquisition areas contain a disproportionately large number of older people (>60 years of age), with the difference least marked in North Wagga. This difference varies from 1.5 to 2 times the proportion in the whole community (Census). In general, people in their 70s are also over-represented compared to the flood free areas, while the intermediate age groups (30-59) are under-represented, a situation in keeping with the patterns of tenancy and length of residence. Between one third and a half of the aged Lismore and Echuca samples live alone, almost all of them widows, and a slightly smaller proportion live with relatives or children, a circumstance typical of the rest of the country (SWPS, 1981:241).

The Commission of Inquiry into Poverty (1974(a):234) found that "...the largest group of people in poverty in Australia consists of those who are over 65 (60 for single women)." However, the high rate of home ownership by older people reduces the percentage technically below the Commission's poverty line from 23.8% to 7.6%, in terms of effective disposable income (Table 6.6). But in making this adjustment there was no
allowance for maintenance costs which are particularly high for frequently flooded wooden houses.

6.2.4 Tenancy and Length of Residence

A relatively high proportion of the most flood prone property is rented, as the proportion of the housing stock rented increases with the degree of flood risk and reaches 40% in the Victoria/Little Keen Sts. area (Census and Questionnaire). It follows that a relatively large number of rental properties will be in poor condition: 29% versus 10% of those owned (for the whole Lismore floodplain); and that the occupants of this property will be the area's poorest residents (Section 6.2.2).

Apart from Lismore, where the floodplain provides the bulk of the low cost rental accommodation, the flood prone areas are not significant sources of rental accommodation (Table 6.7). Outright home ownership is high in all acquisition areas, whereas the numbers buying their homes are very low, less than half the proportion found in flood-free areas (Census). This reflects the difficulty in obtaining finance, length of residence and other factors detailed in Section 6.3.

A striking feature of the tenancy pattern is the high proportion of inherited dwellings, from 8% in North Wagga to 15% in North Lismore compared with less than 2% of the flood free Lismore sample (Table 6.7), which suggests that family attachment to the area may be important.

The tenancy patterns are reflected in the length of residence and age distributions, particularly in the Lismore acquisition areas. In these areas length of residence is distinctly bimodal (Table 6.8): almost half the population has resided for less than five years, these people are predominantly renters; while about one quarter have lived in their present dwellings for more than 25 years. By contrast the flood free area has a more normal distribution of length of residence, a result of the large proportion buying their homes, the number of new properties and of the more generally mobile middle class. Age is associated with tenancy status as Table 6.6 illustrates for the Lismore floodplain. Most of those under 30 are renting and most of those over 60 live in their own homes.
Table 6.7: Tenancy status of samples
Percent of area in each tenancy type.
Number in sample is in brackets (N= )

<table>
<thead>
<tr>
<th>STATUS</th>
<th>ECHUCA WEST</th>
<th>NORTH WAGGA**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=50)</td>
<td>(=168)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RENTING</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>BUYING</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>OWN OUTRIGHT</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>INHERITED</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>OTHER *</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>

* Includes caravan park residents, free occupancy, those given land and one couple living in a bus body on their own land.

** 9% of the North Wagga sample did not answer the question.
Table 6.8(a) : Length of Residence
Expressed as percentages. The number of household heads in each sample is in brackets (N= ).

<table>
<thead>
<tr>
<th></th>
<th>NORTH WAGGA*</th>
<th>ECHUCA WEST</th>
<th>LISMORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=168)</td>
<td>(N=51)</td>
<td>North Lismore</td>
</tr>
<tr>
<td>&lt;5 Years</td>
<td>27</td>
<td>24</td>
<td>49.4</td>
</tr>
<tr>
<td>5&lt;15 Years</td>
<td>19</td>
<td>30</td>
<td>9.6</td>
</tr>
<tr>
<td>15&lt;25 Years</td>
<td>18.5</td>
<td>16</td>
<td>10.8</td>
</tr>
<tr>
<td>&gt;25 Years</td>
<td>33.6</td>
<td>30</td>
<td>30.2</td>
</tr>
</tbody>
</table>

* Data from SKP & MSJKY (1979) reallocated to fit these period categories.

Table 6.8(b) : Percentage born in "suburb" or present dwelling.

<table>
<thead>
<tr>
<th></th>
<th>7</th>
<th>10</th>
<th>31.2</th>
<th>8.9</th>
<th>8.5</th>
<th>.5</th>
</tr>
</thead>
</table>
Clearly this will tend to increase the disposable income available to older people (Section 6.2.3.2).

Two groups of people are emerging from the demographic analysis: young short term renters living in the most flood prone and rundown housing: and older long term residents many of whom inherited their dwellings and were born in the immediate vicinity. It is worth noting that these general associations are not restricted to the Lismore floodplain but are well established in the housing policy literature (Fredland, 1974).

6.2.5 Health

Hospital admissions data for Lismore were collected for an earlier study (Smith et al, 1981; Handmer & Smith, 1980). Although this data is disaggregated by flood risk instead of area, reasonable comparison of acquisition with non-acquisition zones is possible as the acquisition properties are the most flood prone in the city.

The rate of hospital admissions in Lismore increases sharply with flood risk. Results are set out in Table 6.9, which also explains how the material was collected and analysed. The rate for those in flood free Lismore was 11.9 hospital admissions per 100 people per year, about the same as the NSW average, but rises steadily to 34 admissions per 100 people for the same period among those in the lowest houses; an increase of 286%. However, the average length of stay in hospital is shortest for the most flood prone group at 7 days, and increases as property becomes less flood prone to 13 days for those in flood free Lismore. This difference could reflect inability to pay for longer stays by the poorer group. Even after allowing for the difference the hospital bed demand rate, in terms of person days, is still substantially greater for the most flood prone group.

Additional information on ill-health was obtained by interviewers but apart from the Victoria St. area is not considered reliable. Over 20% of the respondents in this area reported that one or more members of their households were suffering from some acute or chronic disease or handicap. In addition a major excuse for interview refusals was ill-health or handicap.
### TABLE 6.9: Hospital Admission Rates in Relation to Flood Risk

<table>
<thead>
<tr>
<th>Flood Risk of Dwelling (Floor Level)</th>
<th>No. of Houses (Cumulative Totals)</th>
<th>Year before 1974 Flood</th>
<th>Year after 1974 Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of admissions in sample</td>
<td>Admission rate* per 100 people</td>
<td>No. of admissions in sample</td>
</tr>
<tr>
<td>&gt;1:8</td>
<td>214</td>
<td>32</td>
<td>29.4</td>
</tr>
<tr>
<td>&gt;1:100</td>
<td>894</td>
<td>92</td>
<td>21.3</td>
</tr>
<tr>
<td>&lt;1:100</td>
<td>1900</td>
<td>199</td>
<td>20.6</td>
</tr>
<tr>
<td>Land&lt;1:100</td>
<td>4907</td>
<td>287</td>
<td>11.6</td>
</tr>
</tbody>
</table>

The overall hospital admission rate per 100 persons for NSW for 1977-78 was 12.8 (ABS, 1981).

* The sample of hospital admissions is in two parts; every admission for the two weeks before and after the flood and one in eight for the remaining 50 weeks. This was adjusted to give an estimate of total admissions. To obtain the admission rate per 100 persons the mean household size is taken as 3.2 persons, this is based on the 1976 Census data for the Lismore Local Government Area.

Reasons for the elevated levels of ill health found among the most flood prone households relate to the social and economic condition of the people, and possibly to the flooding itself. For example increased levels of ill-health have been clearly demonstrated among those who are poorer (CIP, 1974:81), who are highly mobile residentially (Kantor, 1967), and among widows (Madison and Viola, 1968; Parkes et al, 1969). Other demographic aspects may be important though the average age of hospital patients was the same in all groups. Although a study into the health effects of the 1974 Lismore flood found no increase in hospital admissions or mortality (Section 5.4), exposure to constant worry and anxiety about flooding would be expected to produce stress and in turn an elevated incidence of all types of health problems (Smith et al, 1980; Handmer & Smith, 1983). The hospital admissions data of Table 6.9 seem to support this hypothesis and to corroborate comments about anxiety over the "next flood" expressed by many interviewees.
6.2.6 Summary of Findings

By whatever established poverty criterion is employed: income; social and economic functioning through housing standards, health and education levels, level and type of employment; or the most poverty-prone groups as identified by the SWPS (Australia-SWPS, 1981) and others; the acquisition areas contain exceptionally high proportions of poor people - of people socially and economically disadvantaged. Another indicator of low socio-economic status is occupancy of areas where low property values reflect apparently undesirable environmental features such as flood risk.

Within this general description the people, especially those in Lismore, fall into two reasonably distinct groups: elderly long-term owner occupiers, many of whom inherited their homes and were born in the area; and relatively young mobile renters occupying much of the most flood prone and rundown housing. In view of the CIP's findings on the effects of home ownership on poverty, it is expected that the rental group would be the worst off economically.

6.3 REASONS FOR LOCATION

6.3.1 General

Having established that the bulk of the acquisition area residents are socio-economically disadvantaged, it seems probable that their choice of dwelling is severely constrained by cost, and possibly family factors. Nevertheless, to begin with their location process is examined within the context of the flood knowledge and perception model of geographic hazards' research.

The open ended questions produced sixty reasons for moving to the area, sixty for remaining there and forty nine disadvantages. In each case these could be conveniently collapsed into a dozen categories which form the basis of this section. (Tables 6.10, 6.11, 6.12).
Table 6.10: Reasons for Location in the Area

Respondents could list up to 2 persons for their initial location decision. Responses for each reason were combined into a percentage of the respondents for the area in question, thus percentage totals will exceed 100. N refers to the sample size.

<table>
<thead>
<tr>
<th>REASONS FOR LOCATION</th>
<th>NORTH WAGGA*</th>
<th>ECHUCA WEST</th>
<th>Lismore</th>
<th>Victoria /Lt Keen Sts.</th>
<th>Flood-Plain</th>
<th>Flood Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost (when asked specifically)</td>
<td>(69)</td>
<td>(54)</td>
<td>62</td>
<td>26</td>
<td>62</td>
<td>9.3</td>
</tr>
<tr>
<td>Desperate/only house available</td>
<td>-</td>
<td>11.6</td>
<td>-</td>
<td>-</td>
<td>23.2</td>
<td>20</td>
</tr>
<tr>
<td>Availability</td>
<td>26</td>
<td>4.7</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>25.7</td>
</tr>
<tr>
<td>Access</td>
<td>62</td>
<td>9.3</td>
<td>-</td>
<td>-</td>
<td>4.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Flood Free (when asked specifically)</td>
<td>-</td>
<td>2.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Secluded/Quiet</td>
<td>3</td>
<td>39.5</td>
<td>-</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>Family (Friends) Factors</td>
<td>39</td>
<td>55.8</td>
<td>-</td>
<td>-</td>
<td>53.7</td>
<td>27</td>
</tr>
<tr>
<td>Work Factors</td>
<td>6</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>13.4</td>
<td>14.3</td>
</tr>
<tr>
<td>Pleasant area/view</td>
<td>3</td>
<td>14</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>5.7</td>
</tr>
<tr>
<td>Opportunity to Buy</td>
<td>-</td>
<td>4.7</td>
<td>-</td>
<td>-</td>
<td>7.3</td>
<td>5.7</td>
</tr>
<tr>
<td>House Factors</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Animals Allowed</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.7</td>
<td>2.9</td>
</tr>
<tr>
<td>TOTAL (N=)</td>
<td>168</td>
<td>43</td>
<td>82</td>
<td>70</td>
<td>59</td>
<td>59</td>
</tr>
</tbody>
</table>

* Closed question only, see Section 2.2.
Table 6.11: Reasons for Remaining in the Area

Respondents could list up to three reasons for staying in the area. Responses for each reason are combined into a percentage of the respondents for the area in question. Thus percentage totals will exceed 100. N refers to the sample size.

<table>
<thead>
<tr>
<th>REASONS FOR REMAINING</th>
<th>NORTH WAGGA*</th>
<th>ECHUCA WEST</th>
<th>LISMORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>North Lismore</td>
</tr>
<tr>
<td>Cost (when asked specifically)</td>
<td>26</td>
<td>20.5</td>
<td>28.4</td>
</tr>
<tr>
<td>Trapped/no choice</td>
<td>-</td>
<td>-</td>
<td>17.6</td>
</tr>
<tr>
<td>Access</td>
<td>54</td>
<td>6.8</td>
<td>51.4</td>
</tr>
<tr>
<td>Flood free</td>
<td>-</td>
<td>2.3</td>
<td>4</td>
</tr>
<tr>
<td>Rural atmosphere/quiet</td>
<td>54</td>
<td>84</td>
<td>9.5</td>
</tr>
<tr>
<td>Friends/relatives/neighbours</td>
<td>57</td>
<td>18.2</td>
<td>17.6</td>
</tr>
<tr>
<td>Familiar area</td>
<td>-</td>
<td>22.7</td>
<td>33.8</td>
</tr>
<tr>
<td>Other area factors</td>
<td>5</td>
<td>15.9</td>
<td>23</td>
</tr>
<tr>
<td>House factors</td>
<td>-</td>
<td>4.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Too old/hassle to move</td>
<td>-</td>
<td>6.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Own or buying house</td>
<td>69</td>
<td>2.3</td>
<td>12.2</td>
</tr>
<tr>
<td>TOTAL (N =)</td>
<td>168</td>
<td>44</td>
<td>74</td>
</tr>
</tbody>
</table>

* Closed questions only, see section 2.2.
Table 6.12: Location Disadvantages

Respondents were asked to list up to 3 disadvantages in order of severity. In this table responses ranking the particular disadvantage 1st, 2nd, or 3rd are combined into a percentage of respondents for the area in question, so percentage totals will exceed 100. N refers to the sample size.

<table>
<thead>
<tr>
<th>DISADVANTAGE</th>
<th>NORTH WAGGA*</th>
<th>ECHUCA WEST</th>
<th>LISMORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>North Lismore</td>
</tr>
<tr>
<td>None</td>
<td>6</td>
<td>30</td>
<td>21.7</td>
</tr>
<tr>
<td>Floods</td>
<td>54</td>
<td>36</td>
<td>65</td>
</tr>
<tr>
<td>(75 no levee)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Industry/Noise</td>
<td>-</td>
<td>-</td>
<td>28.9</td>
</tr>
<tr>
<td>Council/poor services</td>
<td>1</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td>Poor roads/dust</td>
<td>-</td>
<td>30</td>
<td>2.4</td>
</tr>
<tr>
<td>Site or house problems</td>
<td>-</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>Poor/unfriendly area</td>
<td>19</td>
<td>2</td>
<td>9.6</td>
</tr>
<tr>
<td>(rundown)</td>
<td></td>
<td></td>
<td>(no shops/services)</td>
</tr>
<tr>
<td>Distance from facilities etc.</td>
<td>-</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td>Other physical environment problems</td>
<td>-</td>
<td>8</td>
<td>1.2</td>
</tr>
<tr>
<td>Building regulations</td>
<td>82</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL (N=)</td>
<td>168</td>
<td>50</td>
<td>83</td>
</tr>
</tbody>
</table>

*Closed questions only, see Section 2.2
6.3.2 Choice

6.3.2.1 Flood Knowledge and Perception

Early studies by Kates (1962) and Koder (1961) suggest strongly that low hazard perception (in this case concern) is different from ignorance. They demonstrated that the provision of hazard information does not by itself alter attitudes to flooding, casting doubt on the importance of hazard knowledge in residential location choice. Similar doubts about the knowledge-attitude linkage were expressed as early as the 1940s, when Hyman and Sheatsley (1947) found that "people interpret the same information differently...information does not necessarily change attitudes" and that "people seek information congenial to prior attitudes." These points have been confirmed most recently by environmental risk research (eg. Slovic et al., 1980).

Despite the fairly unambiguous results of these workers it is often assumed that once informed of the risk inherent in floodplains, people, acting in their own best interests, would choose to avoid them. Such an assumption for example implicitly underlies most public education campaigns including those concerned with hazards, where it is wrongly believed that information will change attitudes and in turn behaviour (Illinois Dept. of Transportation, 1980).

In many cases knowledge and awareness is critical in hazard preparedness and the success of individual action to reduce damages. The extent to which a community of experienced individuals may reduce flood damage is discussed in Section 3.3.4.7. Knowledge in this context appears to be gained primarily through personal experience. Furthermore, there is no evidence that knowledge of a low flood risk and information obtained from official information sources alone has any effect on the residential location decision (Handmer & Milne, 1981, post Brisbane flood situation; Palm, 1980), though the situation in areas of high flood hazard, such as the study sites, may be quite different.

Knowledge of the flood risk at the time of moving to the present address was almost universal in the areas surveyed (80-95% depending on the area), apart from Wagga for which suitable data were not collected. A
small but significant number made the point that the flooding was much worse than expected (10% of Echuca West). Flood hazard information had come primarily from personal or family observation and experience, and from neighbours and previous house owners. Less than 5% of the sample in any area had received their principal advice from official information sources such as Councils and flood maps.

As knowledge of the flood hazard in Lismore is widespread why do some people locate in the floodplain and some not? Conventional hazards theory would suggest that the difference lies in the degree of flood perception or concern over the flood risk. At first sight this appears to be the case as nearly 40% of the Lismore flood free sample (80% when asked specifically) and less than 5% of the acquisition samples mentioned that flood risk was important in their location decisions. However, the levels of hazard perception in the acquisition and flood free areas are very similar when the criteria commonly employed to gauge flood perception are examined. These criteria are based on the respondents' expectation of future flooding, and expressed concern about flooding. Some studies have employed alternative terminology labelling those with low flood perception, optimists, and those with high perception, pessimists.

Another possible explanation for locational choice is the level of flood experience. Those with flood experience are expected to want to avoid flood prone locations. In fact, apart from the acquisition areas, the level of flood experience (defined as having experienced water over the dwelling floor) as far as flooded houses are concerned is remarkably similar at 25% for both the floodplain control and flood free samples (previous dwellings for the flood free sample). Not surprisingly the acquisition area residents have had by far the most flood experience at 60% of the sample. Another possible interpretation of these results is that those with more experience are used to dealing with floods and do not see them as a major problem. But, for Lismore at least, the more frequently people have been flooded the more likely they are to see floods as a locational disadvantage (Munro et al, 1980).

The residents of Lismore were, in general, aware of the flood hazard when they first came to the area. Hazard perception and experience of the different samples, both flood free and floodplain, is remarkably
similar. Floods are seen as a major community problem that cause extensive disruption and worry. Yet only those living in flood free Lismore appear able to consider them in their location decisions.

6.3.3 Constraints

6.3.3.1 Introduction

The majority of acquisition area residents appear to have been severely restricted in their locational choice. In Lismore they are living in very high risk areas, despite prior knowledge of the problem and real concern over future floods. Furthermore the residents are just the sort of people identified by Bourne (1981: 143) as being most likely to be affected by location constraints: "the poor, the elderly, the very young, the unemployed, and the transient." A variety of constraints were identified by interviewees. The most important of these are the subject of the following sections.

Additional constraints particularly relevant to flood prone areas are the availability of mortgage finance and the existence of building and other regulations.

After the 1950s flooding NSW building societies stopped lending on flood prone property. Banks are only now starting to follow suit, following repeated flooding during the 1970s, the extensive floodplain mapping programs in NSW and other states which delimit hazardous areas, and government directives in NSW. Generally speaking the oldest and poorest residential areas receive the smallest proportion of mortgage funds (Bourne, 1981). This "discrimination in mortgage lending plays a major role in initiating or accelerating the process of housing and neighbourhood deterioration" (Bourne, 1981:119). However, the contraction of bank finance is unlikely to affect the situation in the older developed floodplains as most of the residents of these areas would not qualify for such funds anyway, though it may have helped to increase the proportion of rental accommodation. Also in some areas, including those under study, institutional lending restrictions may be partly made up by private sources, including inheritances, family and friends, and special aid
agencies such as aboriginal societies.

Apart from a floor level requirement, restrictive building regulations do not apply in Lismore, and have only recently been introduced in Echuca West. On the other hand North Wagga has been subject to the most severe building restrictions in N.S.W. Certainly these have contributed to the reduced property values and to neighbourhood decline but not to the extent generally imagined (Section 3.3.3.4).

The deterioration of the acquisition area neighbourhoods caused by a combination of the factors discussed above, themselves precipitated by periods of severe repeated flooding, has gradually led to the development of spatially well defined housing sub-markets. Such sub-markets are not necessarily always defined by price. The explanation may be ethnic or may lie with the housing preferences of groups of buyers, but in the acquisition areas being examined property price is clearly the most plausible delineater (Section 6.2.2).

6.3.3.2 Economics

People at all acquisition sites considered that housing costs were an important factor in both their initial location decisions and in their continued residence in the areas.

When asked specifically, just under two thirds of the acquisition samples, and one third of the Lismore flood free sample, felt that cost was important in bringing them to the area. In the open question on reasons for location these figures become 27% and 5% respectively (Table 6.10). However, when these people are combined with those who claimed that they had been "desperate" and had moved into their properties because they were all that was available (ie. available within the limits of their aspirations or finance), the proportion financially constrained increases up to 45% for North Lismore residents.

Among reasons for staying cited by interviewees, cost was not as important as it had been in the initial location decision, although the pattern of responses was essentially similar, and responses to the specific cost question were approximately the same as for location (Table 6.11).
It is important to note that cost is overwhelmingly the concern of renters, with 81% citing this as their main reason for staying in the area. In general cost appears to be more important to those in the most flood prone houses. When the reasons for staying are ranked by flood risk, about 60% of those below the 1:2 flood line (ground height) feel the expense of moving is a major factor preventing relocation compared with less than one third of those whose land is above the 1:4 flood. Conversely as ground height increases the absence of serious floods becomes more important as a reason to remain.

If people are really trapped in the area it is reasonable to expect that a substantial proportion of those who have no intention of moving would move if they had the financial opportunity. Overall about 80% of the samples have no moving intentions, with the major rental areas containing the largest proportion likely to move within 12 months. In the Lismore acquisition areas of those who are staying (or are not sure of their movements) just under one third would prefer to leave but believe that it would be too difficult, compared to 13% of the flood free control. Flooding was the main reason cited for wanting to leave (55%), with a desire to "move to the country" being second in importance (17%), and lack of money the obstacle (80%). Within each area these preferences appear to be related to tenancy with over 40% of Lismore's acquisition area renters, and only 25% of outright owners, believing that it would be too difficult to leave. Tenancy type is itself a function of flood risk, with the amount of rental accommodation being smallest in the flood free areas. Thus there is a steady increase in the proportion who would prefer to leave as the flood risk increases.

The relatively low leaving preference in Echuca (18%), is partly explained by the general absence of renters as well as by satisfaction with the area. Further evidence that the people's choice is limited is provided by the reasons for location in the particular dwellings rather than area, if it is accepted that being desperate and having no choice in dwelling selection is worse than simply being under financial constraints. Some 30% of North Lismore interviewees said they had no choice in dwelling selection. The proportion of people in this situation declines as the physical environment improves. Thus 11% of the floodplain control and 0% of the flood free samples claimed to have had no choice.
Another major constraint identified in the study of residential location and housing sub-markets is attachment to a community or place (Bourne, 1981:143). This constraint subsumes a host of family and other variables. In the relocation literature it is generally regarded as the critical factor in determining the success or failure of the relocation process. For many people their flood plain home is just "a losing piece of property they want to leave but can't afford (to). But to others like the elderly it may be their source of identity." (Motz, 1975).

People may feel or find that only housing in a particular location is readily available to them; because of their special needs, eg. easy walking access to sick relatives, town services or because accommodation is arranged or made available through relatives or other contacts. Alternatively the area may hold special significance through family or other association. This situation may simply disguise economic constraints, for instance it has been well established that inheritances (a very high proportion of acquisition area dwellings) and other family accommodation arrangements often operate to offset the inability of residents to obtain mortgage finance (Bourne, 1981:119).

Demographic Evidence

A range of demographic and other factors have been found to be associated with strong attachment to community and place (Table 6.13). Clearly the characteristics of a theoretical "most vulnerable group" derived from Table 6.13 closely approximate the characteristics of a substantial proportion of acquisition area residents: long term elderly residents with strong family/ancestral ties to the area, who own their houses, have a low level of education and, if employed, are unskilled workers. Conversely the mobile younger renter group, important in Lismore, will be relatively unattached to the area (Section b.2.7).

On the basis of the literature, acquisition area residents are those particularly strongly attached to their location (or put another way, constrained from moving). However, the type of attachment or community identification is quite different at each site.
Table 6.13: Demographic factors associated with strong attachment to community

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>COMMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Cycle Stage</td>
<td>Families are more likely to move at certain stages in their life cycle (though old age is more important), at marriage, and as the family expands and contracts. Thus community attachment may vary: Bourne, 1981; Motz, 1975. Rossi, 1980</td>
</tr>
<tr>
<td>Education Level and Occupation Type</td>
<td>Those with higher education levels and higher status occupations are less attached or rather are more mobile residentially: Bourne, 1981; Colony, 1971; Effrat, 1974; Motz, 1978; Perfator &amp; Allen, 1976; Shields, 1975. Burdge &amp; Ludtke 1972, consider that in general socio-economic variables are not very important in water resources planning. However, Shields, 1975, is probably more accurate: socio-economic variables are of some significance in that they are related to other factors known to be important eg. vested interests and at the community level, ability to organise. A further point related to occupation is that those whose livelihood is closely associated with a particular place such as farmers will often identify strongly with the locale: NERBC, 1976; NSW WRC, 1980; Shields, 1975.</td>
</tr>
<tr>
<td>Family History</td>
<td>Ancestral ties will strengthen identification with the locale, and community if relatives still live in the area: Motz, 1978; TVA, 1972.</td>
</tr>
<tr>
<td>Social Interaction</td>
<td>The number of friends and relatives in the community and the frequency of interaction with them is positively associated with level of community attachment: Bourne, 1981; Burdge &amp; Ludtke, 1972; Motz, 1978; SKP &amp; MSJKY, 1979</td>
</tr>
<tr>
<td>Tenancy Status</td>
<td>Renters are more residentially mobile: Bourne, 1981; and often less attached to the community.</td>
</tr>
<tr>
<td>Area/Suburb Type</td>
<td>Dormitory suburb residents often have a low community attachment: Adler &amp; Jansen, 1978.</td>
</tr>
</tbody>
</table>
Community as Place and Community as Function

A theoretical basis for data examination is provided by the literature on community, even though some of the areas under examination may not, strictly speaking, be communities and might be better described as "neighbourhoods". Exactly what constitutes a community is subject to considerable debate and a number of major lines of inquiry exist (Bernard, 1973; Effrat, 1974).

Much of the debate has centred around the importance of locale or territory versus common ties or goals, function or social interaction. Bernard (1973:183) quotes one viewpoint, "The Catholic parish system is an anachronism. Its basic concept is territorial, and nothing but sewer districts operate that way today." There are certainly many whose community or major source of identity may have little or no territorial basis. Such people typically include the very mobile and nationally or internationally oriented government officials, executives, and academics. But, others, including many of those this study is concerned with, may derive "their sense of self-hood through their daily interaction within a particular physical locale." (Motz, 1975:iv-5). Bernard (1973:186) too argues that "(P)hysical boundaries are still meaningful to residents."

Nevertheless the importance of territory and social interaction varies considerably between study sites. This was not initially expected or hypothesised but became apparent after early fieldwork, and further investigation seemed warranted: "Communities are not predefined but (are established) by empirical investigation" (Effrat, 1974:21).

Community attachment was assessed in two ways. First through an examination of the reasons for residential location, and second as revealed by answers to questions on membership in local clubs, attitudes to neighbours, and the proportion (and number) of respondents' friends and relatives residing in the acquisition areas.

In their reasons for staying most Echuca interviewees (84%) stressed the quiet rural/bush atmosphere, (which was also an important factor in their initial location decision (40%)), compared to virtually none of the Lismore and half the Wagga samples. On the other hand, nearly
two thirds of Wagga and only 18% of Echuca interviewees, mentioned friends, relatives and neighbours as important. Also over one third of the Wagga sample selected "community aspects of the area" as a reason for location (Table 6.11). North Wagga is distinguished by very high levels of locally based friends and relatives and local club membership, while the pattern is reversed in Echuca West. Family attachment to the physical area through ancestral ties and being born locally is extraordinarily high in North Lismore, and is also high in both North Wagga and Echuca West. Unfortunately, results of the question on "attitudes to neighbours" are ambiguous.

North Wagga represents a closely knit community with a high level of social interaction while Echuca West residents identify closely with their physical environment. The Lismore areas occupy intermediate positions with one third of North Lismore residents expressing a strong identification with the locale. However, the Lismore situation is complicated by the large proportion of residents, predominantly renters, who simply want to get away from floods but are financially unable to do so (Section 6.3.3.2).

In summary the demographic characteristics of the bulk of each acquisition area are those expected to exhibit strong identification with community and locale and to present a further constraint to people's choice of residential location. This is confirmed by respondents reasons for location, ancestral ties to the area, and patterns of social interaction.

6.4 CONCLUSIONS

6.4.1 Summary

The occupants of the acquisition areas have been examined in terms of the poverty criteria developed by the Australian Commission of Inquiry into Poverty (1975) and other related studies. Regardless of which criterion is employed an exceptionally high proportion of the areas' residents are found to be socio-economically disadvantaged. Their incomes, health and education levels are low, as is the level and type of employment. Much of the housing and urban environment is rundown and property values are depressed.
The residents divide into two groups: owner occupiers who are older long term residents, many members of this group inherited their homes and were born in the area; and a relatively young and mobile rental group occupying much of the most flood prone and rundown housing.

The reasons for location of the acquisition area dwellers are examined to establish why they occupy such hazardous sites. The acquisition area sample emphasised constraints to location consistent with its status as a lower socio-economic group, and with the findings of Bourne (1981; Section 6.1): accommodation costs and availability, the need for easy foot access to particular services, and family related factors of identification with the area and community. In contrast the only constraint prominent among location reasons given by the Lismore flood free sample was that the area be flood free. This group emphasised choice rather than constraints in their dwelling selection: they liked the house, block or area.

Predicably the major problem faced by acquisition area residents was flooding, along with local industry and noise in South Lismore. Off the floodplain, residential satisfaction was much higher with half the sample feeling that there were no locational disadvantages. Although no data were collected it is probable, given the socio-economic status of the different samples, that the expressed level of locational satisfaction reflects satisfaction with life in general.

Choice in residential location and issues of flood knowledge and perception were relatively unimportant for those occupying the acquisition areas; not because they failed to recognise the flood problem, but because other concerns were more important. These other issues, principally lack of money and family and other ties to the area, acted as constraints to their dwelling selection. Many recent arrivals to the areas, particularly those renting, were quite definite that they were there because they had no choice. They had to live in the cheapest accommodation. Long term residents, most of whom bought their housing before the property booms of the 1960s and 1970s have seen their property lose its value, relative to that in flood free areas, to the extent that it is not economically feasible for them to sell their property and move to less flood prone locations.
On the whole geographic hazards research has failed to examine location in a socio-economic context, preferring instead to seek explanations in terms of flood knowledge and perception. Yet there is no doubt that many of the acquisition area residents had no choice in their location decision. Being poor, choice was confined to the cheapest accommodation. In a free market situation the cheapest accommodation will be that considered least desirable by the majority of consumers. In the study sites such property is the most flood prone. Thus in many respects it is the rental group that is worst off. Almost all members of the group live in the floodplain for no reason other than it is the only accommodation available to them. Furthermore a substantial proportion of this group are single mothers, those people found by the CIP (197b) to be particularly disadvantaged. On the other hand many of the longer term owners, while effectively trapped by their economic circumstances, are also strongly attached to the area through family and ancestral ties; and in the cases of North Wagga and Echuca West through the strength of community and spacious bush setting respectively.

6.4.2 Implications for Acquisition

Those implementing certain non-structural measures will need to consider the fact that people living in very flood prone areas often do not locate because of low flood knowledge or perception, and may need to change their approach accordingly. For instance, to be effective, public information and education campaigns should not be based on the assumption that the floodplain dwellers usually locate in ignorance. Data from the study sites show that most residents were aware of the flood problem but found their location choice restricted by socio-economic factors largely beyond their control. Other authorities attempting to stimulate adoption of flood proofing measures will need to consider the issue of incentives carefully. Absentee landlords and owner occupiers on pensions may be disinclined, or indeed unable in the case of pensioners, to undertake dwelling modifications, raising etc., without financial assistance. This raises the broader social question of the availability of low cost accommodation. Action by authorities to require flood proofing or other improvements to rented dwellings, however well intentioned, will almost certainly lead to a contraction of the amount of rental property available and/or rent increases.
Acquisition and demolition of these dwellings will remove a flood problem, but may do little or nothing for the renters, who simply cannot afford more expensive accommodation. Clearly an acquisition program cannot be expected to cope with society's problems, however, the importance of integrating social and other programs is apparent.

The problem of replacement housing is not confined to renters. It appears that many floodplain owner-occupiers would require rather more than the market value of their property to enable purchase of replacement housing. In addition, as many of these residents have strong ties with their homes and areas, money is unlikely to be the only issue. Program officials need to consider how to minimise adverse impacts, especially those of anxiety and stress, on the potential relocatees and also whether they should be moved at all.
Figure 7.1: Local reaction in North Wagga.
7.1 INTRODUCTION

In voluntary acquisition, or indeed in any voluntary government program, the support or at least the acquiescence of the target group (in the present study potential relocatees) is a prerequisite for scheme success. Rigorous adherence to the acquisition area safety and economic selection criteria of Chapters 4 and 5 does little by itself to ensure smooth implementation.

Chapter 6 established that a large proportion of the acquisition area residents are seriously socio-economically disadvantaged and that many had little real choice in their selection of dwellings. It was shown that locational choice was restricted, for reasons of poverty or symbolic attachment to the area, to the oldest, cheapest, most rundown and most flood prone housing. Under these circumstances it might be expected that many residents would welcome acquisition, especially those who claim there is no market for their property. Residents with strong attachment to the area or community would not be so interested in selling.

Yet, support for acquisition is varied, and broadly based outright opposition exists in some communities. To date little in the way of strong community support for acquisition, for example in terms of public demand for the strategy, has been seen in Australia though this has certainly occurred in the USA (King, 1980 per. comm.; Kusler, 1982; Time, 1981).

This Chapter examines the reaction to acquisition in each of the case study sites. On the basis of the examination and a review of the relocation literature, hypotheses are developed to test for the existence and strength of relationships between attitude to acquisition and a range of variables. Suggestions are also made regarding the purchase of damaged property immediately following a disaster. The Chapter's penultimate section includes a brief overview of those factors for which questionnaire data are available and attempts to rank them in order of importance. Finally, policy recommendations are developed which are designed to ease implementation of acquisition programs by increasing local acceptance.
7.2 RELEVANT LITERATURE

Relocation has been examined within a number of disciplinary frameworks including work by: architects (Goodman, 1972), anthropologists (Arnett & Johnson, 1976; Drucker et al, 1973; Smith, 1970; Schweri & Willigen, 1978), geographers/planners (Lee, 1978), economists (Stanley & Ratray, 1978; Mishan, 1970), medical researchers (for voluntary moves Kantor, 1967), psychologists (O'Malley, 1978) and sociologists (Burdge & Johnson, 1973; Derewlany, 1981; Gans, 1959, 1962, 1973; Motz, 1977, 1978; Young & Willmott, 1957). It is not proposed to examine the details of the different approaches or those of individual studies here, though it is particularly interesting that the results of research carried out within these various disciplinary frameworks are reasonably congruent. At first sight part of the explanation for the similar findings may appear to be the widespread employment of questionnaire surveys as the primary research tool. However, some studies have used various official records (Drucker, 1974; Drucker et al, 1973) and anthropological research has relied heavily on long, detailed, repeated interviews and participant observation (e.g. Smith, 1970; Schweri & Willigen, 1978). Where major differences in research results do exist they have been ascribed to (Motz, 1978): differences between communities studied, for example between the low-income residents of major cities and rural populations, or the cultures of different countries; differences in the times, 1950s to early 1960s and the present, which themselves reflect different government attitudes to relocation; differences in the scale of project from wholesale relocation of small rural communities to selective purchase of properties for road widening; and the value orientations of the researchers. This last point is quite apparent in that some workers tend to focus on those benefiting from the relocation experience (Millspaugh, 1961; TVA, 1972) while others focus on those who suffer (Fried, 1963; Goodman, 1972).

The most widely known relocation research has been concerned with the large scale urban renewal (or slum clearance), and highway and reservoir projects of America, Australia and the U.K., and hence has focussed on the compulsory relocation of:

(i) low income urban dwellers, and

(ii) small town or rural occupants of land needed for large public projects.
Studies of the voluntary internal migration of similar "working class" people (Toney, 1976; Weissman & Paytel, 1977), and work on the forced relocation of a different group, military personnel (McKain, 1973), report the same findings as the better known research on compulsory relocation for public works. The few studies that have examined "middle class" voluntary relocatees have found them to be members of a naturally mobile group, who adjust easily to new localities (Gutman, 1963; Landis & Stoetzer, 1966).

Australian cities have sponsored some important urban renewal projects since the 1960s and clashes over relocation have characterised certain freeway and public housing initiatives (Wadley & Ballock, 1980). In rare cases, protests (like Sydney's union imposed "green bans") have been successful in halting or modifying projects (Pringle et al, 1976). Despite these Australian projects and the fact that entire rural communities have been displaced for major public works, for example Adaminaby (between 1956 and 1958) and Jindabyne (completed in 1965) by the Snowy Mountains Scheme, the most prominent early research is North American. Results of two such studies are reviewed here.

Hartman (1966) undertook one of many studies into the displacement of Boston west-enders by urban renewal. He found that relocatees were faced with substantially increased housing costs, that "relocation has made a disappointingly small contribution to the attainment of a decent home in a suitable living environment for every American family" (p.315), and concluded that because of the acute shortage of low cost housing "it is likely that for many families relocation may mean no more than keeping one step ahead of the bulldozer" (p.322), and that slum clearance projects were actually increasing the disparity between the rich and the poor. Fried's (1963) widely quoted study of the Boston West-enders "Grieving for a Lost Home" is very critical of the forced relocation process. The "reaction to the loss of the West End can be quite precisely described as a grief response sharing most of the characteristics of grief and mourning for a lost person. At least 46% of the women gave evidence of a fairly severe grief reaction or worse, with 26% reporting that they felt sad or depressed 2 years after the move. Men appeared to fare slightly better with 38% giving evidence of severe grief reactions". A major recommendation for reducing this impact and for making people less anxious about the prospect of relocation is to provide for people to move within their established
Although Fried's results appear fairly extreme they are supported by much research in the field even where the relocation is quite voluntary (Burdge and Ludtke, 1972). "Migration is likely to provoke stress" which in turn leads to "emotional disorder and general deteriorating health". Furthermore, being told of an impending change such as a job transfer or forthcoming move, provokes stress in much the same manner as the actual event (Burdge and Ludtke, 1972; Smith et al, 1980; Toney, 1976).

A wide range of factors act to exacerbate or mediate the effects of stress on individuals and communities. Public policy can have little influence over some of these variables including: the strength of family and broader social support systems, psychological and personality attributes, biological and genetic predisposition, and demographic factors such as age and income (see Smith et al, 1980). On the other hand there are factors which are largely within the control of the acquisition authority. These factors relate to the relocation procedure and include the financial arrangements, the time taken to reach decisions, and the involvement of potential relocatees in decision making. Long decision periods, inadequate financial arrangements, and a failure to involve residents in project planning and implementation, increases the risk of alienating the community and provoking the development of organised resistance, or of engendering a feeling of helplessness among potential relocatees. Feelings of alienation and helplessness greatly increase stress and the disease potential (Erickson, 1976; O'Malley, 1978; Seligman, 1975). "The psychosomatic effects of exertion of will - active control over outcomes - and the will to live cannot be overestimated. Of all psychosomatic variables, this one may be the most powerful. When an individual gives up, death may soon follow" (Seligman, 1975:184).

One of the worst examples of community alienation from the relocating authority is provided by O'Malley (1978) in her study of compulsory permanent evacuation following a flood disaster. Because of strong attachment to locale and community many residents were opposed to relocation, despite adequate financial arrangements. In an attempt to convince those resisting the project to comply the redevelopment authority hired a public relations firm, "P-R". Members of P-R visited the
"residents and introduced themselves as investigators who were interested in being their advocates. They developed relationships with the residents over a three-week period" and then advised them to sell to the authority. What followed is recounted by one of the residents. "My wife found out that they (P-R) were hired by the Redevelopment Authority. She tried to swallow half a bottle of aspirin over it. The appraisers were around that day and I went and got my gun. A lot of other people joined me too. We chased them off and believe me, I'd do it again" (p.72). Such cases are disturbing, but fortunately rare, and although relocation may still be a stressful experience, especially for the vulnerable groups identified in Section 6.3 and Table 7.1, the outlook for relocatees has improved greatly since the days of Gans (1959,1962), Fried (1963), and Hartman (1966).

The massive urban renewal projects have generally been abandoned after a number of spectacular failures, most notably the Pruitt-Igoe Public Housing Project in St Louis, USA, which was blown up a few years after its construction, and more broadly based opposition (e.g. Pringle et al, 1976).

Legislative and policy changes have seen bulldozer diplomacy replaced by more flexible financial compensation arrangements and negotiated settlements. Recent NSW legislation (Environment Planning and Assessment Act, 1979), caters reasonably well for the financial aspects of compulsory property acquisition (resumption) and relocation (s.116). This is in contrast to the provisions of Victorian, Western Australian and Tasmanian legislation, and the federal Land Acquisition Act (1955) which is based largely on 1845 British legislation, the Land Clauses Consolidation Act (Australian Law Reform Commission, 1980:21).

There are many problems with applying outmoded compensation provisions, but a fundamental deficiency is that these laws were designed primarily to facilitate compulsory acquisition of, and compensation for, tenanted and unoccupied properties. Today, in contrast, most land being purchased is owner occupied. Resumption of such property carries the potential for the full range of tangible and intangible losses discussed in Chapter 5, as opposed to the simple loss of investment the Acts were framed to cope with.
However, administrative and policy changes, such as attempting negotiated settlements, at both the state and federal levels appear to have reduced the hardships associated with land resumption and resistance to the process. Though as pointed out by the Law Reform Commission (1980), the changes may be more apparent than real as people are aware that if they fail to reach a negotiated settlement the government can simply resume the land. In addition there are still aspects of both tangible and intangible losses from relocation where the financial compensation is frequently inadequate.

Australian law makes no provision for compensation where land is not physically taken but is diminished in value by government action. If it were not for the statutory immunity of government bodies such diminution would give rise to an action for the common law wrong of nuisance (Australian Law Reform Commission, 1980:xvii). Also relocatees are often faced with increased living costs for which compensation is generally not available. Studies of people displaced by freeway developments in Melbourne and Brisbane found substantial dissatisfaction among relocatees with the financial aspects of relocation. Even though they had generally sought similar homes in the same area "two-thirds of those interviewed in Melbourne and 56% of those interviewed in Brisbane thought themselves disadvantaged financially by the move. In both cities respondents complained that they were unable to procure comparable homes for the compensation they received" (Australia - The Law Reform Commission, 1981:19). Similarly, a number of U.S. studies have shown that for the majority of relocatees housing costs increase though frequently this results from an involuntary upgrading of housing (Colony, 1971; Buffington, 1973; Clark County, 1975; Perfater and Allen, 1976). Outright home ownership and low rentals are closely associated with long periods of residence and older people. For these people living costs will almost invariably rise, and unfortunately it is just such people who are the most attached to the area (Section 6.3.3.3), and who suffer the most stress from relocation (Table 7.1).

No compensation is payable for certain intangible effects of compulsory relocation such as removal from a sympathetic socio-economic community, possible adverse effects on the education of school children and loss of attachment to community or place. However, relocatees, in
particular older residents, are often less concerned about the extent of payments than about enforced lifestyle changes and the community destruction frequently implied by acquisition. Of course community destruction need not always occur. It may be avoided where relocatees move to new residences within their old community and in the rare cases where whole towns are relocated.

Table 7.1 summarises the relocation literature and examines the impact of a range of factors on relocatee attitudes and the success or otherwise of relocation programs. Shields (1975) summarises the results of this research succinctly: "Most studies of forced migration have found often severe psychological stresses and social strains associated with moving... Apprehension over moving is inversely related to people's willingness to separate themselves from current friends and homes. In addition strong identification with place...was associated with high levels of apprehension over moving". On the other hand those with a high degree of vested interest in the project were more willing to separate themselves from friends and homes. Those with a high degree of interest tend to be "of high socio-economic status, while those who tend to be hurt most are the poor and elderly with little formal education... These difficulties are exacerbated by the financial costs of moving".

Many of the Table's conclusions parallel those of Section 6.3.3.3, "Attachment to Community"; factors found to be correlated with high identification with community and place are also associated with resistance to relocation as is community identification itself. Other issues especially relevant to the present study are, the level of flood experience and perception, degree of vested interest in the program outcome, aspects of the acquisition/relocation program, and level of community organisation.

Those with recent and more severe flood experience are most likely to have high flood perception and be more supportive of relocation to flood free areas. A desire to move out of a hazardous area is one aspect of the vested interests variable; flood plain residents believing that their interests are served by the project are more likely to have a positive attitude towards relocation and vice versa. Important aspects of the acquisition program include: the degree of local involvement, early involvement and two-way communication appears to assist in increasing
program acceptability; the time taken to reach a firm decision to acquire, 
a lengthy period of indecision may increase opposition; the purchase mode, 
compulsory purchase may increase opposition; and the property valuation 
procedure, which is now, reasonably equitable in compulsory purchase, but 
has emerged as a major issue in voluntary floodplain acquisition programs 
primarily because the market price typically employed in such programs is 
often well below property replacement cost putting owner occupiers in a 
difficult position.

It is important to remember that by no means all people are 
adversely affected by relocation. Many want to move (Section 6.3.3) and 
may view the compensation accompanying forced relocation as providing an 
opportunity to better themselves (Motz, 1978; O'Malley, 1978). Among 
those who appear to be worst affected by relocation it is not generally 
known how well such people were adjusted to their original communities. It 
is possible, though highly unlikely given the weight of evidence, that 
relocation becomes a focal point for their pre-existing frustrations and 
anxieties (Mogey, 1964; Motz, 1978).

Also not all relocation programs engender widespread opposition 
and negative feelings. "The University of Pennsylvannia (1963) studies and 
those of Niebanck (1965, 1968) identified benefits in resettlement, and 
another early optimist, Millspaugh (1961:6) argued that to regard 
relocation as a responsibility before the more exciting job of rebuilding 
was to ignore the real gains" (Wadley and Ballock, 1980). Millspaugh may 
have been rather unrealistic, as it appears that attention to the 
relocation process goes a long way towards ensuring that the potential 
gains of resettlement are realised. In a recent study of Yallourn, 
Australia, Wadley and Ballock (1980) found that "initial conflicts were 
largely overcome by the ability of an adequately financed relocation agency 
to tailor policies to the... population and the possibilities of 
resettlement environments".

Based on previous research, voluntary or compulsory floodplain 
relocation will encounter the least opposition if the relocatees are: 
young, mobile short-term residents with non-farm occupations, who have a 
low identification with the community or place; are of a higher socio-
economic status, have a vested interest in the projects' outcome, have
recent flood experience and see the flood problem as severe. The ideal program would have adequate finance (Wadley & Ballock, 1980), involve the potential relocatees in project planning from as early as possible, avoid a lengthy decision period, be voluntary and ensure that owner occupiers were able to obtain equivalent replacement dwellings. Unfortunately, apart from the flood related aspects, the above description of the ideal relocatee does not fit the residents of the acquisition areas under study. In such cases and in particular where strong attachment to community or locale exists then efforts should be made to place relocatees within the same general community (Drucker et al., 1974; Fried, 1963).

7.3 RELEVANCE TO PRESENT STUDY

Most of the research reviewed above deals with response to compulsory property acquisition. It would appear therefore that its relevance to the present study is limited to a hypothetical discussion of the use of compulsion to acquire flood prone land, as in the voluntary programs being examined the government acts like any buyer in a normal free market. In fact, the literature is of broader relevance because in many areas people have objected to voluntary flood plain acquisition schemes on a number of counts: the authority may effectively be the only buyer of property putting it in a monopoly position; the governments aim, or at least the result of government action, is occasionally seen as one of community destruction; acquisition programs are frequently accompanied by stringent building regulations which residents fear will lower the value of their properties and discourage other buyers; and because of misunderstandings some residents see the programs as compulsory. Furthermore, and perhaps more importantly, there is some evidence that the intangible negative effects experienced by involuntary movers are similar to those experienced by people whose movement is voluntary (Butler et al., 1973).

Conclusions about the relevance of the literature on compulsory relocation would founder if the voluntary and compulsory moves were being made by two fundamentally different groups of people. In fact the usual subjects of compulsory relocation research and the residents of the acquisition areas presently under study are very similar: both groups consist of socio-economically disadvantaged people (see Chapter 6).
Table 7.1: Local reaction to relocation: summary of the literature.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>RELOCATION STUDIES</th>
<th>SELECTED WATER RESOURCE DEVELOPMENT STUDIES</th>
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</thead>
<tbody>
<tr>
<td><strong>DEMOGRAPHIC FACTORS:</strong></td>
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<tr>
<td>Sex</td>
<td>Generally not significant in relocation; Booth &amp; Camp, 1974 in hazard studies, Handner (1979); Milet et al (1976); Irwin, 1979, found some differences.</td>
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<tr>
<td>Age</td>
<td>Older people are more negative about relocation and experience greater apprehension (Buffington, 1973; Burdge &amp; Johnson, 1973; Colony, 1971; Hall &amp; Gusman, 1975; Holdsworth, 1972; NERBC, 1976; Perfater &amp; Allen, 1976; Shields, 1975). They are more likely to feel unfairly treated and because of the greater stress are more likely to experience psychological problems of adjustment (Perfater &amp; Allen 1976). However, successful relocation of older people does occur (Wadley &amp; Ballock, 1980).</td>
<td></td>
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<tr>
<td>Length of residence</td>
<td>Longer term residents are likely to be older and to this extent will exhibit reactions similar to the aged. In addition they will generally have a stronger identification with community/place. (Adler &amp; Jansen, 1978; Colony, 1971; Hall &amp; Gusman, 1975; Halfberg &amp; Fitchburgh, 1967; Holdsworth, 1972; James, 1974; NERBC, 1976; Perfater &amp; Allen, 1976). Perfater &amp; Allen (1976) also expect that longer term residents will experience negative health effects due to stress, but offer no evidence. Schweri &amp; Willingen (1976) and O'Malley (1978) found that length of residence alone was not significant in attitude to relocation.</td>
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<tr>
<td>Individual mobility</td>
<td>Life cycle stage is an important mobility determinant (Bourne, 1981) Increased mobility is associated with increased ease of relocation (Fried, 1963; Wadley &amp; Ballock, 1980). There is evidence that migration and/or high mobility causes stress and is associated with increased mental ill-health (Abrahamson, 1965; Kantor, 1967).</td>
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</tr>
<tr>
<td><strong>SOCIO-ECONOMIC FACTORS:</strong></td>
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<tr>
<td>General</td>
<td>There is some debate on the importance of these factors, Burdge &amp; Ludke (1972) for attitudes towards water resource projects in general, consider that socio-economic variables are not very important. While Recker (1971) found that high socio-economic levels were associated with positive attitudes towards projects. Shields (1975) for relocation, is more accurate: socio-economic variables are of some significance in that they are related to other factors known to be important, eg vested interests, and at a community level, ability to organise.</td>
<td></td>
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<tr>
<td>Education</td>
<td>The literature suggests that those with higher education are more supportive of relocation (Perfater &amp; Allen, 1976; Colony, 1971; [significant in the long term]; Shaw, 1975). Schweri &amp; Willingen, (1976) and O'Malley (1978) found that the least and most educated opposed relocation.</td>
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<tr>
<td>Income</td>
<td>See general comments above. Schweri &amp; Willingen (1976) found that higher income respondents were opposed to relocation, while those on low incomes hoped to better themselves (O'Malley, 1978).</td>
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</tr>
<tr>
<td>Occupation</td>
<td>Those whose livelihood depends on the land, farmers, will generally be more opposed to relocation (NERBC, 1976; NSWWRC, 1980; Shields, 1975). See community/place attachment.</td>
<td>Non-farm people (rural areas) more in favour of projects (Dasgupta, 1967; Pothiadis, 1960). Farmers tend to worry about unwanted change, and businessmen tend to support projects (Smith, 1970).</td>
</tr>
<tr>
<td><strong>HOUSING FACTORS</strong></td>
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<tr>
<td>General</td>
<td>A high degree of property investment in both symbolic and monetary terms will generally lead to greater resistance to relocation (Schweri &amp; Willingen 1978). However, in some situations forced relocation may be seen as an opportunity for upgrading accommodation or tenure status (Wadley &amp; Ballock, 1980; Motz, 1978).</td>
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<tr>
<td>Tenancy</td>
<td>Renters are generally less motivated to remain (Schweri &amp; Willingen, 1978; O'Malley, 1978); [see Section on community/place attachment]. Tenancy status may be indicative of other factors: outright home ownership and low rents are associated with older people and longer terms of residence, which in tum are associated with greater attachment to place/community and resistance to relocation.</td>
<td></td>
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<tr>
<td>Inheritances</td>
<td>A highly significant factor - inheritors are particularly likely to resist relocation (Schweri &amp; Willingen, 1978; O'Malley, 1978). The factor is also important in determining identification with the area.</td>
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</tr>
<tr>
<td>VARIABLE</td>
<td>RELOCATION STUDIES</td>
<td>SELECTED WATER RESOURCE DEVELOPMENT STUDIES</td>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>FLOOD FACTORS</strong></td>
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<tr>
<td>General</td>
<td>Personal flood experience and loss are the most important factors in the formation of flood related attitudes (Kates, 1962; Waterstone, 1978).</td>
<td>Flood damage experience is associated with a positive attitude to flood mitigation projects (Becker, 1971).</td>
</tr>
<tr>
<td>Experience</td>
<td>Recent and severe flood experience may be critical in forming a positive attitude towards relocation (James, 1974; Time, 1980).</td>
<td>A particularly propitious time to undertake relocation may be just after the area has experienced severe flooding (Ralf M. Field, 1981).</td>
</tr>
<tr>
<td>Perception</td>
<td>Key perception questions are expectation of future flooding and perception of flood severity (Kates, 1962). The more pessimistic the responses to these questions the more likely the respondent is to want to relocate (Schweri &amp; Willigen, 1970; O'Malley, 1978).</td>
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<tr>
<td><strong>IDENTIFICATION WITH COMMUNITY AND PLACE</strong></td>
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<td></td>
<td>The concepts of attachment to community and place are explored in Chapter 6, and important factors are summarised in Table 6.13. Stronger identification with community/place generally means greater resistance to movement. If relocatees believe they will be in the same community after the move, attitudes towards moving will be more positive (Budge &amp; Ludke, 1970; Fried, 1983; O'Malley, 1978; Napier &amp; Moody, 1979; Sinclair Knight &amp; Partners/MST Keys Young, 1979; TVA, 1972; UNDRO, 1977(a).</td>
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</tr>
<tr>
<td><strong>VESTED INTERESTS</strong></td>
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<tr>
<td></td>
<td>Those who believe that their interests are served by the project are more likely to have a positive attitude towards relocation, and vice versa (Budge &amp; Ludke, 1970, 1972; Napier &amp; Moody, 1979; Shields, 1975). People may see themselves better off in terms of, for example housing or business. This factor relates strongly to the Valuation Procedure, below.</td>
<td>Some studies of water resource development projects have found that high knowledge levels are associated with positive attitudes towards the project (Dasgupta, 1967; Peterson &amp; Rous, 1970).</td>
</tr>
<tr>
<td><strong>ACQUISITION/RELOCATION PROGRAM PROCEDURES</strong></td>
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<tr>
<td>Knowledge/Publicity</td>
<td>Knowledge alone is often not very important in influencing attitudes (Budge &amp; Ludke, 1970, 1972; McDonald et al 1982). But good public relations and two-way communication is considered essential (Buffington, 1973; Colony, 1971; Perfater &amp; Allen, 1976; Ralph M. Field, 1981). Also low levels of knowledge may produce tension and rumors (Drucker et al., 1972). See comments on Public Involvement below.</td>
<td>Some studies of water resource development projects have found that high knowledge levels are associated with positive attitudes towards the project (Dasgupta, 1967; Peterson &amp; Rous, 1970).</td>
</tr>
<tr>
<td>Time taken to decide to Acquire</td>
<td>Longish decision time may serve to increase resistance to relocation (Perfater &amp; Allen, 1976; Platt, 1979; Ralph M. Field, 1979), except where the locals initiated the scheme (Time, 1980). Apprehension, anxiety, resentment and resistance may increase with time and indecision (Budge &amp; Ludke, 1972; Colony, 1971; Kantor, 1967; Knott, 1981 pers.comm; Perfater &amp; Allen, 1976; Platt, 1979; Smith et al., 1980). Uncertainty over a long decision period may lead to gradual neighbourhood deterioration and abandonment &quot;blight&quot; (Perfater &amp; Allen, 1976). This may be an asset to program officials in that relocation may be speeded up and occurs &quot;voluntarily&quot; (Ralph M. Field, 1979).</td>
<td>Some studies of water resource development projects have found that high knowledge levels are associated with positive attitudes towards the project (Dasgupta, 1967; Peterson &amp; Rous, 1970).</td>
</tr>
<tr>
<td>Purchase Mode</td>
<td>Compulsory purchase may increase opposition to the program (Blair, 1980, for agricultural urban land; King, Tennessee Valley Authority, (TVA) 1980, pers.comm; NBBC, 1976; Ralph M. Field, 1979). However, some writers feel that regardless of opposition compulsory purchase should be used if necessary to clear hazardous areas (Kusler, 1978; Platt, 1979).</td>
<td>Some studies of water resource development projects have found that high knowledge levels are associated with positive attitudes towards the project (Dasgupta, 1967; Peterson &amp; Rous, 1970).</td>
</tr>
<tr>
<td>Valuation Procedure</td>
<td>This is an issue of major concern in current Australian, Canadian and U.S. voluntary and compulsory flood plain acquisition projects (Bailey, FEMA, 1981, pers.comm; Natural Hazards Observer, 1980; Toronto, Mandmer, 1981(b)).</td>
<td>Some studies of water resource development projects have found that high knowledge levels are associated with positive attitudes towards the project (Dasgupta, 1967; Peterson &amp; Rous, 1970).</td>
</tr>
</tbody>
</table>
Table 7.1 continued.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>RELOCATION STUDIES</th>
<th>SELECTED WATER RESOURCE DEVELOPMENT STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Involvement in Plan Development</td>
<td>There is evidence to suggest that the involvement of residents early in the planning process assists in increasing program acceptability, (Adler &amp; Jansen, 1978; Colony, 1971; James, 1974; King TVA, 1980 pers.comm; Ralph M. Field, 1981; Shields, 1975). Low levels of communication between the residents and responsible authority increase rumour, misinformation and anxiety (Smith, 1970 for water resources project), and produces tension (Drucker et al, 1973). Ralph M. Field, (1979) contains examples demonstrating, for relocation for flood damage reduction, the strength of the connection between local involvement and program success.</td>
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</tr>
<tr>
<td>Community Organisation</td>
<td>The general evidence for the effect of community organisation is somewhat ambivalent. Strong community leadership is considered an essential factor of a successful program by Ralph M. Field (1981). Such leadership may make it easier to involve the community in project planning. However, strong leadership has played a major part in overturning Wagga’s acquisition program, and is sustaining resistance to projects in Tennessee (Schwert &amp; Willigen, 1976).</td>
<td>Wilkinson (1964 found stronger resistance to water resource projects from a better integrated community.</td>
</tr>
<tr>
<td>OTHER FACTORS</td>
<td>Physical Features of the Flood Plain</td>
<td>The size, shape and location of the flood plain area may make acquisition more acceptable if the hazardous area is well defined and not extensive (James, 1974).</td>
</tr>
</tbody>
</table>
The apparent preoccupation of relocation research with this section of society has itself been the subject of criticism (Jones, 1973), but it is ideal for the purposes of the present research.

Conversely, in the unlikely circumstance that voluntary floodplain acquisition is concerned with high value property, the results of compulsory relocation studies will probably be irrelevant.

7.4 EVOLUTION OF RESPONSE IN THE STUDY SITES

7.4.1 General

A detailed examination of the three acquisition programs is necessary, in conjunction with the literature review, for the development of research hypotheses to aid in the interpretation of questionnaire and other data. As is appropriate, material for this section comes primarily from interviews and documentary sources rather than the questionnaires, which are the subject of later sections.

7.4.2 Lismore
7.4.2.1 Scheme Origins

Lismore's acquisition scheme has its origins in a Council initiative before the record 1974 flood to extend the city's riverside park area, clear what was seen to be a conspicuous slum area, and at the same time reduce the flood problem by buying up dwellings in particularly low areas. Finance came from Council's general loan fund and the scheme was entirely voluntary (Blair, 1980-1). It appears there was no real reaction against the principle of acquisition from any quarter at this stage. The scheme was very small scale and involved the purchase of some dwellings and vacant land in the Ballina Street Bridge area as the properties came onto the market.

The possibility of acquisition purely for flood damage reduction was raised by the Public Works Department (PWD) in 1977. Following agitation by the (now defunct) North Lismore Progress Association, a North Lismore levee system was designed for consideration. However, the
Authorities managed to convince the area's residents that the embankment would be too high and dangerous and would also adversely affect flood levels elsewhere in the city. Instead the Richmond River County Council (RRCC, flood mitigation authority) proposed improving access by road raising. After detailed planning though, Fred Barlow, RRCC engineer "realized that one section of this work costing $100,000 gave only limited access improvement to fifteen old houses. At this point the PWD District Office suggested trying to buy up these places" (Barlow, 1981-1).

After the floods of the early 1970's, there was strong support from most sections of the community and state and local governments to take some action to reduce the Lismore flood problem. In the immediate wake of the record March 1974 flood the Northern Star (18/3) reported that an innovative aspect of the disaster relief was the provision of a $2,000 (1974$) grant or loan, means tested, to re-establish homes in flood free areas. The provision was certainly a step in the right direction, but apparently failed to influence the post-disaster settlement pattern. This failure is probably a reflection of inadequacies in both the scheme and potential relocatees. The owners of many of the dwellings needing major repairs, who were the most likely relocation candidates, lacked the necessary resources. The small amount of money provided by the scheme, and the absence of complementary arrangements (land etc.) did little to assist those most in need.

Far more successful was the expansion of Council's "parkland" acquisition scheme with the support of the PWD District Office. The program was given a subsidy of two state dollars for every local dollar spent. Almost at once the federal government agreed to include the program within the Coastal Flood Mitigation Works funding agreement (Section 3.2).

7.4.2.2 Local Support

Government officials generally felt that there was widespread support for the acquisition scheme from the floodplain residents and other local groups, with the exception of the Lismore Chamber of Commerce, sections of Council, and the Richmond River Flood Action Committee, this last body representing primarily farming interests. A majority of entrepreneurs supported purchase of, at least, the lowest properties and
some commented that the areas should never have been developed. Reasons for this support include the fact that the scheme is seen as very limited in scope, and is occasionally viewed from a post-acquisition perspective: "it is really slum clearance, and the parks will be nice" (Patch, 1981-I).

The major concern of those Councillors initially opposed to acquisition appears to have been the loss of rate revenue. Once Council buys the property it becomes non-rateable, a loss of about $400 a year per property at the most, as the properties are generally on the minimum rate. "An argument to offset this one is of course that the people will buy another property and again become ratepayers somewhere else in the Lismore area" (Wade, 1980-I). As well, many business people and some Council members and residents see money spent on acquisition as unavailable for structural works. These people would much prefer a structural solution to the flood problem and regard "acquisition as admitting defeat and that the government is taking the easy way out - they think something should be done about the flood water" (Barlow, 1981-I).

However, most of the negative response is directed more towards the Goonellebah Town Centre proposal and attempts to regulate floodplain development. Local development and established business interests are concerned at what they see as an attempt to encourage relocation of the main business centre of Lismore out of the floodplain (see Section 3.3.3.5). Some non-Council elements are not only opposed to the Goonellebah scheme and floodplain regulation, but have also been campaigning for a structural solution to the flood problem, even though successive reports (Section 2.3.2.3) have found that structural flood solutions for Lismore's flood problem are not viable. The construction of dams and diversions, etc., is technically feasible but costs would greatly exceed benefits. In any case, the real extent of benefits is uncertain and most proposals would worsen downstream flood problems. Nevertheless the Flood Action Group has recently put forward a reworked version of a diversion scheme rejected by the Richmond River Flood Mitigation Committee in 1958, and a local businessman has developed a rather more ambitious diversion scheme.

This latter proposal involved the creation of an artificial lake,
a diversion canal, sluice gates. Despite its estimated cost of over $50 million (1981$), and truly heroic scale, it aroused enough interest for Council to agree to provide $3000 (plus $2000 of Council money from the Flood Action Group) towards a small feasibility study, conducted essentially at no cost by an Italian urban planning consulting firm, "Urbanitec". The study was arranged by the scheme's proponent, a Lismore resident of Italian descent. Its report concluded that the scheme as proposed was technically feasible, but acknowledged that the final decision must be political. Council has shelved the matter. Any further action would be dependant on State and/or federal funding which is unlikely to be forthcoming.

This minority view in support of a major structural solution to flooding is shared by just under one-third of the Lismore floodplain sample, who advocated canals/diversions or levees (about another third advocated dredging). It is however, reassuring to note that some two-thirds believe that floods cannot be stopped, principally because of the amount of water involved and the geography of the area.

7.4.2.3 Discussion and Conclusion

As the scope of acquisition was extended to low areas throughout the floodplain a Council engineer visited a number of the lowest houses to reassure the inhabitants about the voluntary nature of the scheme, how it was designed to assist them and so on. Undoubtedly this and the overall low key approach by the authorities and local media has helped the smooth implementation of acquisition. There has been no organised resistance as has occurred at the other two study sites. The single most important factor in this between site difference may well be the severity of Lismore's flood problem, with, at the commencement of the acquisition scheme the floor levels of well over 100 houses lying below the 1:5 flood height (Table 2.3), combined with the very short warning time of 6-12 hours. The large transient population and absence of local leadership may also be important factors underlying scheme support.

One exception to this picture has been the now moribund North Lismore Progress Association. The association was instrumental in having a levee designed for the area and, when this proved unfeasible, for having
some important access roads raised. The last effective leader of the association and key to its past success, Mrs Miles, was firmly against acquisition and felt she had the support of other North Lismore residents. She felt a strong attachment to the area and its inhabitants, "I was born in this house (in 1913)...my mother was from the next street" (Miles, 1981-1). Nevertheless, she has since left the area, and with or without the government purchase scheme North Lismore's days as a residential area appear to be numbered. The newly established roller skating rink has been buying up properties along Wotherspoon Street to expand car parking space. In addition two small houses in the area have been condemned.

The smooth progress of acquisition in Lismore, as revealed by the lack of organised protest, the sales figures and the optimism of the scheme's implementers, suggests that the program is gathering momentum and has the broad-based support or at least the consent of those affected (Table 7.2).

7.4.3 Echuca West
7.4.3.1 Background to the Decision to Acquire

The process leading to the decision to acquire Echuca West started well before the Victorian acquisition criteria were established; when, following the severe floods of the early 1970s, an inquiry into flooding in northern Victoria was commenced in 1973 by the State Parliamentary Works Committee (1975). In a submission to the inquiry the then Echuca City engineer suggested that the West could be leveed at a cost of $183,000 (1973$).

After further severe flooding in 1974 and 75 the situation took on a new urgency. The City of Echuca suspended development in Echuca West and other areas flooded in 1975, and in conjunction with the Victorian State Rivers and Water Supply Commission (SR & WSC) examined the City's flood problem within the context of the new Drainage of Land Act (1975) (Section 3.2.4.4). At the time the Act required that the largest flood on record be considered for use as the regulatory event. In Echuca this means the 1870 flood (1:188 frequency) which was substantially higher than the calculated 1:100 level and, if adopted, would put the entire business district under regulation. Naturally the council protested and had a
"tremendous row" with State Rivers, until "the 1:100 standard was imposed on us" as a regulatory base (from interviews with local officials). In general, council staff and most local politicians were content with the compromise as it freed the commercial district from regulation (McCartney, 1981-I). The Victorian government has since adopted the 1:100 flood as the legal floodplain definition.

Initially the SR & WSC investigation focussed on Echuca West because of the local flood frequency and severity. The first report, released in June 1975, estimated that an embankment to protect much of the West against a flood of the 1870 level could be constructed for $250,000 (1975$). However, a number of difficulties were identified: because of afflux problems the levee would probably have to be in two parts with a minor floodway between; the report emphasised the risk of failure and commented that if the levee was overtopped the area would fill rapidly (nevertheless the risk is low when rates of river rise are compared with those on coastal streams); and that the scattered nature of settlement made the area more difficult and expensive to protect. The report concluded by suggesting that in view of the cost and danger of levees the money might be better spent relocating the houses from an area that should never have been developed.

The structural and non-structural flood damage reduction options for Echuca were aired at a public meeting held on December 10, 1979.

Throughout the period from the early 1970's up to the public meeting there were individual as well as semi-organised group protests at the lack of flood mitigation action. Protests took the form of: petitions requesting the removal of embankments and fill which, it was argued, increased flood levels in Echuca West; correspondence with the local Council, state government MPs, the SR & WSC; and a survey on the extent of local flood assistance. This activity was largely at the instigation of one elderly resident, Eric Bethune. With the support of some local residents Bethune obtained legal aid to investigate the two embankments, both of which were constructed by Council, one on its own land and one on a drainage reserve. On both counts it appears that the residents are technically correct: the constructions were undertaken without the necessary permits.
However, on both counts they would have to personally seek remedies through the courts. As Council resolved to examine the drainage reserve matter legal aid was no longer available, although the City appears unlikely to take action. The issues surrounding the other embankment are more complex. "The Minister for Water Supply has supplied the Premier with a report which indicates that the placing of filling (by Council) on the eastern bank of the Campaspe River has aggravated the flooding to the West. It was unfortunate that by the time the State Rivers and Water Supply Commission was approached for approval to place the filling, the works were already completed and it would have been unrealistic to require the filling to be removed. The Commission granted its approval but only on the basis that the Council of the City of Echuca accepted responsibility for flooding caused as a direct result of these works" (letter to Bethune from the Premier's Dept. 28/12/73; other data from Bethune's correspondence, legal counsel files and interviews).

Having proved their case some residents could not understand the absence of corrective action. This simply served to increase the frustration and feelings of powerlessness among Bethune and his supporters, and helped to guarantee their opposition to any government action which did not address the physical side of the Echuca West flood problem. Unlike the Lismore respondents, virtually all the Echuca sample felt that the government (local or state) should do something about flooding and over half thought that the flood water could be stopped from entering the West.

7.4.3.2 The Decision to Acquire and Local Response

A few months after the public meeting in 1979 it was decided to proceed with the acquisition of Echuca West. A joint submission by SR & WSC and the City of Echuca reads that "there is fundamental agreement between the Commission... and City Council... that the existing land uses in Echuca West and the acute flooding problems it suffers, indicate clearly that this area is one where conversion to public ownership of subdivided privately-owned lands is the only feasible solution and should be undertaken as soon as possible" (April 1980:2 and 5). The decision to acquire was made public by the Minister for Water Supply in a news release on 16 May, 1980. After the SR & WSC flood study permanent evacuation was seen as the only viable option given that a political/administrative
decision had been taken to solve the flood problem, and as structural measures were felt to be infeasible (Parks, 1981-1; Stringer, 1981-1).

The apparent Council unity on the issue belies strong opposition from the then mayor, who commented that "the scheme was forced on us by State Rivers" and that it did not have the support of Echuca West residents (Uberlin, 1981-1). He felt that a structural solution was both feasible and preferable to acquisition. One reason for the apparent local political support for the scheme may be the lack of strong public feeling about it in Echuca. A council staff member observed that "if councillors felt it was politically advantageous they would probably all be against the acquisition scheme".

A clear decision was reached to remove all residential development from the lower part of Echuca West through a voluntary acquisition scheme. The scheme was expected to cost $1 million (1980$) and to take at least ten years to complete. It is administered directly by State Rivers and acquired land reverts to the Crown. Echuca City plays an advisory role and shares program costs with state and federal governments. There are no plans for post-acquisition use.

Following the decision to acquire notices of intention to declare flood prone that part of Echuca West lying below the 1:100 flood line "on or after August 1980" were sent to each affected land owner in early June 1980, as required by the Drainage of Land Act (1975). Notice of the intention was also published in the government gazette and local newspaper. Before the acquisition scheme could proceed Proclamation was necessary as it gave SR & WSC the necessary regulatory power (Section 3.2.4.4). There were 60 days for any objections against the proclamation to be lodged. In addition a public meeting (not a statutory requirement) was held in June 1980 to explain the scheme to the affected residents. At this stage some vigorous opposition to the scheme was expressed through written objections and at the public meeting. The SR & WSC received a number of objections which included technical arguments questioning the accuracy of the Commissions' hydrologic calculations. However, the issues addressed by most objections concerned the actual decision to acquire rather than to protect and the valuation procedure to be employed.
The Public Meeting

The meeting was "not intended as a discussion of the merits of the land purchase proposal as opposed to other flood mitigation measures", but was rather to acquaint people with the acquisition scheme (letter from State Rivers to McKenzie, resident of Echuca West, June 1980). Many residents clearly resented being presented with the decision to acquire, and the representatives from State Rivers did discuss the reasons for the scheme. It should be noted that other residents were happy with the quick decision and took advantage of it (Table 7.2).

At the meeting officials gave the following reasons for the scheme and advised that those who opposed the proclamation should write to the Minister:

(i) The infeasibility of structural protection including flood proofing. The danger of levees was stressed. Also the cost of levee protection had risen to $2 million, from the 1975 estimate of $0.25 million.

(ii) The other major reason was the government's concern at the need for repeated compensation for flood victims. "Echuca West can't be a flood problem every year. The state government wanted to relieve the need for compensation" (D. Dole). On these grounds the "only reasonable prospect for Echuca West" was seen to be "to implement a sound, sensitive, and sensible program to enable people, should they so desire, to leave the area" (D. Dole). In fact the amount of flood compensation paid to Echuca West residents is very small, amounting to only $2330 (1974$) after the severe 1974 flood (information from a survey by E. Bethune, per. com.).

Despite attempts by Commission officials to refer the issue elsewhere considerable opposition to the scheme was voiced by a number of long term residents principally on the arguments: firstly that Echuca West is no more flood prone than parts of East Echuca, and that in any case for many residents the problem is not very severe; and secondly that the

1 Information for this section comes primarily from a tape recording of the meeting lent to the author by Eric Bethune, supplemented by comments made to interviewers and a few detailed interviews made by the author.
prices being offered for their properties would not enable purchase of replacement dwellings. This important issue is the subject of Section 7.7.5.4 but it is worth observing that the group that appeared to be most concerned, the long-term residents who moved to Echuca West before the substantial property value difference emerged, stand to suffer the largest financial loss, while those who invested recently will retrieve their investment. Echuca Council commented that once they knew the extent of the problem then perhaps they could approach the state government for assistance along these lines.

Some other issues raised at the meeting elicited replies from the government representatives which appeared vague to many residents. For example the response to a question on the length of the scheme was not unequivocal: "my understanding is there is no time limit". Misunderstanding of these issues was evident during the questionnaire survey, and as a result (and because of their earlier experiences with the law), some people were confused over the extent to which acquisition was actually voluntary, even though they were assured that it was entirely voluntary. The main issues here were: the length of the scheme, people were concerned that after ten years they might be forced off their property; maintenance of services, would public utilities be maintained to remaining properties?; "could they sell to anyone?"; post acquisition activities; and various technical points concerning the embankments mentioned earlier and the accuracy of the 1:100 flood delineation.

Recent Response

Final assessment of the general acceptance of acquisition must be weighed heavily towards evidence from the property sales data (Table 7.2). On this basis there can be no question that the scheme has wide acceptance. This does not mean that those who sold did not have the misgivings expressed at the public meeting, but it suggests that it was more important for them to leave. Also there is a vocal minority of older long established residents who still object to the whole concept of the scheme.
7.4.4 North Wagga
7.4.4.2 The Decision to Acquire and Early Reaction

Preparation of the City of Wagga's planning scheme commenced in the early 1950s. Repeated major flooding during this period gave the work impetus by making prompt decisions necessary on the future development direction of the floodplain area. Considerable attention was devoted to the future of the village of North Wagga, because of the relative severity of its flood problem - though the village is rather less flood prone than the other acquisition sites under study.

As an interim measure while the Planning Scheme was being prepared, Wagga Council placed a number of restrictions on North Wagga in 1955. These culminated in 1957 with the area being zoned Non-urban 1c with few existing use rights. No further subdivisions or new building of any sort were to be permitted; and the users of existing premises were permitted "only minor alterations and repairs necessary for the reasonable preservation and use of existing buildings and works" (incorporated into the Wagga Wagga Planning Scheme as finally adopted in 1965). If these restrictions are compared with those proposed for Lismore under Section 38 of the Coastal protection Act (1979)(see Section 3.3.3.4), generally seen as a last resort, it is clear that the North Wagga situation is very much more prohibitive. Council's decision to zone the village non-urban was not without its difficulties. Nevertheless a firm decision was taken, and it was at this time that the idea of acquiring the village was first mooted.

North Wagga residents strongly opposed to the zoning found useful support in Council. A special Council Committee was established to safeguard the interests of residents (Council resolution 1470, 4/7/57), who were pressing to have the non-urban designation changed to industrial (letter from Progress Association, 1/8/58).

Much stronger reaction came from the residents, however, when it was decided to exclude North Wagga from the levee protection being provided for the main city in 1958/60 (Section 3.3.9.3). On the recommendation of the Town Planner, Council decided to retain the non-urban zoning and to gradually acquire properties as they came onto the market, subject to funds
being available. It was assumed that the village would eventually just "wither away". In the words of a past president of the North Wagga Residents Association "...they said let them die...they don't exist.
Naturally this proposal got a very hostile reaction from the North Wagga residents". In response the Progress Association called a number of public meetings, put forward a petition signed by 300 people (Morris, 1980) and made a submission against the levee to the Wagga Land Board. These actions failed to have any effect on the levee or zoning decisions. "However, the declaration that North Wagga was to 'wither' promoted a strong community spirit and seemed to unify the place, and made people determined that it wouldn't wither away" (Knott, 1980-I). After 27 years the housing stock of the village has been reduced by less than 20% (Table 7.2).

The decision to attempt to phase out development in North Wagga was seen by many as consistent with the historical treatment of the village by the main city. Since the earliest settlement the North was largely ignored (Morris, 1980), and "has always been regarded as a poor quarter" (Burgman, 1980-I).

7.4.4.3 Lack of Commitment and Vacillation by Council

The zoning and piecemeal acquisition were under pressure almost immediately from North Wagga residents and sympathetic Councillors, and later members of the city's Engineering Department. This led to a public inquiry in the early 1960's into the possibility of rezoning the village from non-urban to residential (Daily Examiner 21/2/62). The local newspaper, the Daily Examiner predicted that the village would in fact be rezoned (23/2/62). However, after his investigations the Town Planner claimed that it would be possible to relocate North Wagga for less than it would cost to bring it up to 1962 subdivision standard with levee protection (Daily Examiner, 25/7/62). These costings suffer from a number of deficiencies, discussed in Section 5.3.3.4. Nevertheless, on this basis the N.S.W. Department of Local Government was approached in 1963 for funds to carry out the relocation (Wagga Wagga City Council, or WWCC, et al, 1971). The following year, the Minister for Local Government offered to contribute from the Local Government Assistance Fund, the major part of the funds required for relocation of the village, provided Council developed a
relocation scheme (WWCC et al, 1971). This offer was not taken up, even though at different times Wagga Council bought land in other parts of the city for those who wished to relocate, and prepared plans for relocation of the village to Cartwright's Hill.

Defending Council's apparent inaction on this offer the Town Planner for Wagga Mr Rawlings, speaking in 1971, said that considerable thought had been given to moving houses out of North Wagga entirely with the financial assistance offered by the Department. But, Council had ascertained from a questionnaire survey that the residents didn't want to move to other parts of Wagga (it is not clear what sort of financial or housing offers were made to the residents); and as a result had decided to wait for a report from the Snowy Mountains Authority (SMA) on the provision of flood protection by air space in existing and proposed reservoirs (WWCC et al, 1971). In fact, it appears that advice on the provision of reservoir air space for flood mitigation was not sought until 1966 (Council Resolution 1905, 21/7/66). Furthermore, even before the Minister made his offer some Councillors were again considering rezoning the village. The Daily Advertiser reported that "comments from an Alderman suggested that a concerted effort could lead to the rezoning of the suburb" (14/1/64).

The failure of Wagga City Council to accept the offer of relocation funds represents a major lost opportunity to resolve the problem of North Wagga, and an apparent turning point in the future of the village. It also represented a defeat for the Town Planning Department which has always advocated relocation.

First replies to the air space question were not encouraging. The SMA pointed out that while dams could theoretically reduce flooding it would not be wise to consider expanding flood prone settlement, and in any case the primary purpose of the reservoir was water conservation - a purpose fundamentally at odds with flood control which required that reservoirs be kept partly empty.

Although it was by no means unanimous, a movement within Wagga Council to rezone North Wagga was gaining momentum, and in 1968 Council applied to the State Planning Authority to vary the Wagga Town Plan so as to give full existing user rights to the residents of North Wagga.
Eventually as a result of Council's agitation a conference was convened by the State Planning Authority to discuss the issues. Representatives of the Authority, Council and the Water Conservation and Irrigation Commission (WC & IC) attended the meeting. At the conference the WC & IC confirmed that reservoir air space was not a viable flood mitigation option, and Council was asked to provide more information on the costs of the levee and relocation strategies.

The 1970's saw a firming of resolve by Wagga Council with the support of its Engineering Department and North Wagga residents to obtain existing user rights and to have the village leveed.

The residents organised themselves into the North Wagga Resident's Association in 1972. The powerful leadership appears to have been largely responsible for maintaining the unity of the village through the major floods and over ten years of struggle. A principal foundation member commented that before the Resident's Association was established "the people couldn't defend themselves...it was pathetic and immoral" (Burgman 1980-I). The Association was successful in having a special council committee formed to investigate solutions to the North Wagga problem, especially through the provision of levees (10/6/74), and the Daily Advertiser (26/6/74) commented that "After a twenty year dormant period North Wagga growth is about to be resumed". The newspaper was rather optimistic but two I.D.O.'s of this period did relax the stringent 1950's restrictions and gave some limited existing user rights. However, the severe flooding of the 1970's did not help, in that State government authorities and the Wagga Town Planning Department remained firmly convinced that North Wagga was in the wrong place. Somewhat surprisingly the residents and majority of Aldermen remained equally convinced that the village should stay, and the Engineering Department continued with a levee design citing the success of the city levee.

7.4.4.4 An Attempt to Resolve the Problem

In an attempt to finally resolve the issue, Council commissioned a study into the development options for North Wagga (SKP & MSJKY, 1979). The report combined existing and new economic data with a questionnaire survey of the residents. There are two general solutions to the village's
flood problem which are quite contradictory: relocate the village, or protect the village with levees.

The first draft of this report recommended: "that Council adopt a staged acquisition/relocation program as policy, (and) that North Wagga residents be encouraged to participate in the development and management of the relocation and acquisition program", primarily on the basis that relocation was consistent with NSW Government policy (Section 3.2).

However this initial proposal was dropped in favour of one recommending (SKP & MSJKY, 1979:3): "construction of a 1:100 year levee; extension of user rights, no additional dwellings; continuation of mandatory evacuation on forecast of an isolating flood". The about-face in attitude was primarily on the grounds that "the convergence of economic and sociological factors is such as to outweigh the results of interpreting general policy for the particular circumstances of North Wagga..." (letter from SKP to Knott, Wagga City Engineer, 26/9/79).

Those in positions of power supporting the levee scheme, the City's Engineering Department, the consultants and most local politicians, do so on the basis of its cost efficiency and because the residents are strongly opposed to relocation. "As a class the village to be removed options have a significantly higher financial cost, and because of the anticipated difficulty of raising capital it is considered that these options are not feasible" (SKP & MSJKY, 1979:3). Issues of safety which are the main concern of levee opponents (who have final authority over the future of the village), the Local and State government Planning Departments, are dealt with through a recommendation for a "mandatory evacuation on forecast of an isolating flood". On average an isolating flood occurs every seven years. Another reason for the intransigence of state authorities in approving the proposed North Wagga levee is that the village represents a major test of government flood policy. "They are an ideal example of what should be acquired" (Whitehouse, 1980-1). After 26 years a clear decision on the future of North Wagga has yet to be made, though it appears increasingly likely that the state government will proceed with acquisition.
Table 7.2: Dwellings acquired at case study sites.

Considerable amounts of vacant land have also been purchased at Lismore and Echuca. Figures in brackets refer to relevant dates.

<table>
<thead>
<tr>
<th></th>
<th>LISMORE*</th>
<th>ECHUCA</th>
<th>NORTH WAGGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOUSES AT SCHEME</td>
<td>295</td>
<td>67</td>
<td>241</td>
</tr>
<tr>
<td>HOUSES REMAINING</td>
<td>265</td>
<td>51</td>
<td>202</td>
</tr>
<tr>
<td>PERCENTAGE PURCHASED</td>
<td>10%</td>
<td>24%</td>
<td>16%</td>
</tr>
</tbody>
</table>

* Priority acquisition areas of Figure 2.2.
Worst small pockets largely cleared. Clearance is "aided" by private purchase of property for commercial use.

# An additional 7 sales are pending.
7.5 Hypotheses Development and Testing

To assess which factors are important in acquisition program success research hypotheses are developed from the literature summarised in Table 7.1, and from the reviews of the acquisition schemes under study. These sources were combined to produce hypotheses in the following areas:

- attachment to community, (tenancy, length of residence),
- flood risk (experience, perception),
- vested interest (benefits and losses from acquisition),
- aspects of program development and implementation, (the property valuation procedure, the time taken to decide to acquire and implement the decision, and "public relations" between the authorities and affected populations).

For completeness other variables conventionally examined in relocation studies, even though they are generally acknowledged to have little predictive value by themselves, were also analysed. These included sex and various socio-economic factors. A full list of hypotheses and their sources is contained in Table 7.3. Where appropriate, background detail to specific hypotheses is discussed in the relevant sections.

Hypotheses were tested using interview responses in two ways: qualitatively and statistically. Only the Lismore and Echuca data could be examined statistically, as access to individual Wagga questionnaires was not possible (see Section 2.2.3.7). The variable under scrutiny is cross-tabulated with expressed attitude to acquisition, and a wide range of other factors. Qualitative examination of research questions is necessary to include North Wagga in the analyses and for those variables for which statistical data is unavailable. This type of analysis operates at the community level only. Three statistical tests were employed to examine quantitative data (see Section 2.2.3.4).

The Chi-square test simply helps "to determine whether a systematic relationship exists between two variables" (Nie et al., 1975:223), it does not indicate the strength of the relationship. Two non-parametric tests suited to the nominal measurement level of much of the
Table 7.3: Sources of material for hypotheses on social aspects.
The points listed under sources have either been found by
other studies to be important in attitude to acquisition,
or appear to be significant factors in the case study sites.
The derivation of individual hypotheses is discussed in the
relevant sections of the chapter.
Case study key: NW = North Wagga; L = Lismore; EW = Echuca West.

<table>
<thead>
<tr>
<th>SOURCE OF MATERIAL</th>
<th>HYPOTHESES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LITERATURE (Table 7.1)</td>
<td>CASE STUDIES</td>
</tr>
</tbody>
</table>

1. Strong attachment to community assessed through:
   - length of residence
   - tenancy
   - inheritors
   - ability of community to organise

   1. Community strength (NW).
      - ability to organise (NW, L)
      - tenancy (NW, L, EW).

   1. Strong attachment to community is associated with resistance to acquisition.
      Attachment is measured by tenancy (including inheritors) and length of residence.

2. Attitude to floods:
   - location risk
   - flood experience
   - flood perception

   2. Flood risk (L)
      - experience (NW, L, EW).
      - perception (L, NW).

   2. High flood risk, flood experience, or flood perception, are associated with support for acquisition.

3. Vested interests:
   - perceived losses and benefits from acquisition.

   3. Perceived losses:
      - financial; mainly concern over the availability of alternate affordable accommodation (EW, L)
      - community destruction (NW, EW).

   3. Those who see themselves benefiting from acquisition will support the scheme and vice versa. An important issue is the availability of alternate accommodation.

4. Aspects of acquisition program procedures:
   - property values
   - public relations
   - time to decide
   - local involvement in plan development & implementation.

   4. Aspects of programs:
      - property valuation procedure (NW, L, EW).
      - time to decide (NW).
      - public-relations & public involvement (L, EW).

   4. Acquisition program procedures:
      Owner occupiers will support use of replacement valuation and oppose market values.
      Long periods of indecision will increase opposition and anxiety.
      Local involvement in plan development and implementation will increase acceptance.
data were selected for this purpose: the contingency coefficient and asymmetric lambda. (As used in this study they are described in Nie et al., 1975). The two tests describe different aspects of association. "Asymmetric lambda measures the percentage of improvement in our ability to predict the value of the dependent variable once we know the value of the independent variable" (Nie et al., 1975:225). In the present context the dependent variable is attitude to acquisition, while independent variables include tenancy status, seriousness of the local flood problem, and knowledge of the acquisition scheme. The contingency coefficient is based on chi-square and its upper limit depends on the size of the cross-tabulation table. "For this reason it should only be used to compare tables having the same dimensions, i.e. the same numbers of rows and columns" (Nie et al., 1975:225). Fortunately, all the strongly related variables are cross-tabulated in 2x2 tables. For the few factors for which this is not the case comparisons should be made with asymmetric lambda only.

Results are presented in the form of a matrix showing the significance and strength of the relationships between the major questionnaire variables (Table 7.13, in Section 7.10).

7.6 ATTITUDE TO ACQUISITION

7.6.1 Introduction

The first step in hypotheses testing is to establish the attitude to acquisition at each site through interviews with residents and officials. Straightforward questions on attitudes towards risk and other issues have frequently led to misleading and contradictory results, with a substantial gap between expressed attitudes and actual behaviour. This is a serious weakness of many attitude studies, in particular those concerned with risk and hazards (see Section 1.4). As attitude to acquisition as assessed from the questionnaire responses is the major basis of hypotheses testing, a range of other material is examined in an attempt to validate the questionnaire data.

Thus, for each site attitude to acquisition is assessed from two
separate data sources: the questionnaires, and the semi-structured interview and documentary sources used to compile Section 7.4. A comparison of the results of the two sources should indicate the general accuracy of questionnaire responses.

Those responses found to be most useful are employed in subsequent sections to examine potential explanatory variables.

7.6.2. Questionnaire Results for the Residents

The Lismore and Echuca questionnaires contained questions, or groups of questions to assess directly how the property purchase programs were perceived (Appendix B). These questions sought information on:

(i) the incentives that would be required to persuade interviewees to sell their property to the schemes (Question 19),

(ii) the behaviour of interviewees in relation to the scheme - had they considered selling, had their property valued and so on (Question 22),

(iii) whether and why people in the area would sell to the scheme (Question 16(d)),

(iv) whether the respondents felt acquisition was appropriate for their particular area (Question 17).

Discussion of the incentives issue is left to Section 7.7.4 - "Aspects of Acquisition Program Procedures". The behaviour questions showed that very few people had actually thought seriously about selling; only seven households (7%) in the Lismore acquisition sample. Although the proportion of Echuca respondents who had considered selling was higher (18.2%) it was still low and the combined Echuca/Lismore results were too low for detailed statistical analysis. So it was decided not to use this question in acquisition attitude analysis. As far as Lismore is concerned the very low positive response is almost certainly a reflection of the acquisition schemes relatively low profile rather than an indication of a strong anti-acquisition feeling. Similarly, the question on whether interviewees were likely to sell to the scheme proved to be of limited value. Responses were characterised by a high level of "Maybes" (up to 47% for the Lismore floodplain control) which made results difficult to
interpret. Also there was no comparable question in the Wagga survey, making between site comparisons of the data impossible.

The question seeking an opinion on whether or not the area should be acquired, provided reasonably clear results however, and has equivalents in the Wagga and Munro Lismore surveys. So data from these questions are used in most of the following analyses.

The three communities subject to acquisition schemes represent three quite different levels of program support if all interviewees, both owners and renters, are considered: some three-quarters of North Wagga respondents, two-thirds of those in Echuca West and one-third in Lismore are opposed to acquisition in its present form. If only those owner occupiers who know about the scheme are examined as in Table 7.4, the pattern is much weaker, though still present. In general owner occupiers are opposed to acquisition.

Table 7.4: Attitude to Acquisition For Owners who have heard of the Scheme. Results expressed as percentages rounded to the nearest whole number. Figures in brackets are frequency counts. (Question 17 in questionnaire, Appendix B).

<table>
<thead>
<tr>
<th>Should Area be acquired?</th>
<th>Lismore</th>
<th>Echuca West</th>
<th>North* Wagga</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flood Free</td>
<td>Flood Plain Control</td>
<td>Priority Acquisition Areas</td>
</tr>
<tr>
<td>YES</td>
<td>72%</td>
<td>74%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>(25)</td>
<td>(21)</td>
<td>(12)</td>
</tr>
<tr>
<td>NO</td>
<td>12%</td>
<td>21%</td>
<td>61%</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
<td>(40)</td>
<td>(27)</td>
</tr>
<tr>
<td>Don't know</td>
<td>17%</td>
<td>6%</td>
<td>7%</td>
</tr>
</tbody>
</table>

* Question wording: "Could you tick those options you would consider acceptable" (for North Wagga, and rank preference). Options considered as acquisition were "government property purchase" and "relocation".
7.6.3 Interview and Documentary Evidence

Wagga presented the most interesting results. Perhaps not unexpectedly, in view of the strong opposition to acquisition by North Wagga residents expressed through their resident's association, the local politicians now appear firmly opposed to removing the village. Unlike the politicians, Council staff are divided over the best way to deal with the village. The town planning section supports the relocation concept; it was originally their suggestion in the 1950's, "They shouldn't be there, we should wipe them out". On the other hand the district engineer and his department reject relocation and advocate a levee.

In general, Echuca City Council staff and the great majority of local politicians were content with the flood mitigation package developed in conjunction with the Victorian SR & WSC. However, there was strong opposition to the proposal to acquire Echuca West from the then mayor and his supporters who argued that a structural solution was possible. In his words Council didn't accept the acquisition scheme they "were commanded to do". Now Council is fairly united in its support of the scheme, possibly because it is administered directly by the Victorian government and is largely out of local control. The residents of the West are somewhat divided over the desirability of acquisition. Nevertheless, it is clear from the sales data that a substantial number of residents feel the scheme is worth taking advantage of (Table 7.2).

The situation in Lismore is curious. It is the study site with by far the highest degree of support for acquisition, revealed by the scheme's smooth progress and the virtual absence of vocal opposition from the residents of the affected areas. Yet a number of local politicians and business people (the Chamber of Commerce) were opposed to acquisition. Some Councillors felt that there was a serious potential for loss of rates. But, a broader concern appears to have underlain much of the opposition. Acquisition was seen as part of a comprehensive plan to encourage abandonment of the floodplain, the major element in the plan being the establishment of an alternative flood-free town centre at Goonellebah (Section 3.3.3.5). Naturally, established floodplain businesses see such actions as very threatening, all the more because the recent natural growth of the city is away from the floodplain. However, these concerns are not
shared by the floodplain residents or the great majority of local government staff and politicians.

7.6.4 Conclusions

Attitude to acquisition revealed by questionnaire responses is a reasonably accurate reflection of behaviour towards the schemes, when assessed at the community level. Attitudes and behaviour in individual cases may still vary widely.

At no site is there unanimous support for, or opposition to voluntary acquisition.

The situation in Wagga is the closest to unanimity. There, local politicians, Council's engineering department and most North Wagga residents are firmly against acquisition. The Wagga town planning department supports acquisition but at present is completely overwhelmed by the opposing local forces. At Lismore and Echuca there have been some divisions among Councillors over the merits of acquisition but these have not hindered scheme implementation. The success of the Lismore scheme is largely due to the absence of opposition from potential relocatees and the determination of key state and local government officials. In Echuca the initial opposition to acquisition by some older residents and local government officials appears to have been overcome, but, in any case resistance is unlikely to have prevented implementation as the scheme is under the direct control of the Victorian Government.

7.7 FACTORS AFFECTING INDIVIDUAL AND COMMUNITY RESPONSE TO ACQUISITION

7.7.1 Factors Examined

In the following sections the hypotheses developed in Section 7.5 are tested. Certain other variables were examined but were not significant. Sex of respondent, for example, was not related to any other variable.
7.7.2 Perceived Losses and Benefits of Acquisition

The full range of tangible and intangible acquisition costs and benefits as identified by this and other studies is listed and discussed in Chapter 5. Material on the evolution of the identified effects is also included. This section focusses on those effects expected or perceived by the potential relocatees, also referred to as their "vested interests".

Burdge and Ludke (1970, 1972) and others, found that vested interest is an important explanatory variable underlying attitude to compulsory acquisition (see Table 7.1). Those who believe that their interests are served by acquisition are more likely to have a positive attitude towards the scheme and vice versa.

Two questions were used for the primary analysis of this issue: Respondents were asked:

(i) How they thought they might benefit from the scheme (Question 18), and

(ii) how they thought they might lose from it (Question 25). (Question wording for Wagga: "if leaving North Wagga is required, what, if any, problems do you think this will involve for you?)

Respondents in the Echuca and Lismore acquisition areas were overwhelmingly convinced (approximately 80% of the samples) that the schemes held no benefits for them (Table 7.5). Unfortunately no data on the perceived benefits of acquisition were collected for North Wagga. However, information on expected losses was available for all three sites. Only some 20% of respondents felt that acquisition would benefit them, and a similar percentage saw no losses, with the exception of Echuca West. There, virtually the entire sample (93%), foresaw personal losses from the acquisition scheme. Even the great majority of the Lismore flood free sample saw no benefits from acquisition (70%). It was quite possible, and it would have been quite reasonable for people to see both gains and losses. This might have had the effect of reducing the apparently overall negative response to acquisition, if for example, many of those who saw losses also felt they would gain something. However, with most expecting
losses and no benefits at all the outlook of respondents is clearly pessimistic.

The dominant reason for this perspective is concern over the loss of affordable accommodation. This was especially the case among those renting and results here are closely associated with those who cited economics as an important locational constraint (Section 6.3). Losing affordable accommodation was the primary concern of two-thirds of those who felt economics kept them in the floodplain, and concerned only one-third of those for whom economics were unimportant. Similar results were obtained when the question of economics in the original location decision was examined by perceived loss. Table 7.6 illustrates the association for both owners and renters for the combined Echuca and Lismore acquisition samples.

In the cross-tabulation with attitude to acquisition only the question of expected benefits proved to be of value. This association was the strongest found among the variables examined (see Section 7.10.9.2). Virtually all respondents who are opposed to acquisition see no benefits in the scheme. The relationship between acquisition attitude and expected losses from the schemes was not significant.

7.7.3 Flood Factors

Recent and severe flood experience has been shown to be a powerful motivator for flood adjustment adoption (Waterstone, 1978; Smith & Penning-Rowsell, 1982). It may also be important in forming negative attitudes to flooding and positive attitudes towards relocation (James, 1974; Time, 1981).

Key questions for assessing flood attitudes or perception are expectation of future flooding and perception of flood severity (Kates, 1962). Pessimistic responses to these questions are likely to indicate support for relocation (O'Malley, 1978; Schweri & Willigen, 1978).

Data from a number of sources were used to examine the following hypotheses that attitude to acquisition is related to flood risk, experience and perception. These factors are not independant, especially
Table 7.5: Benefits and losses from acquisition perceived by potential relocatees. Combined Lismore and Echuca data.

7(a) BENEFITS

<table>
<thead>
<tr>
<th>Benefit</th>
<th>%</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>No benefits</td>
<td>85</td>
<td>(165)</td>
</tr>
<tr>
<td>Reduces flood risk</td>
<td>7.2</td>
<td>(14)</td>
</tr>
<tr>
<td>Post-acquisition use</td>
<td>4</td>
<td>(8)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3.8</td>
<td>(7)</td>
</tr>
</tbody>
</table>

7(b) LOSSES

<table>
<thead>
<tr>
<th>Loss</th>
<th>%</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>No losses</td>
<td>16.9</td>
<td>(31)</td>
</tr>
<tr>
<td>Not moving</td>
<td>10.3</td>
<td>(19)</td>
</tr>
<tr>
<td>inconvenient/miscellaneous</td>
<td>7</td>
<td>(13)</td>
</tr>
<tr>
<td>cheap living</td>
<td>47.8</td>
<td>(88)</td>
</tr>
<tr>
<td>home area/friends</td>
<td>18</td>
<td>(33)</td>
</tr>
</tbody>
</table>

Table 7.6: Importance of cost in location and perceived loss from acquisition. Percent of cost category. (Numbers of interviewees in brackets).

<table>
<thead>
<tr>
<th>How might you lose from acquisition</th>
<th>Is cost important in staying here?</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO WON'T LOSE</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>18.3% (18)</td>
</tr>
<tr>
<td>LOSE (miscellaneous)</td>
<td>14% (14)</td>
</tr>
<tr>
<td>LOSE cheap housing</td>
<td>69.7% (67)</td>
</tr>
</tbody>
</table>

Chi-square significant at .05
experience and perception. However, they are examined separately because there is considerable debate about the precise nature of the relationships. The hypotheses are:

(i) Support for acquisition should increase with flood risk.

(ii) Those with severe flood experience and whose routine is affected by flooding should be more positive towards the scheme. Interviews in the second part of the Echuca survey, which was conducted immediately after a major flood, should be more supportive of acquisition, and

(iii) those whose flood perception is low, i.e. who do not see flooding as a local problem, are expected to oppose the scheme.

Flood Risk
Evidence for the importance of exposure to flood risk, comes from two sources: the appropriate Munro questionnaire responses matched up with a flood risk data base for individual properties; and overall community attitude to acquisition ranked by the flood risk of each study site. The data base contains the ground and floor heights of all developed properties in the Lismore floodplain, lower levels are subject to more frequent and deeper flooding (Section 2.2.3.5). Flood risk, here expressed as a probability, is a purely physical measure suffering from a number of major limitations. Apart from the problems set out in Chapter Four, exposure to a flood risk, even if of long duration, does not guarantee flood experience.

Munro asked a sample of all Lismore floodplain residents whether they supported the concept of a resettlement scheme for badly flood prone residents without nominating specific areas such as North Lismore. Table 7.7 shows that for owners increased support for acquisition is associated with increased flood risk. Results for renters are not clear cut. A possible explanation here may lie in the high turnover of rented properties. As a general trend the more flood prone dwellings are the more rundown they become. It is possible then that the most flood prone houses have the highest turnover rate. If this is the case a relatively large proportion of renters would not have experienced the 1974 or 1976 floods, and could be expected to have a lower concern for flooding than adjacent long term residents.
Table 7.7: Support for resettlement by ground height and flood risk. (Lismore owner occupiers only. Figures in brackets are numbers of interviewees).

<table>
<thead>
<tr>
<th>GROUND HEIGHT (metres)</th>
<th>FLOOD RISK (approximate recurrence interval)</th>
<th>PERCENTAGE in each height class supporting the scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5-9</td>
<td>&lt;1:2</td>
<td>100% (6)</td>
</tr>
<tr>
<td>&gt;9-10</td>
<td>&lt;1:3</td>
<td>88% (51)</td>
</tr>
<tr>
<td>&gt;10-11</td>
<td>&lt;1:4</td>
<td>81% (190)</td>
</tr>
<tr>
<td>&gt;11-12</td>
<td>&lt;1:10</td>
<td>69.5% (217)</td>
</tr>
<tr>
<td>&gt;12-13</td>
<td>&lt;1:100</td>
<td>63.8% (94)</td>
</tr>
</tbody>
</table>

Table 7.8: Attitude to acquisition before and after the 1981 Echuca flood.

<table>
<thead>
<tr>
<th>SHOULD ACQUIRE?</th>
<th>PRE-FLOOD</th>
<th>POST-FLOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>18.5% (5)</td>
<td>45% (10)</td>
</tr>
<tr>
<td>NO</td>
<td>77.5% (21)</td>
<td>53% (11)</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>4% (1)</td>
<td>6% (1)</td>
</tr>
</tbody>
</table>
The community-wide data collaborate the Munro results with owner occupiers in the most flood prone area, North Lismore, being most supportive of acquisition; while those in the least flood prone area, North Wagga, are the least in favour of acquisition. In addition, the more flood prone interviewees were most likely to cite floods as a reason for scheme support and vice versa.

**Flood Experience**

Unfortunately the Lismore data on severity of recent flooding (ie 1974) by attitude to acquisition is inconclusive.

However, a clear demonstration of the importance of recent flood experience comes from a comparison of Echuca West interviews conducted before and just after the 1981 flood. In an area where considerable opposition to acquisition exists, support for the scheme in the post flood sample increased to nearly double that of the earlier survey. The change in attitude would be greater than the figures in Table 7.8 indicate, because a number of people who had sold or were selling their houses to SR & WSC as a result of the flood were not in residence and were not interviewed. These people would have almost certainly been scheme supporters.

**Flood Perception**

Perception of the severity of the local flood problem was closely correlated with attitude to acquisition (Table 7.9). In fact the variable was the second most powerful predictor of attitude after vested interests, and explained some 17.6% of the variance (see Table 7.13). Thus in communities where there is widespread recognition that flooding is a local problem support for acquisition, of at least the worst areas, is likely to be strong. Only Lismore owners who knew about the scheme are used in this analysis as the data for this group are complete.

7.7.4 **Attachment to Community**

7.7.4.1 **General**

A major group of acquisition area residents, the older longer-term people, the "stayers", are strongly attached to the community (North
Table 7.9: Attitude to acquisition by flood perception. Figures are column percentages. Numbers of responses are in brackets.

<table>
<thead>
<tr>
<th>Should acquire?</th>
<th>Flood perception</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIGH</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>60.9(70)</td>
<td>39.5(30)</td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td>39.1(45)</td>
<td>60.5(46)</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square sig. .01

Table 7.10: Attitude to acquisition by tenancy status. Figures are column percentages. Numbers of responses are in brackets.

<table>
<thead>
<tr>
<th>Should acquire?</th>
<th>Tenancy status</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OWNER</td>
<td>RENTER</td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>47.7(62)</td>
<td>61.7(37)</td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td>52.3(68)</td>
<td>38.3(23)</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square sig. .1
Wagga), place (Echuca West), or a mixture of both (Lismore). This has been established by the analyses of their demographic characteristics and questionnaire responses in Section 6.3.3.3.

Degree of attachment to community or place has been found to be an important, if not the critical demographic variable influencing attitude to compulsory relocation (Table 7.1). It is expected, given the similarities between the subjects of the compulsory relocation studies and the residents of the case study area, that the strongly attached group will oppose relocation even of a voluntary nature.

In the following paragraphs factors important in the degree of attachment to community are examined for their influence on expressed attitude to acquisition.

7.7.4.2 Housing Factors

Other work has shown that the greater the degree of property investment in both symbolic and monetary terms the greater the degree of attachment to place (Section 6.3.3.3) and resistance to relocation (Table 7.1).

A difference in attitude, therefore, is expected between owners and renters. As renters have a low degree of economic and generally symbolic property investment it is likely that they will be less motivated to remain and will support acquisition. Conversely owner occupiers, and in particular those who inherited their property (O'Malley, 1978), are likely to want to stay.

Occasionally low rents are associated with older people and longer terms of residence. But, this does not appear to be the case in the study sites. The proportion of accommodation rented is low in Echuca West and North Wagga at about 10%; while in the Lismore acquisition areas where the proportion of dwellings rented reaches 40%, the renters are relatively young, mobile, short term residents.

Renters are substantially more supportive of acquisition than owners (Table 7.10). In fact most renters (70%) feel that they wouldn't
lose from having to move or would find it only a nuisance. Those who felt they would lose generally cited money difficulties related to finding alternate low cost accommodation. It should be noted that in the areas under investigation the authorities attempt to ensure that people are not forced from their homes.

At the opposite end of the symbolic property investment spectrum should be those who inherited their dwellings. This is a sizeable group especially in North Lismore where it contains some 25% of owner occupied dwellings (Section 6.2.4). However, inheritors are less certain about their attitude towards acquisition than other occupant groups and their level of scheme opposition is similar to that of the rental group and significantly lower than that of the non-inheritor owner. Unlike renters, on the whole inheritors did not consider themselves trapped by cost but were concerned about the flood problem. The unexpected results may be a reflection of the slightly poorer and more flood prone dwellings occupied by this group, especially as other parts of the questionnaire tend to demonstrate their degree of attachment to the area. The absence of compulsion in the scheme might also be important.

A number of alternative explanations for the higher degree of renter support for the scheme were examined. As the most flood prone areas in Lismore contain the highest proportion of rented dwellings, it follows that the severity and frequency of flooding may explain renter support. Support for the resettlement scheme concept was found to decline with decreasing flood risk, but for the rental subgroup the decline is erratic and does not appear to be significant (Section 7.7.3). This itself is probably a result of the high turnover rate of rental properties and the consequent low level of flood experience among residents. Another possibility is that if renters are less interested in their area they may not be as well informed as owners about the acquisition scheme and thus hold different views. The knowledge question is explored in Section 7.7.5.3, and as expected renters are less aware of the scheme's existence. However, while in the case of renters awareness of acquisition increases scheme support, the opposite occurs among owner occupiers. As renters are relatively unaware of the scheme this relationship should reduce the proportion of the rental group who support acquisition. Knowledge is not
therefore seen as an important factor underlying scheme support by the renter group.

Another potentially important factor is economics. Section 6.3.3.2 establishes that a very high proportion of renters would prefer to leave the acquisition areas because of floods, but find themselves financially unable to do so. Many of these people may support acquisition believing erroneously that it will help them find alternative affordable flood free accommodation.

In summary, tenancy status is an important variable underlying attitude to acquisition, with low levels of property investment associated with increased acquisition scheme support, and vice versa. An anomaly in this pattern is that those who have inherited their property are fairly ambivalent about acquisition. Finally, in each study site the overall level of scheme support is broadly related to the site's tenancy makeup: with Lismore being the most supportive, having the highest proportion of rental accommodation while the residents of the other sites are more likely to oppose acquisition, in particular those of North Wagga where outright home ownership is highest.

7.7.4.3 Length of Residence

Although length of residence is a useful indicator of attachment to place or community (Table 7.1), the variable has not generally been of value in predicting attitude to acquisition (O'Malley, 1978; Schweri and Willingen, 1978). Results from Lismore confirm these findings; the association between attitude to acquisition and length of residence is not significant.

7.7.5 Aspects of Acquisition Program Procedures

7.7.5.1 Organisation of Section

Certain aspects of program development and implementation have been found to be important in securing public support for acquisition. As derived from the literature these are set out in Table 7.1. The review of the case study sites' acquisition programs raised a number of similar points. The issues are discussed as follows:
(i) Decision time.

(ii) Public involvement in program planning and implementation.

(iii) Knowledge of the program, public relations and communication flow.

(iv) Property valuation procedure/scheme incentives.

7.7.5.2 Decision Time and Public Involvement

Lengthy periods of uncertainty for the residents while the decision to acquire is being made, may serve to increase local resistance to the scheme. Although uncertainty may lead to gradual neighbourhood deterioration and abandonment, those who remain may become increasingly determined to stay. The study sites illustrate this problem: the decisions to acquire in Echuca and Lismore were relatively quick, on the other hand property purchase in North Wagga has proceeded in a haphazard fashion for nearly three decades. Over time, opposition to the scheme has increased and become more organised and effective.

Critical factors in the success of the campaign against the scheme and regulations have been the organisation and leadership of the local residents association, which claims members in half the village households (SKP & MSJKY, 1979), and the strong sense of community the area is universally acknowledged to have. Executives of the association and council officers identified the long period of uncertainty during which "residents were deprived of their rights" (Knott, 1981-I) as a major equity issue and called for a speedy and firm resolution of the problem.

There is evidence to suggest that an absence of public involvement early in the planning process may lead to problems similar to those associated with lengthy decision times in that low levels of communication between the residents and responsible authority increase rumours, misinformation and anxiety (e.g. Smith et al, 1980; see Table 7.1 for other references). In no site could public involvement be said to be high at the time of the initial acquisition decision, and the residents were not involved in the early planning stages in a consultative way. Meetings between the residents and authorities have been held at Echuca and Wagga, but have not generally been to seek residents views, rather they have been
called to explain decisions already taken. In Echuca this caused considerable resentment among "stayers", and has also led to some misinformation despite the best efforts of the state and local authorities (Section 7.4.3). Wagga City Council has conducted surveys in North Wagga to obtain residents' views on alternative planning strategies for the area (SKP & MSJY, 1979: earlier surveys are referred to by Rawlings, the Town Planner in WC & IC, 1971, and in Livingston, 1975), but these have been subsequent to the 1956 decision to zone the Village non-urban and to commence acquisition, and were a reaction to public pressure rather than a coordinated part of the planning process.

Undoubtedly cases exist where both the public interest and successful program implementation are best served by a very low key approach to participation. This appears to have worked well in Lismore, though other local circumstances may be responsible for program success, in particular the recognised severity of flooding, lack of sense of community, the obvious and pre-existing decline of the areas, and the ability of the original program coordinator, John Wade, to reassure potential relocatees.

On the other hand, the costs of ignoring the public view may be great, especially when it is strong, as in North Wagga, and increasingly public participation in the planning process is becoming a legislative requirement. Victorian legislation now provides for the use of "Consultative Committees" which formally involve local residents in the planning process (Section 3.2.4.4), though their use is not mandatory. The Dandenong Valley Authority (DVA) in that state has involved the public in decision making for many years and believes that this is a major factor in its success in securing public support for its programs (Thompson, 1981). NSW does not have such formal procedures, but increasing use is being made of public meetings and surveys.

Unfortunately, involvement still tends to be reactive and apart from the Victorian "Committees" little effort appears to be made to incorporate the various public views from the commencement of project planning. Involvement after major decisions have been made, typical of many major inquiries, may reduce the whole procedure to a legitimisation exercise (Bain, 1980).
After a recent review of their public participation exercises the NSW Department of Main Roads concluded that it was not possible to formulate any general guidelines (Watson, 1980-1). Clearly, determining what constitutes the "public interest" is difficult when the public can't agree on values. Arrow and others have argued that where major social choices are concerned reconciliation of all viewpoints is impossible (Arrow, 1950; Kelly, 1978). Certainly, attempts at consensus where widely divergent attitudes exist are often doomed to failure. In these circumstances effort is better directed towards achieving the consent of those opposing the program. For example, many long term residents would never directly support the destruction of their neighbourhood, but may be content to allow those who want to sell to a voluntary scheme to do so. This is, in effect, what has occurred in Lismore and Echuca.

Finally, some general points emerge from the study sites and literature. To reduce feelings of frustration and alienation, participation exercises should commence before major planning decisions are made. They should seek out and attempt to defuse potential objections rather than simply react to strong public feelings. Concern is often expressed that those at public meetings, those who make submissions and so on, do not truly represent the affected public. Grima and Wilson-Hodges (1977) dispute this view, citing examples with no significant differences between viewpoints expressed in surveys and public meetings. In any case other techniques, including panels and surveys, may help to overcome such bias. However, it needs to be recognised that a vigorously held minority viewpoint may be important and may constitute a major obstacle to successful implementation, though in an entirely voluntary program this is less likely to be the case.

7.7.5.3 Knowledge of the Program, Public Relations and Communications Flow

Knowledge alone is often not very important in changing attitudes and behaviour, indeed the majority of public education/information programs do not appear to have significantly influenced public opinion (see Section 6.3.2.1; Hyman and Sheatsley, 1947; Roder, 1961; Kates, 1962; Handmer, 1980; Illinois Dept. of Transportation or IDT, 1980; McDonald et al., 1982). This is the case in programs as diverse as natural hazards,
crime prevention, seat belts and smoking (IDT, 1980).

Nevertheless it has been established that generally very low knowledge levels are associated with higher levels of uncertainty, anxiety, rumours and misinformation about relocation programs (Drucker, 1973, 1974; Smith 1970). Thus the importance of a public relations program and two-way communication is stressed to minimise anxiety and consequent negative reactions to the project (Buffington, 1973; Colony, 1971; Perfater & Allen, 1976; and Ralf M. Field, 1981).

When examining the role of knowledge in attitudes to acquisition at the study sites, it must be borne in mind that only in Echuca West had any real attempt been made to inform residents of the decision to acquire property, and that in this area everyone was aware of the scheme. Unfortunately therefore, much of the following analysis is restricted to Lismore, it being the only site with suitable questionnaire data. Some 25 per cent of the Lismore acquisition sample had not heard of the scheme - most of these people were renters (Table 7.11). Owners are expected to be more aware of the program because of their greater investment and interest in the property and because many renters are short-term residents.

Lack of knowledge does not appear to have affected overall attitudes towards acquisition (Table 7.12). Curiously the effects of knowledge were more profound on renters than owners. Renters were much more likely to support the scheme if they were aware of it, while owner

<table>
<thead>
<tr>
<th>Tenancy</th>
<th>Knowledge of scheme?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>RENTERS</td>
<td>(36)</td>
</tr>
<tr>
<td>OWNERS</td>
<td>(95)</td>
</tr>
</tbody>
</table>

Chi-square significant at .01.
occupiers' attitudes were largely unaffected by knowledge of the scheme's existence.

The main sources of knowledge about the scheme in Lismore were newspapers, and neighbours, friends and relatives. The Council was not an important source. Less than 10% claimed to have heard of the scheme through public officials. This is in contrast to the situation in Echuca West where the local Council and SR & WSC were the major informants (60% of sample) through a public meeting and a letter posted to every resident. Nevertheless there was considerable misinformation about the Echuca scheme (see Section 7.4.3), whereas Lismore residents generally realised that the scheme was voluntary and offered market value.

Table 7.12: Knowledge and Attitude to Acquisition.

<table>
<thead>
<tr>
<th>Should this area be acquired</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>(65)</td>
<td>(21)</td>
</tr>
<tr>
<td></td>
<td>76%</td>
<td>24%</td>
</tr>
<tr>
<td>NO</td>
<td>(41)</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>73%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Chi-square not significant

7.7.5.4 Property Valuation Procedure/Scheme Incentives

Property valuation has emerged as an important issue in voluntary floodplain acquisition programs overseas and in Australia in the study sites. The issue arises because frequently property in the more hazardous areas is of very low value (Section 6.2.2), and residents find that the market prices offered by government authorities are too low to enable them to buy replacement housing. Of course as there is no compulsion in the proceedings and the resident does not have to accept the government's offer there may appear to be no grounds for complaint. However, for the reasons
outlined in Section 7.3, government authorities are frequently not like other property buyers, and many residents feel that they have some moral right to replacement housing.

The questionnaires asked respondents to state the incentives that would persuade them to sell their property to the scheme. After this open question they were asked to indicate how acceptable or unacceptable they found various specified incentives. The Wagga survey did not contain an open question first. It asked interviewees to indicate their preferences for various options and then used the "consumer surplus" technique (Section 5.3.4), to establish how much money would be adequate compensation for relocation.

At the other two sites, over half the interviewees volunteered "replacement housing" in response to the incentives question. A further third of the respondents said that nothing would persuade them to sell. Although attachment to the area is important to many of those who do not want to sell, the removal of economic constraints through the prospect of reasonable alternative housing would enable some to realistically consider relocation. To provide a realistic option the individual requirements of the residents would need to be taken account, for example the need of many people to remain in the same general neighbourhood, and to be able to keep their pets. Among the non-acquisition flood free and floodplain residents interviewed there was virtually no opposition to the scheme, but there was a strong emphasis on the provision of compensation in the form of replacement housing.

The argument is often advanced by local councils that it is immoral if not illegal to prevent, without compensation, the development of land if the zoning at the time of purchase would have permitted it. Frequently this is extended to include situations where the owner might reasonably have expected that the zoning would be changed to permit development. Furthermore compensation generally takes the form of purchase of the property by government, and it is often implicit that the purchase price should include allowances for the loss of speculative profits, rates paid and so on. It seems quite inequitable that owner occupiers are not entitled to the same consideration when regulations prohibiting any further development, including renovations and extensions, are applied to their properties.
7.8 RELOCATEE SATISFACTION

7.8.1 Stress and Ill-health

Unfortunately, given the limits of the study it was not possible to interview relocatees to establish how they felt about the scheme, so the following discussion relies on indirect evidence and relevant literature.

Problems associated with forced relocation and voluntary migration are documented in Section 7.2. As the acquisition schemes under examination are entirely voluntary the worst of these problems, which include elevated mortality and illness rates, are unlikely. However it is well established that moving house is a stressful experience for many people even when the move is voluntary (Kantor, 1967; Rahe, 1972). The degree of stress and its physiological effect are dependant on a variety of factors as set out in Section 7.2. An important factor is age, as it is the chronic, non-infectious diseases, more common among the aged, that seem to be the most influenced by stress (Dodge and Martin, 1970; Rabkin and Struening, 1976). Thus some ill effects may be expected due to the preponderance of older people in the acquisition areas.

Older people constitute a fairly stable group, long resident in the area, in contrast to the other group of people occupying the acquisition zones who are relatively young and mobile (Section 6.2). This second group, many of whom are renters, will not be seriously affected by the move itself, though any difficulties experienced in finding suitable replacement accommodation may precipitate similar stress and health problems.

When considering the effect of relocation on health, Section 6.2.5 should be reviewed. It was shown that the occupants of the Lismore acquisition areas have very high hospital admission rates. If a major contributing factor to these high rates is the stress and anxiety associated with the constant fear of flooding, then relocation may actually reduce the incidence of stress-induced ill health and in this respect save the community resources. However, the high levels of ill health may also be a reflection of poverty, a linkage established in the literature.
7.8.2. **Financial Aspects**

An important question in relocatee satisfaction is the existence of alternate low cost accommodation. This affects both the groups identified above, but in particular those seeking rental housing. Section 6.3.3.2 clearly shows that the great majority of this group feel their locational choice is constrained by finance. Where the low cost housing supply is very limited, the case in many areas, caravan parks may provide the only option. Many relocatees would consider this quite inadequate, and in any case even this option is becoming less viable as costs rise steeply. The weekly charge for an on-site van in some parks now approaches $100.

Another facet of the alternative accommodation issue is the location of the low cost housing. In general relocatee satisfaction is increased if relocation is possible within their own community (Table 7.1). On the other hand extra difficulties appear to be experienced by people relocating from blue to white collar neighbourhoods. These difficulties are documented in other studies (Booth & Camp, 1974), and were commented on by the coordinator of the Lismore scheme (Wade, 1981-1).

7.8.3 **The Official View**

Officials in Echuca and Lismore generally feel that as the program simply provides a market for properties that are otherwise very difficult to sell, people taking advantage of the government's offer must be quite happy with the scheme. No doubt many of those in the acquisition areas see the scheme in this light. Many other residents are not very positive (Section 7.6) and as these people are less likely to take part in the scheme the comments of the then coordinator of the Lismore program are probably quite accurate; "The people (relocatees) have all been most grateful at the time of sale and afterwards...A lot have moved into country areas and some have moved into other flood affected areas" (Wade 1981-1). Other Lismore officials and community business leaders echoed these views though they were not involved in the scheme directly. An interesting aspect is that a few relocatees have moved within the floodplain, from a severely flooded site to one less severely flooded. This may reflect a desire to remain within familiar territory (Section 6.3.3.3), or the difficulty of finding low cost flood free accommodation.
ACQUISITION FOLLOWING A MAJOR FLOOD DISASTER

The immediate post-disaster phase presents an opportunity for a politically acceptable, and cost-effective acquisition program for the following reasons:

(i) The strong political desire often present just after a disaster to do something.

(ii) Large sums of money will be committed to the restoration of public and private assets. Instead this money can be used to relocate activities to flood free areas. In the post disaster situation acquisition will often appear very much more cost-effective than would otherwise be the case. Although restoration aid expenditure remains quite separate from expenditure on structural measures, it may be included in an acquisition budget, thus reducing the allocation of funds required specifically for an acquisition program. This procedure may be made mandatory, for example grants from a number of US state and federal disaster agencies may not be used for rebuilding in high hazard areas.

(iii) People whose homes and businesses have been destroyed or severely damaged are generally supportive of relocation, especially if the disaster demonstrated the limitations of structural works, and of course, if the financial arrangements are satisfactory.

(iv) The provision of open space may by itself be seen as a major community benefit of acquisition. This was the case following major flood disasters in Toronto, Ontario, and Rapid City, South Dakota. The then mayor of Rapid City commented on the decision to relocate settlement: "As we recognised the suicidal danger of allowing residential and commercial use of a dangerous floodplain, we also recognised the fantastic opportunity this would provide to our community to improve the quality of life..." (Barnett, 1976).

Some authorities and investigators recommend that contingency acquisition plans should be prepared for potential disaster sites to minimise post-flood delays in program implementation. Long post-disaster delays in plan preparation and implementation often cause resentment among the potential relocatees, reduce the political will to act, and may greatly reduce cost-effectiveness if rebuilding commences on the original sites (Ralf M. Field, 1981).
The whole issue of post-disaster mitigation, including acquisition, will be the subject of an international symposium in 1984. The meeting is to be held in the US and is organised by Jon Kusler (1983).

7.10 DISCUSSION AND CONCLUSIONS

7.10.1 Section Outline

The first part of this concluding section re-examines the statistical analysis of the questionnaire data in an attempt to provide an overview of the results. The second part uses these results and other material from the Chapter to present a number of policy oriented conclusions and recommendations.

7.10.2 Re-examination of Cross-tabulation Results

Cross-tabulation results are summarised in Table 7.13, using a matrix. Each matrix cell contains three figures. The top or first number indicates the significance of the relationship in terms of Chi-square. A significance level of .01 (or 99%) indicates that there is only one chance in 100 that the relationship observed in the sample is random, or put another way it is 99% certain that the observed relationship actually exists in the population. Associations significant at less than the .1 (90%) level are considered not-significant. The second and third figures are measures of the strength of the association. The first of these is the contingency coefficient which has a maximum value of .707 for a 2x2 table, and the last number is the asymmetric lambda expressed as a percentage.

The most obvious point about Table 7.13 is the large number of relationships which are not significant at the .10 level. All the variables have been thoroughly examined individually earlier in this Chapter. Here the focus is on those found to be associated with attitude to acquisition in Lismore and Echuca. In order of strength of relationship, these factors are:

- perceived benefits from acquisition,
In each cell the first figure is the Chi-square level of significance, the second figure is the contingency coefficient, and the third is the asymmetric Lambda value. All statistics were applied to 2 x 2 tables except where otherwise indicated. For a detailed explanation of the statistics see the text. An association significant at less than the .1 (9U%) level is considered not significant. The contingency coefficient, a measure of association strength, has a maximum value of .707 for a 2 x 2 table. Asymmetric Lambda, here expressed as a percentage, measures the predictive power of the association.

Table 7.13 : Cross-tabulations. Significance and strength of the associations.
- perception of floods as a problem,
- and tenancy (used as a surrogate for attachment to community),
with the first two factors being by far the most important.

According to the asymmetric lambda statistics, flood perception and perceived benefits each explain some 17% of attitude to acquisition. Tenancy adds 6.6% to this making a total of 42% of the variance in attitude explained. In arriving at this combined figure it is important that the components are quite independent of each other. This appears to be the case because although tenancy status (owner/renter) is related to flood perception the relationship is weak; at a significance level of .1 lambda is 0, and the contingency coefficient is .136. Of course other variables altogether may be important, for example tenancy status in Lismore is, itself, largely a function of age.

From the perspective of public policy two disappointing results of Table 7.13 are the very weak performance of the "type of scheme incentive" and knowledge of acquisition. It appears that both variables have no effect on attitude to acquisition, and cross-tabulations with knowledge recorded the weakest levels of association in the matrix.

On this basis public information programs cannot be recommended as a way of improving local reaction to acquisition, although again other factors may be at work here. Knowledge was high among owners and low among renters, while for other reasons renters tended to support acquisition and owners oppose it (Section 7.7.3.2). Nevertheless these results are in broad agreement with those of other studies, as reviewed in Section 7.7.4.3. Care is needed to distinguish the simple provision of information to the public from public involvement in the planning process. Provided there is some flexibility in program development, involvement of the affected public may ease implementation and reduce community alienation. On the other hand, the "information" approach may even be counterproductive. The one standard measure of alienation employed in the questionnaire, the Srole Anomie Scale (Question 46) (Srole, 1956), was not related to acquisition attitude.

Investigation of the incentive issue was complicated by the fact that the schemes in all three sites were the same in that they all offered
market value, and because effectively all (95%) interviewees said either that they would not sell (39.3%) or that only replacement housing or its equivalent would be satisfactory (55.7%). It is clear however, from other evidence, that the cost of replacement housing is a major issue and that offers of relocation assistance would improve scheme acceptability provided that residents' individual needs could be accommodated. This is not so much in terms of material desires, but the need of many older people to stay in the same general neighbourhood and to maintain their independence and lifestyle.

7.10.3 Conclusions

Only a few of the wide range of variables examined were found to be associated with attitude towards acquisition in the study sites. Of those associations which could be subject to statistical testing the question of perceived benefits of acquisition had the highest predictive power, followed closely by flood perception and then attachment to community. Other factors not analysed statistically but also important were aspects of acquisition program procedures, in particular public involvement in the planning process, decision time, and the property valuation process, and issues of community organisation and leadership. Specific conclusions and recommendations follow.

Those with greater attachment to community, here assessed as those with greater economic and symbolic attachment to their community or property, i.e. owner occupiers, are more likely to resist relocation. Much of the resistance, especially in areas with a severe flood problem, is due to the "market value" purchase policy. In contrast to the findings of other studies inheritance of property was not related to attitude to acquisition.

Acquisition programs will be best received where local residents recognise the existence of a severe flood problem. This is a major reason for the failure of acquisition in North Wagga and its success in Lismore.

Implementation success is particularly likely where people feel that their interests are served by the scheme. This vested interest or perceived benefits of acquisition variable has the strongest predictive power of the factors examined. Those who see themselves benefiting from
acquisition are much more likely to support it. However, this number was very small in all the case study sites (15%). Again, the property valuation procedure is almost certainly a major reason why people cannot see benefits in acquisition. In most cases their flood prone property is worth half that of comparable flood free property, and payments under "market value" purchase policies will therefore generally preclude outright purchase of flood free replacement dwellings.

Unfortunately, no data on relocatee satisfaction was available from the present study. But, it is clear from the results of other studies that the stress and anxiety accompanying relocation may precipitate a range of health problems, including elevated mortality rates, especially among the aged and poor - people who constitute a substantial proportion of the acquisition areas population. Financial problems and difficulties at the time of moving will only exacerbate any stress and its subsequent effects. Although these remarks are based primarily on literature concerning compulsory acquisition there is considerable evidence that the same general comments apply to voluntary moves. A further caution is applicable to Lismore (and similar situations). There the residents of the most flood prone areas exhibited hospital admission rates over double those of flood free area residents. It is most likely that this differential is at least in part a reflection of the anxiety associated with living in constant fear of floods. If this is the case then relocation to a flood free area may actually reduce the demand on health resources. Some of the anxiety observed in the study sites was because the residents were unsure of the acquisition program procedures, but experience with public information campaigns has not been encouraging.

The issue of perceived benefits therefore, is important in scheme success, especially where owner occupied housing is involved and where the authorities wish to minimise adverse impacts on the affected population. In a policy context benefits are closely linked to scheme incentives to sell. If at all possible consideration should be given to taking responsibility for relocating genuine needy cases. Such cases would include long term owner occupiers whose property does not realise enough to enable the purchase of replacement housing. Some potential relocatees in the study sites have been offered housing commission accommodation, but have declined the offers because of the conditions typically attached to such housing,
such as no pets. The conditions are particularly difficult for people who may have spent 50 years or more in their homes. Nevertheless this approach is a step in the right direction.

Another approach to reducing the economic problems of moving would be to relocate the existing dwellings to flood-free sites. This is being investigated in Lismore and may prove to be quite viable where Council owns undeveloped blocks. If these are situated near the acquisition area the approach may also appeal to those with a strong symbolic attachment to their location or community and help to reduce the disruption associated with relocation.

There is evidence that involvement of the public early in the planning process will also reduce anxiety and disruption; by reducing the sense of alienation and frustration that often develops as people find that major decisions affecting their lives are being made without their opinions or consent. This is not to deny that in some circumstances a complete lack of public involvement works well. But, as the major justification for acquisition schemes is frequently that it "will help the people get out" (i.e. in other words it is directed at assisting a disadvantaged group), it seems reasonable to seek the views of potential relocatees and to incorporate these into the policy development/implementation process where possible, and to reassure them about the scheme's aims and procedures. Knowledge, and hence public information, was found not to be associated with attitude to acquisition, so satisfactory public participation involves more than the provision of information. In many instances reconciliation of the sectional interests among the potential relocatees, local and state governments is demonstrably impossible. Attempts to reach consensus under such circumstances are doomed to failure, and may be little more than a frustrating waste of time and money. However, it may be quite possible to obtain consent for program implementation from those opposing acquisition. In effect this is what is occurring at Echuca West and Lismore.

Communities will frequently be especially supportive of acquisition immediately following a flood disaster. Furthermore, under such circumstances acquisition may be a particularly cost-effective flood damage reduction strategy. As both public support and cost-effectiveness are reduced as government and private assets are restored in their pre-
flood locations, rapid action is essential. To this end consideration should be given to the preparation of contingency acquisition plans for potential disaster sites. In addition certain disaster aid may be made unavailable for rebuilding in high hazard areas.
CHAPTER 8

IMPLEMENTATION PROCEDURES

8.1 INTRODUCTION

The previous chapters cover a wide range of broad issues concerning flood damage reduction policy and acquisition. Criteria have been established for determining the role of acquisition at different locations, and the social and political implications of the strategy have been investigated. However, a number of important questions concerning implementation details remain unanswered, in particular the issues surrounding post acquisition land use. Also examined in this chapter are: individual property selection procedure, program publicity, purchase procedures, continuation of public utilities to affected properties, and the treatment of historic buildings, and the funding of acquisition programs.

Readers interested in implementation details from a wider range of communities are referred to two US publications: Appendix B of Kusler (1982), for summaries of community experience in implementing innovative floodplain management programs; and Ralf M. Field (1981), for general guidelines and suggestions regarding acquisition schemes.

8.2 INDIVIDUAL PROPERTY SELECTION PROCEDURE

8.2.1 General

Recommended acquisition area selection procedures are set out in Chapters 4 and 5. Considerable emphasis is placed on public safety and hence on the physical dimensions of the flood hazard. Occasionally the viability of acquisition may be assessed on economic grounds, or in certain circumstances governments may be bound by law or policy to offer landowners the option of voluntary acquisition.

Individual purchase priorities will sometimes be decided on the same criteria, though more frequently the order of property purchase within a defined acquisition area will be influenced by other factors.
8.2.2 Desire to Sell

Paramount among these factors in a voluntary program is the desire of residents to sell. In all three study sites properties are acquired as they come onto the market. The failure of the North Wagga program is due primarily to the fact that the residents, for whatever reasons, were not prepared to sell their property under the conditions of the scheme. The inclination to sell would also be important in a compulsory scheme given the present policies of attempting negotiated settlements before using resumption powers.

8.2.3 Availability of Funding

A corollary to 8.2.2 is that in a voluntary program where the government agency is acting like any real estate buyer, not only must properties be offered for sale, but the agency must be able to afford to buy them. Lack of adequate funds severely hampered implementation of the Toronto floodplain acquisition scheme for many years (Handmer 1981(b); Ontario-MTRCA, 1965), and precluded use of the US federal flood insurance Act's acquisition option until 1980, 12 years after the option became law (US Federal Register, 1980). Frequently, available money may be more effectively spent, initially at least, by purchasing cheaper more run down dwellings. Indeed this approach is likely to satisfy the fundamental public safety aims of acquisition schemes, as the cheapest property will probably also be the most flood prone (Section 6.2). Funds may be rapidly exhausted on expensive properties without bringing a significant amount of land into public ownership. Again the same point may be valid in a compulsory scheme. Though here the need for relocation allowances will reduce the cost differences between the poorest and most expensive residential properties.

8.2.4 Development/Redevelopment Pressure

Local governments often feel that they are morally, if not legally, obliged to acquire land for which development applications consistent with the zoning have been refused. However, there is increasing evidence that Councils are entitled to refuse development applications on the grounds of flood risk (Section 3.2).
As new technical information on flood risk comes to hand it is appropriate that it be incorporated into the planning process, even though this may lead to land originally zoned for intensive development becoming unavailable for such development. More frequently the question is not whether the land is flood prone, in fact all too often the property in question is known to flood regularly and severely. Nevertheless, threats of legal action by developers have in the past resulted in building permission. Despite the apparent legal right (even obligation given NSW and Victorian government policy) of local governments to refuse development permission, it may be desirable in terms of local politics, and situations where a clear moral case can be made, to give property under strong development pressure a high priority in an acquisition program.

8.2.5 Land Required for Public Purposes

Priority may be given to rounding out other purchases so that public utilities do not have to be maintained, or so the acquired land presents a viable unit for parkland, agriculture, etc. The question of utility maintenance is explored in Section 8.7.

8.2.6 Environmental Issues

Protection of certain natural values may be a major objective. This may encompass preservation of natural stream and floodplain hydrology and hydraulics including the prevention of wetland drainage. Wetlands or backswamps in particular may perform valuable functions in natural flood storages, groundwater recharge, the maintenance of low flow, and wildlife breeding areas (US Council on Environmental Quality, 1978). In large urban areas another important potential use of natural areas is for recreation and study. Much of the floodplain land acquired in Toronto, Ontario, is kept in as natural a condition as possible (Ontario MTRCA, 1980(b); Toronto Field Naturalists' Club, 1976). Locally the Nowra development strategy plan emphasises the importance of accessible natural areas for study purposes.

Environmental issues are likely to grow in importance as public concern expands. Recent legislation, for example the NSW Environmental Planning and Assessment Act (1979), (especially sections 77, 90, 110-114),
increases the probability that these issues will receive due attention.

8.3 PROGRAM PUBLICITY

Section 7.7.5.3 "Knowledge of the Program, Public Relations and Communications Flow" examines this question. In summary it appears that very low knowledge levels are generally associated with high levels of uncertainty, anxiety, rumours, and misinformation about relocation programs. Poorly organised information campaigns may be counter productive and lead to confusion over the issues and to unfounded fears about the socio-economic impacts of the project (Canter, 1977; Munn 1979).

8.4 USE OF COMPULSORY PURCHASE

The three schemes examined involved the voluntary purchase of full title to the land.

Although no specific questions were asked, it is clear from the comments of Lismore interviewees in both the acquisition area and flood free samples that people felt the schemes should be voluntary. On the whole officials were of the same view, primarily on the grounds of public support, and in some instances were quite adamant that there should be no compulsion. There is considerable support in the research literature for this view (US NERBC, 1976; Ralf M. Field, 1979; Blair, 1980, for agricultural land). Also some North American officials believe public acceptance of acquisition programs depends on their voluntary nature (King, Tennessee Valley Authority (TVA), pers. comm. 1980; Prince (1980-1)).

Of course, from an agency perspective voluntary acquisition greatly reduces program costs, as relocation compensation payments are not required. However, it is just this point that has prompted a few Echuca West residents to request that their property be resumed (compulsorily acquired). The implementing authority (State Rivers and Water Supply Commission) would then be required to ensure that people were properly relocated in equivalent dwellings and that they were compensated for moving expenses, disruption and so on (Section 7.2). Costs to the agency, and
hence monetary benefits to the residents, could easily double. On the other hand, if the extra money was available there would probably be little need for resumption, as insufficient funds for relocation are a major reason why many people feel unable to take part in the schemes (see Section 7.7.5.4).

An obvious potential problem with a voluntary scheme is that it may fail altogether to obtain the land: North Wagga provides an example. In these circumstances some writers feel that the use of compulsory purchase is desirable, especially if the flood risk is great or the properties are required for some clearly defined public purpose (Kusler, 1979; Platt, 1977). A few case study area officials would not entirely rule out the use of compulsion to complete an acquisition program, particularly if high utility provision costs were involved.

8.5 PROPERTY VALUATION PROCEDURE

This has emerged as one of the major issues in voluntary floodplain acquisition programs. The subject is covered in depth in Chapter 7. In essence the problem arises because frequently property in the more hazardous areas is of very low value, and residents find that the market prices offered for their dwellings are too low to enable them to buy replacement housing. Resentment develops because voluntary programs are not always seen as such, and although the government may be acting like any other purchaser, its ultimate aim, often the destruction of the community, is unlike that of most other buyers (Section 7.3).

Clearly the issue would be quite different in programs which seek to provide satisfactory alternative flood free accommodation, and in the case of compulsory acquisition, where the provision of sufficient funds for replacement accommodation is generally required by law.

8.6 PURCHASE MODE

8.6.1. Introduction

Control over floodplain land is obtained by acquiring full title
to the property (known as purchase in fee simple), or through the purchase of partial control by easements, development rights etc. As a general rule only purchase of full title can be recommended.

A number of procedures exist, apart from the normal real estate transaction, for effecting the transfer of land to government. Some of these approaches may reduce the costs of the purchase, or increase public acceptance of acquisition by easing the burden on relocatees. The main procedures are discussed below. Other approaches, less likely to find wide applicability in Australia, are examined in Half M. Field (1981).

8.6.2 Subdivision Dedication Requirements

Developers of new subdivisions are generally required to set aside a certain percentage of their land for open space and recreation purposes. According to the jurisdiction either the developer or community may retain title. When part of the land is in a flood risk zone it may be possible to require the dedication of the flood prone area, thus flood-prone land may be acquired at no economic cost. Where a large proportion of the land is involved it may still be possible to effect a transfer of the flood-prone area in exchange for permission to develop the remainder to a higher density, e.g. flats instead of detached dwellings, which also has the advantage of maintaining the rate (local land tax) revenue. This approach has been used extensively in Toronto where it has been quite successful in preserving flood prone land as open space. Lismore City Council has also employed the technique recently, though there generally the whole subdivision has been flood prone, and it has been a case of restricting the extent of development in an area that originally should probably never have been developed.

In areas where redevelopment is occurring opportunities may exist for converting land to open space by applying dedication requirements to redevelopment proposals.

8.6.3 Easements

Easements represent another potential cost-saving approach. "An easement is a right to use land for a particular purpose", e.g. access,
utility corridors, or it may prohibit the "landowner from doing something" (Hale M. Field, 1981). It may be forever or for a set term. In theory easements may be used to preserve property in its natural state or to limit the use to be made of the land. However, in practice attempts to control land use through easements of this type have not been very successful in North America (Kusler, 1979; Wright and Webber, 1978), and were not mentioned as a viable alternative by Australian officials. Purchase of an easement rather than full title often does not represent a substantial saving, and owners frequently violate the easement restrictions creating enforcement problems (Kusler, 1979).

8.6.4 Exchange of Property

It may be possible to acquire flood prone land by exchanging it for publicly owned flood free property. Though this approach involves little immediate financial outlay by the acquisition authority, there are obvious losses in simply exchanging a block of valuable flood-free land for a block with virtually no urban value. To offset such losses it may be worth considering a leasing arrangement or a long term purchase plan tailored to the relocatees' ability to pay.

Exchange of property includes residents who want to move but do not...

| Table 8.1 Acceptability of the relocation incentive: A block of "flood free land and your present house moved there" (Q20, Appendix B). |
|-----------------+---------------+-------+------|
| ACCEPTABILITY   | Number in Sample | Unacceptable | Unsure | Acceptable |
| North Wagga     | 168           | 73.5       | 10    | 16.5       |
| Echuca West     | 16            | 68.8       | 0     | 31.2       |
| Lismore Acquisition | 95         | 34.8       | 16.8  | 48.4       |
| Floodplain Control | 45         | 6.7        | 11.1  | 82.2       |
| Flood free      | 52            | 23.1       | 13.5  | 63.4       |
not have the necessary resources (Section 6.3), and where it is feasible to relocate their dwellings; i.e. the houses are wooden and land is available. Various arrangements are possible: the relocatees may simply receive a flood free building site in exchange for their old block and be responsible for moving their dwelling. Alternatively the responsible agency may undertake to relocate the structure. This approach is being considered in Lismore and has been successfully used in Albert Lea, Minnesota (Minnesota Department of Natural Resources, 1980). Interviewee responses suggest that many people in Lismore, at least, would find this option quite acceptable (Table 8.1).

8.6.5 Purchase and Leaseback

Under this procedure the acquisition agency purchases the property and receives title to the land, which is then leased back to the owner for specified purposes and period. The owner receives the purchase price immediately but has continued use of the land. According to the agreement rent and rates may have to be paid by the leasee. The draft regulations dealing with U.S. federal implementation of non-structural alternatives state that where relocation is recommended home owners may elect to live in their houses for up to 15 years under a leaseback arrangement. However, all other benefits under the various federal flood damage assistance and relocation acts are forfeited (Ingram, 1976).

A variation of this approach, known as purchase subject to life estate, gives the owner lifetime use and possession of the land. Thus for example, elderly people who do not want to face relocation may obtain some financial benefit from the sale of their property, yet continue to live in familiar surroundings while the acquisition agency has title and ultimate control over the land. This "life estate" approach has been used extensively by the U.S. Park Service to reduce overall costs and landowner objections to compulsory acquisition (Kusler, 1979).

8.7 MAINTENANCE OF PUBLIC UTILITIES TO THE AREA BEING ACQUIRED

The maintenance of public utilities to scattered properties in an acquisition area may add significantly to the costs of the scheme. This is
because utilities are being maintained for a decreasing number of rate paying properties as acquisition progresses. The loss of rate payers from an acquisition area is not itself an argument against the strategy, as these people will most probably occupy property with much higher rates elsewhere in the municipality. In fact the Echuca City Council expects to substantially raise its minimum rate, and thereby increase overall rate revenue, once acquisition of Echuca West is more or less complete. The Council is reluctant to raise the minimum rate at present because of the low level of services provided to Echuca West (McCartney, 1981-1).

A situation could arise, for example, where full urban services including water, sewer, road, power and street lighting were being maintained for one dwelling in the centre of an acquired area. This issue concerned both officials and residents alike. Officials recognised the potential problem but at this stage were quite positive that services would be maintained, "I'm certain there will be no drop off in services" (Barlow, 1980/81-1), though some foresaw the day when this policy could be reviewed. A number of residents, particularly in Echuca West, commented that they would have to move eventually as services would be cut off when their neighbours sold out to the scheme.

Just how serious a problem is this? Maintenance of services has certainly been a major problem with Toronto's floodplain acquisition scheme. However, most of this may be ascribed to peculiar local circumstances: the location of dwellings in almost inaccessible ravines, and the cost of snowploughing in the different terrain (Toronto Star 2/11/59).

There are no local data of the sort required to answer the question definitively, but maintenance of services is unlikely to be a major problem in Australian acquisition schemes for the following reasons:

(i) The level of services is quite low in all three study sites. Only in the Lismore acquisition areas which were all sewered was the service provision remotely comparable to that in the rest of the city. Echuca West by contrast has no sewers or drainage systems, minimal street lighting, and only gravel and earth roads. Evidently the cost of maintaining the standard of service would be small.
(ii) In areas where a higher standard is provided services could be continued at a lower level or even, in the case of roads and drainage, be allowed to fall into disrepair. In some circumstances the remaining householders could be invited to pay higher rates or to otherwise contribute to costs in return for the continued maintenance of certain services, in particular, roads, street lighting, storm water sewers and garbage collection.

(iii) Some acquisition areas by their shape and location may require little beyond house connections for public utilities, for example the Victoria, Parkes and Little Keen Street areas of Lismore.

(iv) Finally it may be desirable to keep some services on site for the post acquisition use. If the area is to be developed as parkland and used for recreation, access roads, water supply, and electric power may be necessary. A clear plan for post acquisition use would make it possible to decide what and where to maintain.

8.8 TREATMENT OF HISTORIC BUILDINGS

The initial development of settlements in Australia and elsewhere was frequently along watercourses (Section 1.2). Thus for many towns the riverbank and floodplain development often represent the most historical and architecturally interesting part of town, and in some instances may seem to embody "the whole heritage and history of the community" (Mitchell, 1980-I). A substantial building with a national trust classification is located on the fringe of one of Lismore's priority acquisition areas. The structure is currently used for doctors' surgeries, and it will probably be excluded from the acquisition program.

More intractable problems have occurred in floodplain acquisition programs in Ontario, Canada. One example will illustrate the issues. Following severe flooding in 1974 the Grand River Conservation Authority accelerated its floodplain acquisition program, buying up properties in a number of communities as they came onto the market. Trouble began in 1979 when the Local Architectural Conservation Advisory Committee (the LACAC, a voluntary local group) tried to block the Authority's plans to demolish the acquired buildings. The LACAC submitted that 11 of the 47 buildings scheduled for demolition had to be preserved. After negotiations the Conservation Authority agreed to leave only two of the structures, to the

As most floodplain acquisition schemes in Australia will be dealing with areas subject to frequent severe flooding, rather than areas which are simply flood prone, the issue of historically valuable buildings is unlikely to arise very often. Nevertheless, there is growing community concern and interest in the national heritage and planners can expect to have to increasingly confront these issues. "These buildings were just old dumps ten years ago...now, apparently, they are of some historical value!" (Watson 1980-I).

Voluntary Australian programs should be able to avoid the conflicts that have occurred in Ontario by identifying buildings of potential historical or architectural merit early in the planning process, and excluding these from the program. Where such a structure must be, or is inadvertently acquired, it should if possible be incorporated into the post acquisition land use scheme. This approach has worked reasonably well in Toronto (Prince, 1980-I). Cost saving measures may include the use of the local historical society for maintenance and administration of the structure.

8.9 FUNDING

Some acquisition schemes have been funded entirely from local sources. Naturally this severely limits scheme scope, and speed of implementation. The present trend towards cost sharing between the three levels of government, with 20% local and 40% each from the state and federal authorities, is a rather more realistic arrangement. This is all the more welcome as it has been explicitly extended to land use management adjustments, including acquisition. For example, the additional one million dollars the NSW government is adding to its annual flood mitigation budget is to be used primarily for such measures.

As most acquisition programs run over a number of years continuity of funding is essential (Ralf M. Field, 1981). This has not been the case in the past, and Echuca West is the only study site where funding of the
entire ten year acquisition program is guaranteed. In contrast funding of
the Lismore scheme has been on an ad hoc annual basis with approval being
necessary for each structure purchased.

Funding uncertainty for either reason reduces confidence in the
program among government officials and members of the public, and may make
it more difficult for state authorities to convince councils of the
viability of acquisition.

8.10 POST ACQUISITION LAND USE

8.10.1 Introduction

As floodplain acquisition is often employed to preserve open
space, it comes as no surprise that post acquisition use especially
recreation, is a frequent major justification for acquisition. In fact the
Victorian Government interviewees emphasised the need to find reasons other
than flood damage reduction to justify acquisition.

With respect to the use of high flood risk areas, this section
examines the relevant literature, interviews with officials implementing
acquisition programs, and ordinary citizens. The section concludes by
recommending appropriate land uses.

While the degree of sophistication and the approaches used to
delineate high risk vary considerably there is general support for open
space uses in high flood risk situations.

8.10.2 Literature

Existing land use in high flood risk areas frequently leaves a lot
to be desired. Much of this development not only carries a high damage
potential, but a significant risk to human life. Thus flood compatible
land uses will not be found by a general examination of the present
situation. Instead a selective examination of the literature, legislation
and the few comprehensive post acquisition plans illustrates the ideal.
This examination is presented as part of Table 8.4 "Appropriate land uses in high flood risk areas". (The Table is found at the end of the Chapter).

The major difference between the ideal prescribed in the research literature and legislation, and that articulated by state and local officials, concerns the degree of acceptable risk. Parts, at least, of the developed acquisition areas under study flood every few years. In contrast, areas suggested for open space regulations in the literature variously extend up to the 1:75 flood line (Williamson, 1975); whichever is the greater of the 1:100 flood and Regional Storm (Ontario-MTHCA, 1980(a)); to all areas where during the 1:100 flood the water is over 0.5m deep or flows at more than 1 metre per second (Victorian WRC, 1978); or to the most risky 10% of the municipality (Foster, 1980); and so on as set out in Table 8.4.

8.10.3 Views of Officials and Floodplain Residents

It is notable that in all three case study sites no clear plan for post acquisition land use existed at the time of the field work. As already discussed in Chapter 7 this situation is likely to increase opposition to acquisition, because inevitably some residents believe that Council intends to redevelop the area at a profit. It is indeed unfortunate that apparent inconsistencies by Councils will occasionally fuel such speculation.

Recent residential development in East Echuca at elevations equivalent to the higher parts of Echuca West has left a number of Western residents feeling that their area has been "singled out" unfairly for acquisition, and a few state that it is a "con by Council". This latter view is also held by a very small percentage of Lismore acquisition area residents. There, new industrial and residential development is occurring adjacent to properties being acquired, and while most people recognise that property purchase schemes should logically concentrate on the worst areas many are naturally concerned about the continuing development in adjoining flood prone areas. This development is such that the overall damage potential is rising steeply in Lismore despite clearance of certain areas (Figure 2.2). Clearly the development undermines the credibility of the
acquisition program and underscores the need for a comprehensive floodplain management plan incorporating hazard considerations. In response to criticism by residents officials stressed the voluntary nature of the schemes (see Section 7.3).

Lismore's floodplain management Strategy represents the beginnings of a plan, though in all probability it comes a few years too late as much of the floodplain is already developed. In some respects Wagga presents a similar story. Although no further residential development has occurred in the unleveed floodplain since the 1950s, there has been considerable industrial development of flood-prone areas and commercial redevelopment behind the main city levee. The redevelopment of the business district in the absence of flood proofing regulations or emergency plans results in an increasing disaster potential.

Officials

In this context the question of appropriate floodplain land use seems irrelevant - almost any use appears to have been permitted, at least up until the recent past. Furthermore, when interviewed officials had no clear idea of the eventual use of acquired land. This is not unexpected in view of the absence of formal plans. "We're getting rid of the houses - we don't want Council seen as the landlord of substandard housing - but the whole question of ultimate usage is in limbo and we haven't decided what to do. The state government and Council have to decide what to do with it and keep it tidy" (Crowther, 1980-1). The lack of certainty was typically justified by comments like..."we will leave the possible uses open...we don't want to discourage innovative thinking" (Hendley, 1980-1).

Uses felt to be appropriate fell into one of two broad categories: public open space and recreation; or agriculture, grazing and forestry. At the NSW government level the possibility of redevelopment for industry was suggested. Redevelopment was not mentioned by local officials, but recent actions by Lismore Council show some support for this approach (Sect 8.10).

Residents

Little support for the fill and redevelop option was expressed by
interviewees. Only some 10% of each sample (flood free, acquisition, etc) suggested this approach (Table 8.2). Actual support would probably be even lower as a few of these respondents saw such development as inevitable rather than desirable.

Open space uses were the overwhelming preference of all groups of interviewees, with parks or community use being suggested most often by the Lismore samples. Among the Echuca West respondents there was strong support for farming as a post acquisition use, probably because much of the land there is used for market gardening and grazing, and the area has a long market gardening history.

8.10.4 Open Space Maintenance

Officials were in general agreement that public open space in the form of parkland and passive recreation facilities was an appropriate post acquisition land use in urban areas. However, concern was expressed at the cost and other difficulties associated with extensive open space holdings. "We can't support large areas of parkland" (Crowther, 1981-1).

This has become of major importance in many large metropolitan areas like Sydney (Fitzhenry, 1980-1), and Toronto (Fine, 1980-1). On the other hand Bankstown municipality, which has acquired a considerable amount of flood-prone land since the 1950s, does not find maintenance a problem (Haddy, 1980-1). The level of maintenance and amenity provision is at issue here. Public open space may take the form of formal manicured gardens at one end of the cost scale, through to urban natural areas or revenue producing agistment paddocks at the other.

In Toronto, Ontario, and Milwaukee, Wisconsin, long established floodplain acquisition programs are integrated with park development plans (David, 1973; Ontario MTRCA, 1957(b)). From the beginning of the acquisition program in the 1950s detailed plans and goals "the public ownership of all valley land in Toronto"(Ontario MTRCA, 1959) were part of the Toronto scheme. Much of the purchased area has been landscaped and maintained as parkland by the municipality. The remainder has been kept in as natural a state as possible. Policing of these and adjacent flood prone areas has been greatly assisted by the activities and vigilence of the Toronto Field
Table 8.2  Post acquisition land use preferences of residents.  
Sum of 1st and 2nd suggestions from question 26 (Appendix B).  
Both frequencies (N) and percentages (%) are shown.

<table>
<thead>
<tr>
<th>Echuca West</th>
<th>Lismore</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acquisition</td>
<td>Floodplain Control</td>
<td>Flood Free</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% N</td>
<td>% N</td>
<td>% N</td>
<td>% N</td>
</tr>
<tr>
<td><strong>Public Open Space</strong></td>
<td>34.6 (18)</td>
<td>47.3 (80)</td>
<td>51.6 (32)</td>
<td>68.8 (44)</td>
</tr>
<tr>
<td>- parks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- recreation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- community use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Farming</strong></td>
<td>32.6 (17)</td>
<td>14.2 (24)</td>
<td>12.9 (8)</td>
<td>4.7 (3)</td>
</tr>
<tr>
<td>- market gardens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- grazing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- forestry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fill and Redevelop</strong></td>
<td>5.7 (3)</td>
<td>10.6 (18)</td>
<td>19.4 (12)</td>
<td>14 (9)</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>3.8 (2)</td>
<td>3.6 (6)</td>
<td>1.6 (1)</td>
<td>1.5 (1)</td>
</tr>
<tr>
<td><strong>Don't know</strong></td>
<td>23.0 (12)</td>
<td>24.3 (41)</td>
<td>14.5 (9)</td>
<td>10.9 (7)</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>100</td>
<td>52</td>
<td>100</td>
<td>169</td>
</tr>
</tbody>
</table>
Naturalists (Sane, 1980-I). Nevertheless, particularly in parklands serious problems are emerging in the form of vandalism and other crimes such as arson and the poaching of wildlife (Globe and Mail, 13/5/80).

Rising maintenance costs and increasing incidence of vandalism and other crimes may constitute a strong argument for greater use of urban natural areas, and private management. In many cases, especially on property located at the urban/rural fringe individuals may be able to profitably employ acquired land for a variety of flood compatible uses, and thus the land may actually contribute to the public purse, instead of simply being another drain.

8.10.5 Recommended Uses

Specific post-acquisition land uses must be established on a case-by-case basis. Ultimately the most appropriate use will be determined by constraints imposed by the physical environment, in particular flood warning times and land uses in adjacent areas.

A guiding principle for the type of land use planning recommended throughout this thesis, i.e. planning with a public safety emphasis, is that structures and activities should be located so that community vulnerability to both tangible and intangible flood damage does not increase. Certain works and activities may increase the potential for disaster simply by their existence or, in other cases by their unwise location on a floodplain. For example, as demonstrated in Chapter 3, some structural flood mitigation measures encourage further development by their presence, and thereby increase the damage potential and risk to life. The positioning of certain facilities and public utilities may similarly encourage undesirable development (Section 3.3.3.5). Worse, some establishments, as well as suffering flood damage themselves, may create additional hazards by their failure, examples include chemical factories, major regional communication and power centres, and disaster command posts. Such facilities should be located on the safest land available in the settlement. Information on the issue of land uses and activities appropriate for areas subject to different degrees of flood risk is presented in Figure 8.1. Further details may be found in Foster (1980), Williamson (1975) and in the other references accompanying Table 8.4.
Figure 8.1: Flood risk and appropriate land-use. Land-use zoning is based on the consequences of activity failure. Data from Foster (1980).

<table>
<thead>
<tr>
<th>Very Low Flood Risk</th>
<th>High Flood Risk</th>
<th>Low Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional communication centres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional power intertie systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disaster command posts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous activities such as chemical factories, nuclear power stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire and police services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospitals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical road links</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Courthouse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal government buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus and other transport stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursing homes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication and power networks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural gas, oil and sewer lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major local employers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensive grazing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extensive pastoral use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractive industries and facilities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Consequences of Activity Failure Increasingly Severe
Selection of appropriate use for acquired or any other areas subject to a high flood risk (as defined in Chapter 4) should be guided by the following criteria:

(i) The safety of the public and emergency service personnel is paramount (Chapter 4).

(ii) Nothing should be permitted that interferes or alters the natural function of the area in conveying flood water (Victorian WRC, 1978).

(iii) Given the above constraints the strategy that maximises the economic return on the public investment (Chapter 5).

Uses should be selected from those listed in Table 8.4. These fall into the general open space categories set out in Table 8.3, with the most preferred use being categories (i) and (ii) recreation and primary industry.

Table 8.3 Categories of Recommended Land Uses.

<table>
<thead>
<tr>
<th>(i) Open space recreation: e.g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- natural areas</td>
</tr>
<tr>
<td>- parks, golf courses, playing fields</td>
</tr>
<tr>
<td>- open air cinemas/drive-ins</td>
</tr>
<tr>
<td>(ii) Primary industry: e.g.</td>
</tr>
<tr>
<td>- grazing</td>
</tr>
<tr>
<td>- market gardening, forestry</td>
</tr>
<tr>
<td>- extractive industries</td>
</tr>
<tr>
<td>(iii) Commercial activities: e.g.</td>
</tr>
<tr>
<td>- parking areas</td>
</tr>
<tr>
<td>- car sales</td>
</tr>
<tr>
<td>(iv) Residential: e.g.</td>
</tr>
<tr>
<td>- lawns, gardens</td>
</tr>
<tr>
<td>- play areas</td>
</tr>
<tr>
<td>(v) Public utilities</td>
</tr>
</tbody>
</table>
8.11 MAINTAINING APPROPRIATE POST-ACQUISITION LAND USE

8.11.1 General

As governments acquire land to obtain complete development control, and/or to correct past development errors, it seems reasonable to expect that the post acquisition land use will be appropriate. However, effective long term land use management requires long term resolve and commitment to the objectives of the acquisition plan. The evidence suggests that local land use regulation frequently lacks such commitment (Section 3.3.3.4). To ensure continued appropriate use of high risk areas at least some control needs to be removed from the whims and policies of successive local councils. Although complete state control is not necessarily the answer either, as it is often politically unacceptable and may be prohibitively expensive to administer without local support, it has demonstrated its relative effectiveness in land use management (see Section 3.3.3.3).

8.11.2 The Case Study Sites

Some evidence for the inconsistencies and lack of political resolve in local government is available from the case study sites. Details of the Wagga and Echuca examples are found in Chapters 7.

8.11.2.1 Wagga

North Wagga, the acquisition area, was zoned non-urban lc in 1956. Existing development was subject to stringent nonconforming-use regulations and was to be bought up by Council as individual properties were offered for sale. However, since the rezoning successive councils have attempted to overturn the non-urban status and have sought structural protection for the village. If it were not for the fact that a change of zoning requires state government approval the acquisition scheme would not have lasted more than a few years, and only flooding (which did not occur in the 1960s) would have inhibited development.

8.11.2.2 Echuca

Echuca's acquisition program is very recent and in any case is under direct state government control. The City Council has come under
intense local pressure to alter the "flood-prone land" designation on its
draft planning scheme for some locations, but not Echuca West, the area
being acquired.

8.11.2.3 Lismore

At the commencement of the acquisition program no formal binding
agreement concerning the development of acquired land existed between
Council and the state government. There was simply a council resolution
not to develop land purchased under the scheme. There was "really nothing
to prevent council going back on its word, though it would be very dirty if
they did" (Wade, 1981-I). Early in 1981 a formal contract was drawn up
between the two parties. This document binds future councils and specifies
that the acquired land will be used only for flood amenable purposes. The
Public Works Department may decide what constitutes a flood amenable
purpose.

As a result, preventing inappropriate development is "No problem"
according to some Lismore officials, because the whole state government
subsidy is dependant on no redevelopment. In the terms of the agreement
the subsidy is provided on the condition that the ultimate use is non-
urban" (Barlow 1980-I) (The state and federal governments provide 80% of
acquisition costs).

Nevertheless, commitment by council to the intent of the agreement
has on occasions been ambivalent. Early in 1981 Mobil Oil Limited applied
for permission to establish an LPG filling depot on low lying land (8-9m
AHD) in North Lismore. Apart from the fact that the area was zoned
"residential" and would have had to be rezoned to "hazardous and offensive
industries", part of the proposed site had been bought by council under the
acquisition scheme. Initially Lismore Council supported the development
application and applied to have the site rezoned arguing that the LPG depot
"was an acceptable type of development for flood prone land" (Northern Star
6/3/81). Just why Mobil Oil was interested in establishing a depot on a
site with a 1:4 flood risk is itself puzzling, and the weight of informed
opinion is that such uses are not suited to high flood risk areas (see
Section 8.10.5). The NSW government, through the District Public Works
Department office, vigorously and successfully opposed the application.
8.11.3 State Control

Ultimate land use management authority in Australia is generally vested in the State Governments. This authority is employed to varying degrees in the study sites to ensure appropriate land use. State planning schemes, (Environmental Planning Instruments in NSW) subdivision and rezoning regulations apply to all sites, and are the only state level land management devices employed in North Wagga. Direct state government control is used in Echuca West where title to acquired land is held by the crown, while a formal agreement is relied on for Lismore.

Unfortunately, even direct state control is no guarantee of a satisfactory long term situation - although such controls are the best available (Section 3.3.3.3). To illustrate the potential problems overseas experiences are drawn upon.

Certain levels and divisions of government may be largely beyond the control of the responsible state agency. Federal organisations and public utilities in particular have wide powers. Their exemption from local land use regulations is discussed in Chapter 3. In Toronto ravine and valleylands acquired as part of the Plan for Flood Control (Ontario, MTRCA, 1959), have been used extensively as corridors for roads, electric power and other utilities (Fine, 1980-1), thus increasing the flood damage potential. In addition these uses are largely incompatible with linear park and urban natural area concepts.

The successful implementation of state-supported acquisition schemes frequently requires strong leadership and sustained political and administrative commitment. When this lapses inappropriate development may occur. Two Canadian examples follow. Part of the Ontario Science Center, a large, modern museum of science and technology, is constructed on flood prone land originally acquired for open space. The second example also illustrates a weakness in formal agreements. Floodplain land acquired in 1956 in Bridgeport (now part of Kitchener), Ontario, was handed over to the municipality on the condition that it remain as open space. However, a community center was constructed on the area when the Provincial-Local agreement was nullified in the late 1960s (Mitchell et al 1978). This development was severely flooded in 1974.
8.11.4 **Ensuring Appropriate Land-Use**

8.11.4.1 **Rezoning and Land Title**

The land to be acquired should be rezoned as open-space, or non-urban, and existing development treated as a non-conforming use. The most effective control occurs where scheme administration is a state responsibility and **title to acquired land is vested in the crown**. Under Victorian law an area may be Proclaimed "flood prone" and development control and title to acquired land assumed by the drainage authority, a state instrumentality. This is the situation in Echuca West. In NSW, flood prone land may be placed under direct state planning control through the Coastal Protection Act (1979), though this is more in the form of a punitive measure (Section 3.3.4.7). Also in NSW title to acquired land is retained by local government. In this context it is worth noting that for acquisition undertaken as part of the U.S. flood insurance scheme (Section 5.3.2.5) property titles are held jointly by local and federal governments. Should the local council permit inappropriate development title becomes the sole property of the federal government.

8.11.4.2 **Reservation of Land to be Acquired**

The land scheduled for acquisition may be reserved in a Planning Scheme as "open space, a public place or public reserve" or for some other public purpose which effectively prevents private development. Planning Schemes may not be varied without State government approval. Under the NSW Environmental Planning and Assessment Act (1979) and the Victorian Town and Country Planning Act (1944) local governments must make provision for the eventual acquisition of reserved land.

8.11.4.3 **Minimal Regulation**

The land to be acquired may be subject to little in the way of development controls except perhaps a prohibition on new subdivisions and restrictions on building permits. After a substantial contiguous area has come into public ownership the area may be rezoned. Although state governments may disallow new subdivisions, under the procedure there is little to stop the local council redeveloping land in ways incompatible with the flood risk, unless some form of contract exists between the state and local governments. This is the situation in Lismore.
8.11.4.4 Sale or Lease of Acquired Land

Once acquired and rezoned the land may be sold or leased to private interests. (Purchase and leaseback to the original property owners is discussed above in Section 8.6.5). Where the land is well suited to agriculture or certain recreational activities this approach may be an effective way of reducing costs, although over the long term land use control problems may be greater especially if there is a long flood free period. Where feasible, privately run nature reserves may help to offset land purchase expenses, and minimise post acquisition land use problems. Nature groups in Toronto, Ontario, have been quite aggressive in reporting land use violations on both public and private land to the local floodplain management authority (Sane, 1980-1).

8.11.5 Guidelines

The possibility of inappropriate development of acquired land always exists, especially when there are lengthy flood free periods. To minimise this possibility the land should be rezoned as open space or some non urban use (Section 8.10.5). Rezoning should occur at the commencement of the acquisition program to demonstrate and ensure commitment to the scheme objectives, and to prevent new development increasing the costs and difficulties of program implementation. The stability of the new zones is enhanced if they are part of an overall floodplain management plan specifying clear post acquisition uses. In the absence of a properly enforced comprehensive plan new development may occur in flood prone areas adjacent to those being acquired, thereby reducing local confidence in the real aims of the scheme. Ideally to further insulate the land from local politics title should be held by the crown. In some circumstances sale or lease of the land for agricultural or recreational uses may serve the purposes of offsetting purchase and maintenance costs, and of maintaining a flood compatible use. Though this approach may seem very attractive care must be exercised to ensure that future land use problems do not arise.
Table 8.4 Land Uses Appropriate in Areas Subject to a High Flood Risk

<table>
<thead>
<tr>
<th>DEFINITION OF HIGH RISK</th>
<th>USES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Foster, 1981).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The 10% of the municipality's area carrying the greatest risk.</td>
<td>Ideally open space, recreation, farming. Development having strong locational requirements and providing substantial benefit such as extrac-tive industries and related industry e.g. port facilities.</td>
<td>The safest 5% of the municipality's area should be reserved for certain activities. These include communication centres, regional power substations, disaster control centres, chemical factories and nuclear power plants. Uses that should avoid high risk zones include, hospitals, fire and police services, and water supply systems.</td>
</tr>
</tbody>
</table>

Australian Department of Housing and Construction (Williamson, 1975)

<table>
<thead>
<tr>
<th>Prohibitive (1:10 flood):</th>
<th>No obstructions to the free flow of water.</th>
<th>Suggests that political and socio-economic considerations are most important. Clearly the suggested zoning is particularly restrictive.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The zone should be large enough to accommodate storm drainage increase caused by urban growth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restrictive (1:30 up to 1:75)</td>
<td>Ideally open space: car park, car sales, forestry, open-air cinemas, passive recreation, railway.</td>
<td></td>
</tr>
</tbody>
</table>
Table 8.4 con't

<table>
<thead>
<tr>
<th>DEFINITION OF USES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH RISK</td>
<td></td>
</tr>
</tbody>
</table>

**American Society of Planning Officials**  
(Kusler & Lee, 1972)

Floodway defined by afflux (0.5-1.0 foot for a 1:100 flood discharge).  
(Defined in Section 4. ).

"No use that shall obstruct the channel, or floodways of any tributary to the main stream, drainage ditch, or any other drainage facility or system".

**Permitted uses:**  
"Agricultural uses such as general farming, pasture, grazing, outdoor plant nurseries, horticulture, viticulture, truck farming, forestry, sod farming, and wild-crop harvesting. Industrial-commercial uses such as loading areas, parking areas, airport landing strips. Private and public recreational uses such as golf courses, tennis courts, driving ranges, archery ranges, picnic grounds, boat-launching ramps, swimming areas, parks, wildlife and nature preserves, game farms, fish hatcheries, shooting preserves, target ranges, trap and skeet ranges, hunting and fishing areas, hiking and horseback riding trails. Residential uses such as lawns, gardens, parking areas, and play areas."  
(p.47).

**Special permit uses:**  
Uses or structures accessory to open space or Special-Permit Uses. Circuses, carnivals, and

Flood fringe area:  
flood water is shallow and slow moving

Flood free area:  
in some areas basements outside the flood-fringe flood due to seepage. In such situations it is suggested that regulations governing basement construction be extended beyond the floodplain.
Table 8.4 con't

<table>
<thead>
<tr>
<th>DEFINITION OF USES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH RISK</td>
<td></td>
</tr>
</tbody>
</table>

American Society of Planning Officials con't
(Kusler & Lee, 1972)

- High risk uses (Kusler & Lee, 1972) *
  - amusement enterprises.
  - Drive-in theaters, new-and-used-car lots, roadside stands, signs and billboards.
  - Extraction of sand, gravel, and other materials.
  - Marinas, boat rentals, docks, piers, wharves.
  - Railways, streets, bridges, utility transmission lines, and pipe lines.
  - Storage yards for equipment, machinery, or materials.
  - Kennels and stables. Other similar uses (p.48).

LEGISLATION/POLICY

Toronto, Cananda,
(Ontario MTRCA, 1980(a))

<table>
<thead>
<tr>
<th>Areas within the Regional Storm or 1:100 flood whichever is greater.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general risk of flooding should not be greater than 50% over next 100 years. Areas of shallow backwater flooding may be subject to different regulations.</td>
</tr>
<tr>
<td>Undeveloped Areas</td>
</tr>
<tr>
<td>&quot;Activities which do not alter the flood plain contours and do not interfere with its natural function&quot;</td>
</tr>
<tr>
<td>Structures associated with these activities and parking lots should be located outside the 1:100 flood plain.</td>
</tr>
<tr>
<td>- agriculture, outdoor recreation/open space, garden, nurseries, arboretums and other similar uses.</td>
</tr>
<tr>
<td>- public utilities, sewers, natural gas/oil pipes, power corridors, transportation links.</td>
</tr>
<tr>
<td>- bridge or structural abutments should be located outside the floodplain.</td>
</tr>
<tr>
<td>- all associated structures must be flood proofed to the standards below.</td>
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Table 8.4 con't

<table>
<thead>
<tr>
<th>DEFINITION OF USES</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>HIGH RISK</td>
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Toronto, Canada, (MTRCA, 1980(a))

Infilling is permitted provided
- all new structures or buildings must be protected so that the risk of experiencing a 1:100 flood is less than 25% over the entire structure life (usually taken as 100 years)
- no development, redevelopment, or additions where the flow is deep and velocity high.

Wagga Wagga, NSW
(City of Wagga Wagga Planning Scheme, 1965)

North Wagga and surrounds
Land uses permitted in most of the North Wagga area.
"Agriculture; forestry; extractive industries; roads; drainage; non-residential clubs; road transport terminals."

Existing Use
existing development is treated as nonconforming use.

Ultimate Control Mechanism
Area is zoned non-urban Ic in the Planning Scheme. Only the above uses are permitted unless the zoning is varied with the Minister's approval.

Victoria
(Victoria-Water Resources Council, 1978)

Afflux, restrictive uses may be applied to the whole floodplain ie 1:100 of maximums historic flood.
The flood fringe may be exempt ie water depth <0.5m, velocity _1m/s.
- public utilities, (below ground); roads, rail and above ground transmission lines
- clear spanning the proclaimed area.
- agricultural uses, including nurseries and forests
- passive recreation uses/open space.

"On no account shall the primary function of the area for the passage of flood waters be subordinated to the above permitted uses unless appropriate compensatory measures are taken" (p.40).
- any existing structures may be permitted at the discretion of the flood plain management authority.
Table 8.4 con't

<table>
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<tr>
<th>DEFINITION OF HIGH RISK</th>
<th>USES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A. (Federal Register, 1980)</td>
<td>Permitted uses of land acquired under Section 1362 of the U.S. National Flood Insurance Act (1968) &quot;Outdoor recreation activities, nature reserves, cultivation, grazing, camping (except where adequate warning time is not available to allow evacuation), temporary storage in the open of wheeled vehicles which are easily movable (except mobile homes), unimproved parking lots, buffer zones or (planned) open space areas...&quot; (p.50283) &quot;Structures functionally related to these uses are open-sided picnic and camping facilities, kiosks, and refreshment stands of non-habitable, elevated or floodproofed service structure associated with a marina...Any structures...shall be floodproofed or elevated to withstand the effects of the 500 year or .02 percent chance flood&quot; (p.50283).</td>
<td>Ultimate Control Mechanism Land title, vested in the local community, is subject to &quot;restrictive covenants, conditions and agreements violation of which may cause the title to revert to the Federal Government&quot; (FEMA).</td>
</tr>
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CHAPTER 9

CONCLUSIONS

9.1 INTRODUCTION

Following the traditions of geographic hazards research, this document has a strong applied orientation. Most effort has gone into producing guidelines for policy development and implementation. The conclusions reflect this emphasis. Some theoretical points were also investigated during the study. These are the subject of comment in Section 9.4. Separate observations are also made regarding the implications of the research for the three study sites.

That acquisition has a viable and important role to play in flood damage reduction is clear from its past use, a study of its relationship with different flood strategies and its other characteristics. Historically the measure has found most use after major flood disasters. Occasionally it has also been employed to provide recreation and environmental benefits in the form of open space and the preservation of wetlands and natural floodplain storage. Additional long term advantages of acquisition include the virtual elimination of urban flood damages, the avoidance of an irreversible commitment of resources, and the potential economic use of floodplains for agriculture and sand and gravel mining.

Just what this role is, or more specifically in a geographical context, where and how acquisition should be applied, has been the subject of this inquiry. Criteria have been established for the selection of areas for acquisition, or prohibitive zoning if undeveloped, and guidelines have been developed to improve implementation prospects. These are reviewed below, and are summarised in Figures 9.1 and 9.2, where the information is presented in modified decision tree form. The review is in terms of the broad policy objectives identified in Chapter 1.

The author acknowledges that the decision to acquire will probably always remain political, but presents specific criteria with the hope that they may prove useful to policy makers. Quantitative criteria are designed to be applied in a consistent manner from site to site, and would ideally
largely remove from the local political process decisions regarding the use of land subject to high flood risk.

Before presenting the guidelines the limitations to the study should be restated. First, the geographic distribution of the study sites is such that direct generalization of results is limited to non-metropolitan urban areas, in particular those in NSW and Victoria. Second, although the three acquisition schemes vary they possess certain major similarities which again act to limit the scope of the study: the schemes are voluntary, and are concerned with residential areas.

9.2 POLICY GUIDELINES: ACQUISITION CRITERIA AND IMPLEMENTATION RECOMMENDATIONS

9.2.1 Quantitative Criteria for Acquisition
9.2.1.1 Legal Requirements

Regardless of other policy objectives, mandatory legal requirements must be satisfied. State and federal governments can override existing laws by using their legislative power. Local governments are not in this position, though they may attempt to evade their obligations. Although the law is not entirely clear, it appears that the only circumstance where a government authority would be legally obliged to acquire land is where the land is reserved in a planning scheme. Typically land is reserved for public purposes such as access, open space, recreation, cemeteries and so on. Where the owner of reserved land so desires, public authorities must be prepared to acquire the property as compensation for the development restrictions.

Other circumstances exist where acquisition may be required by law or by government policy. As far as floodplains are concerned these circumstances occur when effectively all economic land uses are prohibited or where existing-use rights are very limited. For example, when zoning is downgraded, or when a development application consistent with the zoning is refused. It is now NSW government policy to purchase certain urban land which is under stringent flood-related land use restrictions. However, in general local governments are under no legal obligation to compensate landowners for floodplain development restrictions.
9.2.1.2 Public Safety

A fundamental theme of this study is concern with public safety and intangible costs and benefits. This reflects an increasing community and political concern with social issues. Also the main thrust and justification for non-structural flood damage reduction measures is public safety, unlike structural flood adjustments which are usually assessed on an economic basis. It is further emphasised that one of the highest priorities in land use planning should be to prevent community vulnerability to floods and other hazards from rising. In particular this applies to vulnerability to rare events beyond the design limits of most structural works. Such works may occasionally increase the vulnerability or damage potential from extreme events while actually reducing average annual damages.

Water Depth and Velocity

The recommended procedure is based on a model developed by Sinclair Knight and Partners and the NSW Public Works Department. In essence a flood depth of two metres is the survival limit of an average house. Velocity does not appear to be as important as depth where structures are concerned, though it may be critical when assessing the risk to residents and emergency service personnel. Furthermore, application in many areas is limited by lack of velocity data. Depths (and velocities) would normally be related to the 1:100 regulatory event, however the importance of considering the effects of the MPF is emphasised. Areas delimited by the criteria should be acquired or left undeveloped.

Flood Warning Time and Isolation

Areas with less than 6 hours flood warning time for the regulatory flood should not be used for residential development, neither should locations with a high risk of isolation during floods. Particularly dangerous are islands of low relief. The residential development of such locations can only be seen as an extraordinary abrogation of responsibility by planning authorities.

Human Occupance

The risk to life and property is increased substantially if the areas defined by the physical criteria contain relatively high proportions
Figure 9.1: Criteria for the decision to acquire.
of people who lack the material and human resources necessary to cope with severe flooding: the elderly or handicapped, single parents with young children, or transients who would normally lack local flood experience. This is particularly the case where warning times are limited.

9.2.1.3 Economic Efficiency

The economic criterion for acquisition is expressed in terms of flood probability: dwellings with floor levels lying below the 1:5 flood level should be acquired. This figure was arrived at through a benefit-cost analysis using Lismore data, and is in close agreement with North American work. When the analysis is subject to sensitivity tests the floor level below which acquisition is economically feasible varies from the 1:4 to 1:8 flood height. This variance is not considered excessive for two reasons. First, the discount rate was halved in the sensitivity analysis, and second, the results are virtually identical to those of US studies employing different methodologies.

Despite the apparent insensitivity of the results it is important to appreciate the underlying assumptions. The most basic are the definition of economic efficiency; and the methods used to calculate the flood damages avoided, which constitute the benefits of acquisition. Economic efficiency is assessed by comparing local costs and benefits, these are treated in isolation from the Australian economy. This approach is similar to that followed in most Australian and US flood studies.

The recommended procedures for flood damage assessment were developed by the author in conjunction with D.I. Smith, T. Lustig, and Sinclair, Knight and Partners. The procedures use a synthetic approach, rather than a structure by structure survey of historical flood damages. Standard procedures are presented for assessing both the potential tangible and intangible forms of damage. Potential damage refers to the probable loss if no mitigating action is taken. The single most important factor influencing the effectiveness of mitigating action is preparedness, which in turn is closely related to flood experience. In the cost-benefit analysis used to arrive at the 1:5 criterion, the estimated potential tangible damage was halved on the assumption that the community would be very experienced and well prepared for floods. Other assumptions are: the
absence of intangible costs or benefits from the calculations, the use of a 10% discount rate, and that the dwelling would be purchased and demolished rather than relocated.

In a community as prepared for flooding as Lismore, intangible damages, apart from the safety issues, were found to be quite small compared to dollar losses. It was felt that the intangible costs of moving could well have outweighed those associated with floods, at least in the short term. For these reasons intangibles were not included in the formal calculations. On the other hand, communities with little flood experience would sustain substantial intangible losses which might influence the outcome of benefit-cost or other analyses.

All these assumptions work to make the economic criterion more conservative. Under quite plausible circumstances the acquisition limit would be at a much higher level than the 1:5 flood. For example, if dwellings are to be relocated rather than demolished the acquisition limit approximates the 1:8 flood.

9.2.2 Qualitative Criteria for Acquisition

In terms of the present study, social factors, in particular that of social equity, should be given greatest weight. It is just these issues that have in the past been ignored in flood damage reduction policy development and implementation. To be successful, voluntary non-structural measures, such as the acquisition programs under consideration, require the cooperation of those they seek to help. It is therefore essential that some local support exists for voluntary acquisition.

Acquisition programs may be instigated to satisfy a number of social welfare objectives. Apart from the safety criteria discussed above, there may be: a genuine desire to help people seen as trapped in high risk areas by low property values; a feeling that it is immoral to severely restrict land use without some form of compensation, such as acquisition; and a need for acquisition as an essential complement to other government programs. Typical programs in this category include riverside park or public access creation, slum clearance or redevelopment schemes, schemes designed to provide improved housing for disadvantaged groups, and
environmentally based programs such as the preservation of natural flood-
plain storage or wetlands.

The ultimate use of acquired land for some of these purposes has
been widely employed to justify floodplain property purchase in the US and
underlies the original Lismore program. Occasionally it is felt that a
severely flood prone residential area would have greater value as a park or
for some other public purpose. All areas reserved on planning schemes
fall into this category. Though park creation etc. may be advanced as
reasons for acquisition, in some cases the authorities may simply want to
remove development perceived as an eyesore.

Concern over public safety and the political need for action
underlie acquisition in the immediate post disaster phase. The key to
successful program development here is similar to that under the social
welfare objective, public support for acquisition. Timing is critical to
achieving and maintaining support: the program must be implemented before
rebuilding commences and while the disaster is still fresh in people's
minds. To assist rapid implementation consideration should be given to
preparing contingency plans for the acquisition of potential disaster
sites.

One of the most common reasons for acquisition is the desire to
eliminate repeated aid payouts or the disruption associated with frequent
flooding. These were the reasons advanced for the Echuca West program. In
the US a number of communities have requested acquisition as the only
viable solution to their chronic flood problems. Also in the US,
government authorities have initiated acquisition in communities where
flood insurance payouts have exceeded or approached the value of the
insured property. Under the insurance scheme circumstances the US
procedures are also satisfying an economic efficiency objective.

9.2.3 Recommendations to Ease Implementation of Acquisition
9.2.3.1 Adoption of Innovation by Local Government

Greatest resistance to new policy or programs generally occurs
when they are seen as new and non-incremental or revolutionary in nature
(Pressman and Wildavsky, 1973). Unfortunately, even though many non-
structural flood damage reduction measures have been well established in some jurisdictions and in the research literature for decades, their effective and widespread implementation is generally seen as novel. The following discussion is summarised by Figure 9.2.

**Government**

Support for flood related land-use management programs by local and state government instrumentalities is dependent on local community support, or an otherwise attractive political and administrative environment. Factors important historically in creating an environment hostile to the implementation of land-use measures have been identified. Today, the situation appears very positive. Many states and the Commonwealth have announced policies which emphasise the role of non-structural measures, and these are being implemented through the provision of enabling legislation and funds. However, some problems remain: funding needs to be made available on a sustained basis for programs rather than simply for individual projects. Many of the relevant organisations have a strong "construction" mentality, and much legal uncertainty remains. Higgins and Robinson (1981) suggest that lack of technical knowledge and expertise may be important, leading for example to an inability to produce local flood maps. While this has probably been a significant limitation in many areas, it is a poor excuse for inaction in locations where sophisticated delineation procedures are not needed to establish that a serious flood risk exists.

**The Community**

Often working against the adoption of land use measures, including acquisition, are those who perceive personal losses from the schemes. These individuals or groups oppose acquisition because of their land and business interests, because they are attached to the community and fear its destruction, or because they believe that they will be forced into accommodation they cannot afford. Businesses tend to oppose land use management and support structural works, largely because the former measure restricts development, while the latter permits and indeed encourages floodplain encroachment.

Local councils are very sensitive to pressure, especially that coming from development interests or large identifiable sectors of their
electorates. Ability to resist such pressures is related to, among other things, the rate of growth of the local area, perceived prospects for the development to go elsewhere, perceived severity of the flood risk, and the compatibility of the proposed land use measure with existing flood adjustments. Local governments frequently find it simple and expedient to be directed by state agencies on questions of hazard land use. Council is then implementing state policy, rather than manufacturing its own. Alternatively the state government may elect to administer hazardous land directly, bypassing local councils. This effective procedure is being used in Victoria.

9.2.3.2 Attitude to Acquisition by Potential Relocatees

The implementing authority can expect the support of the local community when residents believe they will personally benefit from acquisition. This was found to be the most important questionnaire factor in scheme support. Other significant factors were high perception of the local flood problem, and low attachment to the community or place.

Convincing potential relocatees that they will benefit from acquisition would greatly increase scheme acceptance. Unfortunately even when perception of the flood problem is high many residents do not see themselves benefiting from acquisition. Experience in a wide range of fields shows that the simple provision of information through public education programs does little to change attitudes.

However, effective public relations are important, and public involvement in the decision making process from the beginning of scheme development may greatly improve scheme acceptance. Although circumstances exist where minimal publicity is quite successful, in general failure to properly involve the affected public increases rumours, misinformation and feelings of alienation and powerlessness.

A key issue in scheme acceptance, and in reducing the amount of stress and anxiety experienced by (potential) relocatees, is the property valuation procedure. In almost all voluntary acquisition schemes in Australia and overseas, property is purchased at its market value. This is usually well below the price of an equivalent flood-free dwelling. For
The Local Community

**FACTORS IMPORTANT IN COMMUNITY ACCEPTANCE OF ACQUISITION**

**ATTACHMENT TO COMMUNITY**
- **IF LOW:**
  - Residents are likely to be happy to move provided the property purchase arrangements are satisfactory.

- **IF HIGH:**
  - Authorities should bear in mind that old and/or well-established residents are more likely to experience stress and anxiety about relocation, and that financial problems will exacerbate this.

**BENEFITS PERCEIVED FROM ACQUISITION**
- This was found to be the most important factor in scheme acceptance.

**PROPERTY PURCHASE PROCEDURES**
- Only purchase of full title can be recommended.
- A number of procedures are available to reduce costs and improve public acceptability. Applicability of procedures depends largely on whether the land is developed or vacant.

**PROPERTY VALUATION PROCEDURE**
- Market value: this reduces costs but is often very unpopular, as it does not allow purchase of replacement housing.
- To improve public acceptability: purchase at replacement value (ie flood free replacement dwelling) the authorities may undertake to relocate the residents, esp. needy cases, if resumption (compulsory purchase) is considered the funds may be used to relocate people in negotiated settlements.

**PERCEPTION OF LOCAL FLOOD PROBLEM**
- **IF LOW:**
  - Disinterest is probable.

- **IF HIGH:**
  - Support is likely.

**DEVELOPED PROPERTY**
- Purchase of full title
- To reduce costs: properly exchange purchase and leaseback

**UNDEVELOPED LAND**
- Purchase of full title
- To reduce costs: property exchange purchase and leaseback easement purchase purchase and leaseback

**PUBLIC INVOLVEMENT IN DECISION MAKING**
- Especially important when scheme justification is to help people get away from floods.

**PUBLIC INFORMATION PROGRAMS**
- Experience with these programs has not been encouraging. However this does not reduce the importance of good public relations.

**POST-ACQUISITION PLAN**
- May reduce rumors/fears that councils plan to redevelop the land, and help people to see the benefits of acquisition.
- It is important that councils be seen to be consistent in their treatment of flood prone land.

**APPROPRIATE LAND USE**
- Specific use must be determined on a case by case basis. But only open space uses can be recommended.
- Points that should be considered when considering uses are:
  - warning time and isolation risk
  - adjacent land use
  - the use should not create additional hazards
  - the financial and social costs of maintaining the use.

**MAINTAINING APPROPRIATE USE**
- A serious problem. The situation is simpler if title is vested in the crown (state govt).
- Control may be exercised at a number of levels:
  - the land may be reserved or zoned as open space in the planning scheme
  - rezoning should occur at the start of the scheme
  - after rezoning land may be sold or leased
  - non regulatory measures may be employed

- Use may be managed without local land use laws. State govt., sub-division control may be employed, and at the local level health regulations may restrict development of high risk areas. State govs. may use other fiscal measures to direct development.

**FACTORS UNDER THE CONTROL OF STATE/FEDERAL LEVELS OF GOVERNMENT**
- Funding arrangements
- Legal basis for land-use control
- Fragmentation of authority, esp. the lack of liability enjoyed by local govt. for its land use decisions.
- Construction orientation of relevant authorities.
- Council staffs may lack the necessary technical expertise.

**Other Pressure Groups (e.g.)**
- Environmental grounds
  - Increases support, esp. from environmental pressure groups.

**FIGURE 9.2 : IMPLEMENTATION GUIDELINES.**
older residents who bought or inherited their property before the property boom of the 1960s, the low property values represent a major loss and an important reason why they still live in such dangerous areas. While the use of market value does not represent a financial loss to recent arrivals, the property may offer the only accommodation within their finances. Ideally provision should be made to relocate especially needy cases. Where the wider community stands to gain significantly from acquisition, from park or access creation for example, a strong case can be made for the redistribution of some of these benefits in the form of relocation allowances.

Under compulsory acquisition governments are required to ensure that relocateses are resettled in reasonable housing, and are compensated for disruption. Nevertheless, use of compulsion is not recommended due to the public opposition it typically engenders. Rather, if the funds are available for compulsory purchase, satisfactory negotiated settlements will usually be possible.

Another important factor in attitude to acquisition is attachment to community or place. Attachment may result from a wide range of factors including family and ancestral ties, length of residence, fear of new and unfamiliar places, and demographic variables such as age. Those most affected are the older long-term residents who own their properties. Public authorities may reduce the impact of acquisition on these people by relocating them within the same community or neighbourhood. Alternatively some form of purchase and leaseback arrangement might be feasible.

Where the land being acquired is vacant or under threat of redevelopment very much greater flexibility exists in the purchase procedures.

9.2.3.3 Post Acquisition

The long term effectiveness of acquisition as a flood damage reduction strategy rests with appropriate post-acquisition land use. Selection of appropriate uses for high risk land should be guided by the following criteria:
- The safety of the public and emergency service personnel is paramount.
- Nothing should be permitted that interferes with flood flow.
- That strategy which maximises the return on public investment.

In general, only open space uses can be recommended, in particular those associated with recreation and primary industry.

The possibility of inappropriate development of acquired land always exists, especially when there are lengthy flood-free periods. To minimise this possibility the land should be rezoned as open space or to some non-urban use. Rezoning should occur at the commencement of the acquisition program to demonstrate and ensure commitment to the scheme objectives, and to prevent new development increasing the costs and difficulties of program implementation. The stability of the new zones is enhanced if they are part of an overall floodplain management plan specifying clear post-acquisition uses. In the absence of a properly enforced comprehensive plan new development may occur in flood prone areas adjacent to those being acquired, reducing local confidence in the real aims of the scheme. Ideally to further insulate the land from local politics title should be held by the Crown. In some circumstances sale or lease of the land for agricultural or recreational uses may serve the purposes of offsetting purchase and maintenance costs, and of maintaining a flood compatible use. Though this approach may seem very attractive care must be exercised to ensure that future land use problems do not arise.

9.3 IMPLICATIONS FOR THE CASE STUDY SITES

Physical and economic criteria for acquisition were applied to the three study sites in Chapters 4 and 5.

Lismore stands out as meeting both sets of criteria for the acquisition of most houses in the city's priority acquisition areas. Under the economic standard some 80% (242) of the dwellings in these areas may be acquired and relocated on a benefit-cost basis. In Echuca West about one quarter of the developed properties may be purchased under the same standard and the purchase of another 25% is only marginally uneconomic. The situation in North Wagga is quite different. There, over 90% of
dwellings have floor levels above the 1:8 criterion and over 85% are above the 1:10 level. Acquisition of the village cannot be justified on benefit-cost grounds, although it may still be feasible on a cost-effectiveness basis. For example, if the alternative means of flood damage reduction were more expensive.

It is stressed that such comparisons between the three sites understate the situation in Lismore. This is because almost all the Lismore floodplain houses are raised. If lowered to 0.5 metres above ground (making them equivalent to dwellings in the other sites), the floor levels of some 1200 houses, two thirds of the city's floodplain dwellings, lie below the 1:8 flood. Consideration should be given to extending the scope of the Lismore program.

When the physical criteria are applied, Lismore is by far the most dangerous site because of water depth, velocity, a short warning time and the isolation of South Lismore. Echuca West is the safest site with its long warning time and low isolation risk. Although the potential for deep flooding exists the available warning time should ensure safe evacuation. On the other hand, North Wagga has a high isolation risk. This is partially balanced by a reasonable warning time and only moderately deep flooding. Final judgement on the risk for North Wagga awaits a MPF estimate and assessment of the probability of further episodes of mid 1950s type flooding, when parts of the village were under water for nearly a year.

The three schemes present marked contrasts in their manner of implementation. The clear implications are that there must be general consensus in support of acquisition at the local government level, and that voluntary purchase programs will only succeed with the support of the affected residents.

The Echuca West program is the most organised and has proceeded fastest. Its key elements are: clear delineation of the purchase area; prevention of any further development; the provision of adequate funds for the complete ten year program; the use of public meetings and personal contacts; and the direct administration of the scheme by the Victorian government, removing the scheme from the influence of local politics. The
North Wagga acquisition scheme presents the opposite picture with over 20 years of indecision. The Lismore scheme has few of the elements of the Echuca program, but is proceeding smoothly. Initially this scheme lacked assured or adequate funds, complementary land use regulations or an entirely supportive local council. Success has been largely due to the determination of locally based state officials and key council staff, who have reassured potential relocatees, and in some cases helped them arrange alternate accommodation.

In conclusion, the first priority for acquisition should be the most flood prone property in Lismore and similar sites. The major potential problem with the scheme being the reticence of Council to prevent further residential development or major improvements in these areas. Echuca West is the next priority. Of the three sites North Wagga has the lowest priority due to its relatively low assessment on the selection criteria, and also because of the sustained local resistance. The site does pose something of a test for NSW government policy and state authorities would like to see the village moved. Success is unlikely to be achieved without an aggressive program with funds for the purchase of replacement dwellings or relocation of existing structures. Alternatively a low interest loan or other form of subsidy could be introduced for house raising. Construction of a ring levee to higher than the present 1:20 standard cannot be supported on safety grounds.

9.4 IMPLICATIONS FOR THEORY

People living in the more flood prone parts of Lismore and Echuca could be placed into either of two groups: older long-term residents occupying their own homes, and relatively young short-term renters. By any of the commonly used poverty criteria high proportions of both groups are disadvantaged in socio-economic terms. It is hardly surprising therefore that they occupy the least desirable and cheapest housing, with the most common reason for dwelling occupancy being cost. This was particularly the case with renters, many of whom stated that they had no choice in dwelling selection. Although economics were important for the owner occupiers, in that the sale of their properties would not realise enough to enable purchase of a flood free replacement housing, family and ancestral ties to the area were also of significance.
Similarly, choice of adjustments was limited by issues of cost and local tradition. This was especially the case in Echuca West where small owner-constructed levees were the only affordable option.

As economically disadvantaged people many of the residents have little in the way of capital or other material assets with which to absorb flood damages. In many cases they are in poor health, are elderly or living alone, and thus lack the human resources necessary for effective emergency action or post-flood clean up. This relative absence of personal resiliency suggests that many of the residents of these particularly flood prone areas are less able than most to cope with the effects of flooding.

This material constitutes further evidence that the growing concern in hazards geography over the importance of "external factors" (factors of social organisation) in shaping choice and precipitating disaster is justified. Issues of flood knowledge and perception did not play a significant role in the location decisions of these people. Whether or not accommodation cost accurately reflected flood risk and potential damages was irrelevant to the residents. The important point was that they could afford the accommodation, or were otherwise tied to the area.

Knowledge of flooding was, however, important in the location decisions of those living in flood free areas and those in areas subject to relatively infrequent flooding. In general, these people have the resources to choose their housing relatively unencumbered by financial constraints.

Logical extensions of these concepts lead to an interpretation of disaster and hazard based on external factors. People who are poor locate in the cheapest areas, areas considered undesirable by the majority of the community in this case because they are subject to frequent and severe flooding. Furthermore, because the affordable dwellings are substandard and the people themselves have no capital or large human reserves to call on a flood may have serious consequences, although the same event occurring in an area of well constructed dwellings inhabited by well off people would have negligible long terms effects on the lives of those flooded.
Seen from this perspective resolution of these problems requires more than acquisition of severely flood prone areas, it touches on the organisation of society itself.

9.5 FUTURE AND SCOPE OF ACQUISITION

Acquisition is the most effective method of flood damage reduction, as within the acquired area damages are completely eliminated, theoretically forever. However, this degree of damage reduction is attainable only if acquisition proceeds in concert with mitigation measures designed to prevent further development in the acquisition area during the life of the scheme, restrict the development of adjacent flood prone areas and prevent post-acquisition development. To achieve this a combination of regulatory and non-regulatory (financial incentives) land use techniques should be employed. Traditionally, regulations alone have been used to direct development, leading to the anomalous situation where governments were actually in part funding development in areas designated for open space. This occurs through the vast range of financial subsidies normally available to development, as well as the more obvious payments for disaster relief and infrastructure repair.

Implementation of acquisition is not without its problems, but many of these are common to other land-use flood adjustments. Any measure designed to rectify an existing serious flood problem by removing or protecting development is expensive and frequently disruptive. Also, unlike structural works, all non-structural adjustments are dependant for their success on the cooperation of people. Of course it may be possible to obtain this cooperation through legislation, but even under these circumstances broad community support is usually necessary for successful implementation.

The precise role of acquisition in any given floodplain management plan has been defined by safety and economic criteria. To grasp the extent of the flood problem and the potential contribution of acquisition these criteria should be applied to national data. Unfortunately, data available on this scale are only suitable for the economic criterion.
There are 61,000 dwellings in Australia at risk from the 1:100 flood according to Devin and Purcell (1983). Assuming that the floor levels of these dwellings are distributed in the same way as those in Lismore, the floors of some 7,300 houses would lie below the 1:8 flood, the limit of economic acquisition. Using the recommended procedures the average annual tangible damage is approximately equal to 10 million dollars. Converting this figure from an infinite annual series of future damages to a present value, using a 10% discount rate, gives a result of 100 million dollars. Acquisition costs for all 7,300 properties would amount to between 73 and 146 million dollars, based on individual property values of between $10,000 and $20,000. No allowance has been made for community preparedness which could reduce the damage estimate substantially. Nevertheless purchase of much of this severely flood prone property is, in cost-benefit terms, feasible.

It is not seriously suggested that acquisition should be contemplated on such a large scale. The actual flood damage might be substantially lower, and especially in the inland areas flood proofing and levees may provide adequate flood protection. Nevertheless, the first priority is clearly to prevent the problem from expanding. Steps are being taken in this direction, primarily through the implementation of local land-use controls as a result of pressure from state governments. Past experience with these measures gives cause for concern. The permissive and discriminatory nature of most land use controls, employing in the name of flexibility and equity a case by case appraisal of development applications, has lead to the incremental encroachment and infilling of high risk locations. When particularly high risk environments are involved, both regulatory and non-regulatory land use management measures must be resolute and inflexible, if the costly and widely recognised mistakes of the past are not to be repeated. It is these mistakes which are frequently the subject of acquisition.
BIBLIOGRAPHY

Notes
1. Interviewees are listed in Appendix E. When referenced in the text they are identified by the letter "I" following the date.

2. Where references have been abbreviated, both forms are given in the bibliography. Abbreviations are also defined in Appendix A.


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### APPENDIX A

### LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACDC</td>
<td>Australian Counter Disaster College, Macedon, Victoria</td>
</tr>
<tr>
<td>AGPS</td>
<td>Australian Government Printing Service</td>
</tr>
<tr>
<td>ANU</td>
<td>Australian National University</td>
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<tr>
<td>ANUFLOOD</td>
<td>Interactive Computer Program developed at CRES, ANU for the Assessment of Urban Flood Damages and Mitigation Strategies</td>
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<tr>
<td>AWRC</td>
<td>Australian Water Resources Council</td>
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<tr>
<td>AAD</td>
<td>Average Annual Damages</td>
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<tr>
<td>CRES (ANU)</td>
<td>Centre for Resource and Environmental Studies</td>
</tr>
<tr>
<td>CD</td>
<td>Census Collector's District</td>
</tr>
<tr>
<td>CIP (Australia)</td>
<td>Commission of Inquiry into Poverty</td>
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<tr>
<td>DVA (Victoria)</td>
<td>Dandenong Valley Authority</td>
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<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
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<tr>
<td>FIA (US)</td>
<td>Federal Insurance Administration</td>
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<tr>
<td>FHF</td>
<td>Flood Hazard Factor</td>
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<tr>
<td>HUD (US)</td>
<td>Department of Housing and Urban Development</td>
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<tr>
<td>IDC (NSW)</td>
<td>Inter-Departmental Committee inquiring into Richmond River Flooding</td>
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<tr>
<td>IDO</td>
<td>Interim Development Order</td>
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<tr>
<td>LACAC</td>
<td>Local Architectural Conservation Advisory Committee of Cambridge, Ontario</td>
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<tr>
<td>LGA</td>
<td>Census Local Government Area</td>
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<tr>
<td>MPF</td>
<td>Maximum Probable Flood</td>
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<tr>
<td>MTRCA (Ontario)</td>
<td>Metropolitan Toronto and Region Conservation Authority</td>
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<tr>
<td>NERBC (US)</td>
<td>New England River Basin Commission</td>
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<tr>
<td>NSW</td>
<td>New South Wales</td>
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<tr>
<td>PPWC (Victoria)</td>
<td>Parliamentary Public Works Committee</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
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<tr>
<td>PEC (NSW)</td>
<td>Planning and Environment Commission</td>
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<tr>
<td>PWD (NSW)</td>
<td>Public Works Department</td>
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<tr>
<td>RRCC (NSW)</td>
<td>Richmond River County Council</td>
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<tr>
<td>RRHS</td>
<td>Richmond River Historical Society</td>
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<tr>
<td>RRVGMC</td>
<td>Richmond River Valley Flood Mitigation Committee</td>
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<tr>
<td>SKP</td>
<td>Sinclair, Knight and Partners Pty. Ltd., Consulting Engineers</td>
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<tr>
<td>SMEC</td>
<td>Snowy Mountains Engineering Corporation, Consulting Engineers</td>
</tr>
<tr>
<td>SES</td>
<td>State Emergency Services</td>
</tr>
<tr>
<td>SR &amp; WSC (Victoria)</td>
<td>State Rivers and Water Supply Commission</td>
</tr>
<tr>
<td>SPWS</td>
<td>Australian Social Welfare Policy Secretariate</td>
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<tr>
<td>TVA (US)</td>
<td>Tennessee Valley Authority</td>
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<tr>
<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UNDRO</td>
<td>United Nations Disaster Relief Office</td>
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<tr>
<td>US</td>
<td>United States of America</td>
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<tr>
<td>US-FEMA</td>
<td>Federal Emergency Management Agency</td>
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<td>National Science Foundation</td>
</tr>
<tr>
<td>WWCC</td>
<td>Wagga Wagga City Council</td>
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</table>
Dear Householder,

Someone from the Lismore Floodplain Survey will be calling on you during June.

The survey is seeking your views on present government floodplain management policies for the lower parts of the Lismore floodplain. Our work is financed by the Australian Water Resources Council (a joint federal-state government body). The research has the support of, and results are of interest to, Local, State and Federal government officials. We expect that our results will help planners here and elsewhere deal with floods.

We realize that other researchers have undertaken surveys of Lismore floodplain residents. However, we are aware of the results of only one of these surveys: that conducted by the Northern Rivers College of Advanced Education in 1979. Unfortunately the College survey did not address the specific policy issues we are examining on behalf of the Australian Water Resources Council.

We can personally assure you that your answers to the questions will be treated as strictly confidential and that no identifying information will be used in presenting the results of the survey. Interviewers carry an identity card signed by the Project Director so you can be sure that they are genuine interviewers employed by this Department.

We hope that we can look forward to your cooperation in the Lismore Floodplain Survey when our interviewer calls. If you would like any further information about the survey, please don't hesitate to contact either of us personally, Canberra 49-3258, or 49-4267 reverse charges, or the fieldwork supervisor, John Handmer at Lismore.

Messages through:
Fred Hogan 211686
Ken Parr 211665

Yours faithfully,
Dr. N.S. McDonnell
Senior Lecturer & Project Director

Mr. E.M. Johnson
Lecturer and Deputy Project Director

TO WHOM IT MAY CONCERN

This letter is to introduce who is assisting with a survey being conducted by the Geography Department of the Australian National University.

The survey is seeking your views on present government policies for the management of the Lismore floodplain. The work is funded by the Australian Water Resources Council and forms part of their Water Research Programme. Federal, State and Local government officials support the research, and we expect that our results will help planners deal with floods.

We can personally assure you that the answers to the questions will be treated as strictly confidential and that no identifying information will be used in presenting the results of the survey. Interviewers carry an identity card signed by the Project Director so you can be sure that they are genuine interviewers employed by this Department.

We would be grateful for any help you can give, NEIL

MCDONALD

If you would like any further information about the survey, please don't hesitate to contact either of us personally, Canberra 49-3258, or 49-4267 reverse charges, or the fieldwork supervisor, John Handmer at Lismore.

Messages through:
Fred Hogan 211686
Ken Parr 211665

Yours faithfully,

N.S. McDonnell
Senior Lecturer & Project Director

Mr K.M. Johnson
Lecturer and Deputy Project Director
INTERVIEWER TO COMPLETE AFTER INTERVIEW OR IF INTERVIEW IS REFUSED OR HOUSE VACANT.

<table>
<thead>
<tr>
<th>Date/time</th>
<th>Call backs</th>
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<tbody>
<tr>
<td>A. Interview Obtained</td>
<td></td>
</tr>
<tr>
<td>appointment made</td>
<td></td>
</tr>
<tr>
<td>not home</td>
<td></td>
</tr>
<tr>
<td>House vacant</td>
<td></td>
</tr>
<tr>
<td>House abandoned</td>
<td></td>
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</tbody>
</table>

IF VACANT ASK NEIGHBOURS HOW LONG IT HAS BEEN VACANT

DWELLING

B. Type of dwelling - house subdivided house | specify |
| semi-detached | flats |
| other | |

C. Material of outer walls - brick | concrete |
| wood | fibro |
| other | specify |

D. Condition of house (see explanatory sheet) - very good | good |
| fair | poor |
| very poor | |

E. Size of house (see explanatory sheet) - small | medium |
| large | |

F. House raised | not raised |
| height | metres |

SPACE UNDER HOUSE | Used | Not used |
| Specify | |

G. Sex of respondent - female | male |

H. Estimate of respondents age - 18 - 29 | 30 - 39 |
| 40 - 49 | 50 - 59 |
| 60 + | |

J. Ethnic origin - | |

If you have any other information please write it down here: | |

---

Hello, my name is [name]. I'm from the Department of Geography at the Australian National University. We are conducting research into the effects of flooding in this area. A letter about the survey was sent here a few days ago. The aim of the study is to help planners deal with floods. The interview results are confidential and will only be reported in combination with those of other people. The interview should take about 30 minutes. We would greatly appreciate your assistance.

Before getting on to floods I'd just like to ask you a few questions about your background.

1. When did you move to North Lismore/Ballina Bridge & Victoria St (describe area we are referring to) (if born here go to question 3a,

2a) When you moved here in - (year) what was it that made you come to North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area?

2b) Was the cost of housing important in your decision to come to North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area?

   NO YES

2c) Why was it that you chose this particular house?

(d) Which of the reasons was most important in your decision to come to this area. (repeat reasons if necessary)

   Which was next most important? etc. (rank reasons)

   MOST IMPORTANT

   LEAST IMPORTANT

3. Are you likely to leave this address within the next 12 months?

   Definitely will move - Why do you intend to move?

   Quite likely to move

   Not sure

   Unlikely to move - Go to question 5

   Definitely will stay

423.
4. (FOR MOVERS)
Would you prefer to stay but find it too difficult?
NO — GO TO QUESTION 7
YES — Why would it be too difficult to stay? GO TO QUESTION 6

5. (FOR STAYERS & NOT SURE)
Would you prefer to leave but find it too difficult?
NO —
YES —
(a) Why would you prefer to leave?
(b) What makes it too difficult?

6. As you have lived here for some time and know the area, I am interested in why you stay here.
(a) What is it in particular that keeps you in North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area?

(b) Is the cost of housing important in your decision to stay in North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area?

(c) Are the people in this area (North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area) important in your decision to stay here?

(d) Is there anything about this particular house that keeps you here?

7. What would you say are the disadvantages of living in North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area? (PLEASE RANK IN ORDER OF IMPORTANCE . FROM 1 = MOST IMPORTANT)

(a) Which of the reasons most important in keeping you in this area? (repeat reasons if necessary), which is next most important? (RANK REASONS)

- MOST IMPORTANT
- LEAST IMPORTANT

8. Do you own, rent or have free occupancy of this property?

- Own
- Rent
- Free occupancy
- Other

9. Are floods a problem for people in North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area? Would you say they are a: (READ OUT)

- Serious problem
- Problem
- Nuisance
- Not a concern
- Other

NOW I'D LIKE TO TALK ABOUT FLOODS AND WHAT YOU FEEL SHOULD BE DONE ABOUT THEM.
4.

(b) What about for the rest of the City of Lismore, South Lismore, (North Lismore) the city centre - are floods a problem there?

(TAKE DOWN COMMENTS)


10. Did you know that this area was affected by floods when you first moved here?

□ NO

□ YES

□ DON'T KNOW

Where did the information come from?

□ City Council

□ Real estate agents

□ Local people (neighbours)

□ Owner/Prior owner

□ Other source → Specify

□ Don't know → People at work

11. Do you know of anything that has been done by government/to reduce the risk of flooding in Lismore? (Local, State, Federal)

□ NO

□ YES → What has been done?

□ DON'T KNOW

12. Should anything (more) be done about flooding in Lismore?

□ NO

□ YES → What should be done?

□ DON'T KNOW

13. Do you think floods in this area can be stopped from occurring again?

□ NO → Why do you say that?

□ YES → How can they be stopped?

□ DON'T KNOW

14. (a) If something (more) was to be done about floods in Lismore, who should be responsible for getting it done?

□ NO

□ YES → Please specify

□ DON'T KNOW

15. (a) Have you been involved to try to get something (more) done about floods?

□ NO → GO TO QUESTION 16

□ YES → What?

□ D/K

Details

□ Signed a petition

□ Talked to local officials

□ Attended a local meeting

□ Other → Please specify

(b) What were the results of your actions?

□ NO

□ YES → Please specify

□ DON'T KNOW

IN SOME FLOOD PRONE AREAS, STATE AND LOCAL GOVERNMENTS ARE THINKING OF ENCOURAGING PEOPLE TO MOVE TO FLOOD FREE AREAS BY OFFERING TO BUY THEIR PROPERTY. SUCH A SCHEME HAS BEEN UNDERTAKEN IN PARTS OF LISMORE FOR ABOUT TWO YEARS. A FEW PROPERTIES HAVE BEEN BUtTED UP AND THE PURCHASE OF OTHERS IS BEING NEGOTIATED.

16. (a) Had you heard about this scheme?

□ NO → GO TO QUESTION 17

□ YES → If YES ->

(b) Where did you hear about it?

□ NO

□ YES → Please specify

□ DON'T KNOW

(c) What do you understand the scheme to be?

□ (IF NECESSARY - Pmise - Voluntary/Compulsory - House Value/Comp'y)

□ NO

□ YES → Please specify

□ DON'T KNOW

□ (IF NECESSARY - Pmise - Voluntary/Compulsory - House Value/Comp'y)
6. (d) Do you feel that people in this area will sell?
   - [ ] NO
   - [ ] UNLIKE
   - [ ] UNLIKELY
   - [ ] LIKE
   - [ ] LIKELY
   - [ ] YES

   Why do you feel that?

(e) Could you tell me what areas are included in the scheme? (USE MAP)

NORTH LISMORE/BALLINA BRIDGE, VICTORIA AND MOLESWORTH STS. AREA IS ONE OF THE AREAS CURRENTLY BEING BOUGHT UP.

17. (a) Do you think this is what should be happening to North Lismore/Ballina Bridge, Victoria and Molesworth Sts. area?
   - [ ] NO
   - [ ] YES

   Why do you say that?

(b) Should it be happening anywhere else in Lismore?
   - [ ] NO
   - [ ] YES

   Why is that?

18. How do you think you might benefit from the government scheme?

   (PROMPT - getting away from flood)

   FOR OWNERS ONLY - IF RENTER GO TO QUESTION 23.

19. What incentives would it take to persuade you to sell your property to the scheme?

   Should not be encouraged to sell

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7. FOR OWNERS ONLY

20. I have a number of incentives that I'll read out to you. We are interested in how acceptable or unacceptable each of these are to you as an incentive to move. (PROMPT AND USE CARD).

<table>
<thead>
<tr>
<th>very accept</th>
<th>unsure</th>
<th>very accept</th>
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(a) An alternative equivalent house in a flood-free part of Lismore. Would you find that:

   - [ ]

(b) Flood free land & your present house moved there. Would you find that:

   - [ ]

(c) Either equivalent flood free house, or land & your house moved there. In an area with your present neighbours

   - [ ]

(d) Cash for your property at its present market value

   - [ ]

(e) Cash for your property at its market value before the building restrictions were imposed here in 1979

   - [ ]

(f) Enough cash to buy an alternative equivalent flood free house

   - [ ]

---

21. Suppose flooding was controlled in some way, and you were offered a reasonable price for your house (i.e. enough to buy another place), would you sell it?

   - [ ] NO
   - [ ] MAYBE
   - [ ] YES
   - [ ] DON'T KNOW

---

22. (a) Have you considered selling your property to the government?

   - [ ] NO

   Why?

   - [ ]

   YES Did you Decide to sell Why?

   - [ ]

   Decide against selling?

   - [ ]

   - [ ]

   - [ ]

   - [ ]

   - [ ]
27. Suppose that the government wasn't buying up properties what do you think the future of this area would be?

27A. Suppose you were going to move - where would you like to go?

THANKS FOR YOUR VIEWS - NOW I AM INTERESTED IN YOUR EXPERIENCE WITH FLOODS.

28. (a) Since you've been in Lismore has flood water ever entered your house?

(b) Since you've been in Lismore has flood water ever entered your yard?

(c) Have you been flooded anywhere else you've lived?

Water in House?

Water in Yard?

29. (a) Have you yourself ever done anything to reduce the risk of flood damage to your property? READ OUT LIST

(b) What are the advantages of having a house raised like this?

IF HOUSE IS NOT RAISED GO TO QUESTION 30.
10. (c) Are there any disadvantages?
   - NO — (PROMPT - What about the steps etc.)
   - YES — What are they?

30. Has anywhere you've worked been flooded?
   - NO
   - YES — When was that?
   - How serious was it?

31. (a) Does a flood in Lismore affect your normal daily routine, such as going to work, shops, school etc?
   - NO
   - YES — How long?

32. (a) Were you here in the 1974 flood?
   - NO — Go to question 33
   - YES — Were you able to cope without outside assistance? (List)

34. Do you (if family - or members of your household) belong to any local clubs or associations, including local government committees, council, etc.?

35. (a) Do you have any relatives in North Lismore/Ballina Bridge, Victoria & Molesworth Sts. area, that you keep in touch with?
   - NO
   - YES — How many households?

36. (a) Do you have any close friends in North Lismore/Ballina Bridge, Victoria & Molesworth Sts. area?
   - NO
   - YES — How many households?

37. How many people live here? Over 18 ________ Under 18 ________

38. Which of these best describes your household. READ OUT
   - Young single person
   - Single parent with children
   - Young group house
   - Single parent with children
   - Couple with young children
   - Couple with school age children
   - Couple with children
   - Elderly couple
   - Elderly single person
   - Other (eg. extended family) Specify

39. Lismore has had a number of floods over the last 20 years. Over the next 20 years how many floods do you think might enter
   - Your house: ________
   - Your yard: ________
39. (a) Where were you born? IF LISMORE ASK SUBURB/STREET.
(b) If applicable where was your spouse/partner born? IF LISMORE ASK SUBURB/STREET.

(If in house less than 20 years)

40. Before you came here where did you live?

When did you move here?

If numerous moves ask how many moves in the last year.

(Repeat to 1961)

41. (a) Is your family from this area?

NO YES

(b) If applicable is your spouse's family from this area?

NO YES

42. Have you travelled in the last 10 years? (READ OUT)

Interstate Overseas Local (Northeast NSW) None

43. Are you employed?

YES NO

Are you retired? YES NO

Are you looking for work? YES NO

HOME DUTIES OCCASIONAL WORK

44. How much education do you have?

No schooling Primary Secondary

Some primary (4yrs age 10) Some secondary

Secondary - school certificate (4 years) Technical college/Trade certificate

Higher school certificate (5/6 years) Bachelor's degree (Univ or C.A.E.)

Masters/Ph.D. Other (Specify)

45. Would you tell me what age category you fit into.

How old are you?

<10 10-19 20-29 30-39 40-49 50+ 60-69 70-79 80-89 90+

46. Finally I would like to get your reaction to several statements.

Based on your experience and the way things are going for you now, would you tell me whether you agree or disagree with the following?

(a) There's little use in writing to public officials because often they are not really interested in the problems of the average person. Agree Disagree

(b) Nowadays a person has to live pretty much for today and let tomorrow take care of itself. Agree Disagree

(c) In spite of what some people say, the lot of the average person is getting worse. Agree Disagree

(d) It's hardly fair to bring children into the world with the way things look for the future. Agree Disagree

(e) These days a person doesn't really know who he or she can count on. Agree Disagree

47. Do you have any comments on the acquisition scheme - floods?

Floods/acquisition

This community/survey

THANK RESPONDENT FOR HIS/HER TIME AND COOPERATION

48. Int Att.

Enthusiastic, Cooperative, Ambivalent, Uncooperative, Hostile, Other Comments
APPENDIX C

QUESTIONNAIRE DEVELOPMENT AND SAMPLE ACCURACY

QUESTIONNAIRE DEVELOPMENT

The first draft of the questionnaire was prepared after a review of relevant literature and interviews with local officials and interested citizens.

As there is very little material specifically on voluntary acquisition/relocation for flood damage reduction a range of reports dealing with compulsory acquisition for major public works was consulted. Interviews with government officials and local people helped to identify issues of particular importance at each case study site and to ensure that these were covered by the questionnaire.

Material on the use and development of questionnaires was also consulted, in particular: James (1974) The Use of Questionnaires in Collecting Information for Urban Flood Hazard Planning, and Whyte (1977) Guidelines for Field Studies in Environmental Perception.

After review of the draft questionnaire by Roger Jones of the ANU Survey Research Centre, and a meeting of the study's supervisory panel on 24 March 1981, a questionnaire was prepared for pilot testing in Echuca.

The questionnaire sought information on people's reasons for their location, mobility, socio-economic characteristics, flood experience, and attitudes and behaviour towards the acquisition issues.

Echuca Pilot Survey

The pilot questionnaire was administered in Echuca West on 2/5/81. Three interviewers were used including the Project Officer. Employment of interviewers other than the Project Officer was considered essential in the pilot survey to obtain a wide range of feedback on questionnaire logic and question wording and appropriateness.

Thirty interviews were successfully completed. This number constitutes a good pilot sample (Yeates, 1974:61). Interviews were attempted at 54 of the 67 houses in Echuca West. In most of the unsuccessful attempts people were out and there were few refusals. As the sample is one of people home on Saturday 2/5/81 it is not random. In addition, residents of the caravan park on Campaspe Boulevard were not interviewed. As these people do not own property and are almost certainly highly mobile residentially they are the group least impacted by acquisition and relocation schemes, and were therefore the lowest priority for the pilot survey. They were however, included in the final Echuca West survey. Half the pilot interviewees were male and half female. (For further details of the Echuca survey see Chapter 2).

As a result of the pilot survey some suggestions for improvement of the questionnaire were made by the interviewers and by those present at an supervisory panel meeting on 12/5/81. These concerned increasing the number of questions related to acquisition and minor question rewording and re-ordering.
Slightly different versions of the final questionnaire were produced for each of the 3 zones included in the Lismore survey:

(i) The area being acquired. This is in two distinct parts: North Lismore; and the Ballina Bridge/Victoria Street area, plus a small number of houses on Little Keen and Zadoc Streets.

(ii) Areas outside the acquisition zones. These are included for control or comparison purposes:

(a) That part of the floodplain not being acquired, and

(b) the flood free part of Lismore.

The questionnaire versions were tested in Lismore in early June by the author, the study supervisor and an employed interviewer, and were considered satisfactory.

THE LISMORE SURVEY

Two hundred and seventy two useable questionnaires were completed: 153 in the acquisition areas and 119 in the two non-acquisition control areas (59 in the flood plain control and 60 in the flood free control).

Seven people were employed to administer the questionnaire by personal interview. The interview schedule of 46 questions took an average of 40 minutes to complete. Interviewing took place on weekdays and weekends during June, and was completed by the Census of June 30.

Sampling Unit

The household was selected as the sampling unit. Interviewees answered on their own account in single person households, or on behalf of a couple. This is the approach followed by Wadley and Ballock (1980), on the basis of findings by Booth and Camp (1974). In group households the respondent was assumed to be representative of the whole household.

Ideally an in-house selection of respondents should have been made, but this approach was not adopted for two reasons. First it would have greatly increased the average time taken to secure an interview, especially with the need to make extensive use of appointments and follow-ups. Secondly, it was felt that insisting on interviewing a particular person could have adversely affected the response rate, especially as the area has been surveyed frequently (see Public Relations below).

SAMPLE SIZE (Lismore)

Given the project's limited resources most sampling effort and money was concentrated in the acquisition areas, where an attempt was made to interview every household. The samples from the rest of the floodplain and from the control area outside the floodplain do not require the same degree of representativeness, as their primary purpose is for comparison and because sub-groups within the control samples will not be explored in detail. By employing smaller samples for the two control areas small differences within these groups and between the control and acquisition samples will be obscured. However, differences of practical significance
should be revealed. The calculations of sample size are based on the formula presented in Silk (1979)\(^1\). The fundamental assumption is that the sample is selected randomly, a condition met in the present Study (see Sample Selection below). It is emphasised that the calculations consider only errors due to sampling. An accuracy of between 5 to 10\% at the 95\% level is normal.\(^2\)

**Acquisition Zone**

The entire acquisition area contains 283 houses which were mapped in the Project's 1980 field survey. As this area consists of 2 distinct parts, the sample from each must be large enough to achieve a reasonable degree of accuracy.

There are 163 households in the acquisition area of North Lismore. To reach an accuracy of 7.5\% (at the 95\% level) 83 of these would have to be interviewed. While for the 110 houses of the Ballina St Bridge/Victoria St area the sample would have to be 68 households.

**Control Areas**

For the non-acquisition floodplain (approximately 1700 houses) and flood free (approximately 5000 houses) samples the level of accuracy may be considerably less as these areas are primarily serving a control function. Given that the interviewing budget is limited the final sample size of 55 for each of these groups is considered adequate. The resulting sample accuracy is ±13\% at the 95\% confidence level. The accuracy figure is relatively insensitive to sample size: doubling the number of interviews would only increase accuracy to about ±10\%. On the other hand, further reduction in sample size would not only decrease accuracy but also make comparisons between samples difficult.

**Comparisons Between Groups**

Comparisons of these samples to assess similarities or differences between their populations will require differences of greater than 14\% (at the 95\% confidence level) to be sure that the variances are not due to sampling errors. Because of their size, comparisons between the two acquisition groups show significant differences at ±10\%. These results are not particularly sensitive to changes in sample size: for example, doubling the size of the control samples increases accuracy from ±14\% to ±11\%.

**Total Sample Size**

The final sizes of the various samples are set out in Table C1.

---

1. The 95\% confidence level (or occasionally the 99\% level) is a standard normally adopted in statistical tests of this type. In effect it means that there is a 95\% probability that the true situation lies in the specified range, or put another way there is a less than 5\% probability that results could have occurred by chance.


3. Discrepancies between structure totals here and in Chapter 2 result from the inclusion of abandoned dwellings and the Little Keen Street area in Chapter 2.
## Table C1: Lismore sample size.

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Number of Houses</th>
<th>Desired Sample Size No. of Households</th>
<th>Sample Size Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition Zone</td>
<td></td>
<td>7.5% at 95% confidence</td>
<td></td>
</tr>
<tr>
<td>North Lismore</td>
<td>163</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>Ballina Bridge/ Victoria St.</td>
<td>110</td>
<td>68</td>
<td>70</td>
</tr>
<tr>
<td>Little Keen St</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL ACQUISITION</td>
<td>283</td>
<td>(151)</td>
<td>153</td>
</tr>
<tr>
<td>NON-ACQUISITION</td>
<td></td>
<td>13% at 95% confidence</td>
<td></td>
</tr>
<tr>
<td>Flood Plain</td>
<td>1654</td>
<td>55</td>
<td>59</td>
</tr>
<tr>
<td>Flood Free</td>
<td>5000</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>TOTAL SAMPLE</td>
<td>261</td>
<td>272</td>
<td></td>
</tr>
</tbody>
</table>
SURVEY IMPLEMENTATION

Questionnaire Administration

The questionnaire was administered by personal interview during June. Survey timing is not considered important in Lismore as major floods can occur in any season.

The use of mail questionnaires and those left with the respondent for completion were considered. However, it was felt that a self-completion survey would not be appropriate because:

(i) of the type of information required, for example many of the questions depend on being put in a particular sequence.

(ii) 10% of the Echuca sample had minimal or no schooling. These people and those who are handicapped or ill are largely excluded from self-completion surveys.

(iii) The acquisition areas are fairly small, thus reasonable response rate is required to ensure representative results. Mail surveys are characterised by relatively low response rates.

Sample Selection

Systematic random sampling was used to select interviewees in the control sample. All Lismore city blocks were assigned numbers. Blocks to be included in the sample were selected using a random number table, then using a random starting point an attempt was made to contact every third house on the blocks selected. Approximately the same number of interviews were completed in each block. For the acquisition areas an attempt was made to contact every household. In all areas refusals and non-contacts were monitored to establish whether any systematic bias was occurring, such as renters or aborigines refusing to be interviewed (see Chapter 2).

If the initial attempt to contact the household failed call-backs, or additional attempts, were made during the interviewing period. The number of call-backs varied slightly but was a minimum of 3. The call-back procedure, which involves going to specific and often dispersed addresses, is time consuming and expensive.

Public Relations

The Lismore floodplain has been subject to a number of surveys over the last few years. The author is aware of 2 surveys for the "Healthy Lifestyle" program, one for the Education Department and 2 related to floods, as well as several for teaching purposes. Hence a special effort was made to inform people about the aims of this survey.

The local newspaper (Northern Star) carried an article about the survey as interviewing was commencing (Figure 1). In addition a letter was delivered to houses in the acquisition areas (Appendix 1). The letter explained the purpose of the survey and requested the householders cooperation. As not all houses received a letter before being interviewed it was possible to compare responses to the survey of those with and those without the introductory letter. It appears the letter did not substantially increase the response rate. However in many cases it made the task of securing the interview shorter by eliminating the need for explanation or persuasion on the part of the interviewer.

Each interviewer was provided with an ID card bearing his/her photograph, and a letter of introduction.
APPENDIX D

INTERVIEW GUIDELINES

(for officials and other key individuals)

1. ORGANISATIONS ROLE IN FLOODPLAIN MANAGEMENT AND ACQUISITION
   - Extent of flood problem
   - Action taken up to present
   - Alternative strategies available

2. IS THERE A COMPREHENSIVE FLOOD MITIGATION PLAN?
   - What other measures are used/necessary in conjunction with acquisition

3. HOW AND WHY DID ACQUISITION PROGRAMS DEVELOP?
   - History of land use control in the area
   - Why acquisition? Why not zoning, subdivision, building regs etc?

4. SELECTION CRITERIA FOR ACQUISITION/ie PROPER ROLE OF ACQUISITION IN FDR
   - Engineering aspects of delineation
   - Degree of risk/acceptable risk
   - Existing versus future/potential risk
   - Suitability for post acquisition use, eg. parks or access
   - Physical features of flood plain
   - Cost of utility maintenance
   - Condition of housing
   - Low rate revenue

5. ACQUISITION PRIORITIES
   - Is there a priority list?
   - Changes in priorities

6. WHAT LAND USES ARE AFFECTED BY ACQUISITION?
   - Churches, schools, historic buildings, commercial, industrial, agricultural

7. MECHANISM OF ACQUISITION/IMPLEMENTATION OF POLICY
   - Publicity of program
   - Individual house selection procedure
   - Purchase procedure
   - Disposal after purchase, rental, lease
   - Buildings to be relocated to specific sites
   - Problem of checkerboarding
   - Level of services to be maintained
   - Legal basis

8. VOLUNTARY/COMPULSORY PROPERTY PURCHASE
   - Easement purchase
9. FUNDING SOURCE
   - Stability of future funds
   - Extent of controls

10. VALUATION OF PROPERTY
    - Adequate compensation, what is?
    - Provision of a relocation allowance
    - Provision of new house/with old neighbours
    - Provision of land and move old house

11. LOCAL REACTION TO ACQUISITION PROGRAMS, WHY?
    - Local attitude to program
    - Councils' reaction
    - Chamber of commerce, real estate agents, developers
    - Residents action groups
    - Local newspapers
    - Environment groups
    - Community participation in the DM process

12. PEOPLE IN THE ACQUISITION AREA
    - Type of people
    - Constitute a distinct group
    - Do they want to move
    - Where will they go

13. RELOCATEE SATISFACTION

14. ULTIMATE AIM OF PROGRAM
    - What happens to the area after it is acquired?
    - How is a flood compatible use ensured - eg. problem of the power of public utilities and other government departments

15. WHAT PROBLEMS DO YOU ANTICIPATE?

16. SUCCESS/FEASIBILITY OF ACQUISITION IN FLOOD DAMAGE REDUCTION
    HOW SHOULD THIS BE MEASURED?
    - Legal
    - Administrative
    - Economic esp. maintenance costs
    - Political acceptability

17. PROGRAM PROGRESS

18. POLITICAL SUPPORT/OPPOSITION FROM STATE AND FEDERAL GOVERNMENTS
# APPENDIX E

## LIST OF INTERVIEWEES

(Only main interviews listed)

*Note: Interviewees are identified in the text by the letter "I" following the date.*

### Interviews conducted in AUSTRALIA:

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Position, Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARLOW, F.</td>
<td>23/10/79</td>
<td>Chief Engineer: Richmond River, County Council Flood Mitigation Authority</td>
</tr>
<tr>
<td>BETHUNE, E.</td>
<td>22/2/80</td>
<td>Resident of Euchuca West (and other dates)</td>
</tr>
<tr>
<td>BLAIR, Mr.</td>
<td>28/1/81</td>
<td>Mayor: Lismore City Council</td>
</tr>
<tr>
<td>BOWN, M.</td>
<td>28/2/80</td>
<td>Chief Engineer: Clarence River, County Council Flood Mitigation Authority</td>
</tr>
<tr>
<td>BURGMAN, Mr.</td>
<td>5/6/80</td>
<td>President: North Wagga Residents Association</td>
</tr>
<tr>
<td>CAVENAGH, J.</td>
<td>11/2/81</td>
<td>Engineer: Liverpool Council</td>
</tr>
<tr>
<td>COOK, Mr.</td>
<td>30/4/80</td>
<td>Deputy Principal Engineer: Construction Section, Water Resources Commission</td>
</tr>
<tr>
<td>COOPER, Mr.</td>
<td>13/6/80</td>
<td>NSW Dept of Main Roads</td>
</tr>
<tr>
<td>DEREWLANY, M.</td>
<td>30/4/80</td>
<td>Research Officer: Urban Transport Research Unit, Sydney</td>
</tr>
<tr>
<td>EARL, C.</td>
<td>13/4/81</td>
<td>Chief Engineer: Main Drainage, Melbourne, Metropolitan Board of Works</td>
</tr>
<tr>
<td>FITZ-HENRY, J.</td>
<td>30/4/80</td>
<td>NSW Planning &amp; Environment Commission, Sydney</td>
</tr>
<tr>
<td></td>
<td>10/2/81</td>
<td>Assessor: NSW Land &amp; Environment Court, Sydney</td>
</tr>
<tr>
<td>FREEMAN, D.</td>
<td>per com.</td>
<td>South Grafton Flood Action Group</td>
</tr>
<tr>
<td>GRAHAM, Mr.</td>
<td>5/6/80</td>
<td>Town Planner: Wagga City Council</td>
</tr>
<tr>
<td></td>
<td>19/3/81</td>
<td></td>
</tr>
<tr>
<td>GROOT, R. de.</td>
<td>9/2/81</td>
<td>Sinclair, Knight &amp; Partners, Consulting Engineers, Sydney</td>
</tr>
<tr>
<td>Name</td>
<td>Date</td>
<td>Position</td>
</tr>
<tr>
<td>---------------</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HADDY, J.</td>
<td>2/5/80</td>
<td>Engineer: Bankstown City Council, Health and Building Section</td>
</tr>
<tr>
<td></td>
<td>11/2/81</td>
<td></td>
</tr>
<tr>
<td>HARTWIG, Mr.</td>
<td>19/3/81</td>
<td>Secretary: North Wagga Residents Association</td>
</tr>
<tr>
<td>HAUVILLE, B.</td>
<td>22/2/80</td>
<td>President: Chamber of Commerce, Lismore</td>
</tr>
<tr>
<td>HENDLEY, J.</td>
<td>27/2/80</td>
<td>Chief Engineer: Murwillumbah Council</td>
</tr>
<tr>
<td>HOGAN, F.</td>
<td>27/1/81</td>
<td>Engineer: District Office, NSW Public Works Dept., Lismore</td>
</tr>
<tr>
<td>JONES, D.</td>
<td>6/6/80</td>
<td>Lecturer: Dept. of Geography, Riverina College</td>
</tr>
<tr>
<td>KNOTT, C.</td>
<td>4/6/80</td>
<td>Chief Engineer: Wagga City Council</td>
</tr>
<tr>
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<td>19/3/81</td>
<td></td>
</tr>
<tr>
<td>MANN, J.</td>
<td>10/4/81</td>
<td>Director: Victorian Water Resources Council, Melbourne</td>
</tr>
<tr>
<td>MARJORAM, J.</td>
<td>2/6/80</td>
<td>Planner: formerly with Wagga City Council</td>
</tr>
<tr>
<td>MATHLIN, D.</td>
<td>13/6/80</td>
<td>Sinclair, Knight and Partners, Consulting Engineers, Sydney</td>
</tr>
<tr>
<td>McCARTHY, K.</td>
<td>14/4/81</td>
<td>Town Clerk: Echuca City Council</td>
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<tr>
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<td>3/9/81</td>
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<tr>
<td>MILLIGEN, P.</td>
<td>15/2/80</td>
<td>NSW Water Resources Commission</td>
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<tr>
<td>OBERLIN, D.</td>
<td>1/9/81</td>
<td>Former Mayor: City of Echuca</td>
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<tr>
<td>PARK, A.</td>
<td>1/9/81</td>
<td>Chief Engineer: City of Echuca</td>
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<tr>
<td>PARR, K.</td>
<td>21/2/80</td>
<td>District Engineer: District Office, Public Works Dept., Lismore</td>
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<tr>
<td>(with F. Hogan)</td>
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<tr>
<td>PATTERTSON, W.</td>
<td>15/2/80</td>
<td>Sinclair, Knight &amp; Partners, Consulting Engineers, Sydney</td>
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<tr>
<td>PUCH, A.</td>
<td>12/2/81</td>
<td>NSW Dept. of Environment and Planning</td>
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<tr>
<td>ROBINSON, P.</td>
<td>28/6/81</td>
<td>Lismore Valuer</td>
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<tr>
<td>ROGERS, W.</td>
<td>12/2/81</td>
<td>Planner: Riverina Planning Section, NSW Dept. of Planning &amp; Environment</td>
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<tr>
<td>RUSSEL, J.</td>
<td>14/2/80</td>
<td>Engineer: Ports &amp; Rivers Branch, NSW Public Works Dept.</td>
</tr>
<tr>
<td>Name</td>
<td>Date(s)</td>
<td>Position/Committee</td>
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<tr>
<td>Wade, J.</td>
<td>21/2/80</td>
<td>Engineer: Lismore City Council</td>
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<td>22/2/80</td>
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<tr>
<td></td>
<td>23/1/81</td>
<td></td>
</tr>
<tr>
<td>Walrut, B.</td>
<td>23/2/80</td>
<td>Richmond River Flood Mitigation Committee</td>
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<tr>
<td>(with J. Brown)</td>
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<td></td>
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<tr>
<td></td>
<td>23/1/81</td>
<td></td>
</tr>
<tr>
<td>Watson, Mr.</td>
<td>1/5/80</td>
<td>Deputy Principal Surveyor: NSW Dept. of Main Roads, Survey and Property Division</td>
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<tr>
<td>Watt, B.</td>
<td>1/5/80</td>
<td>Planning Section: NSW Water Resources Commission, Sydney</td>
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<tr>
<td>Wood, J.</td>
<td>11/2/81</td>
<td>NSW Water Resources Commission</td>
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</table>

**Interviews conducted in CANADA**

(Only main interviews are listed)

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<thead>
<tr>
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<th>Position/Committee</th>
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<tbody>
<tr>
<td>Deans, A.</td>
<td>22/7/82</td>
<td>Research Planner: MTRCA</td>
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<tr>
<td></td>
<td></td>
<td>and other occasions</td>
</tr>
<tr>
<td>Fine, M.</td>
<td>30/9/80</td>
<td>Planner: Metro Toronto Council</td>
</tr>
<tr>
<td>Gryniewski, P.</td>
<td>15/10/80</td>
<td>Ontario Ministry of Natural Resources, Conservation Authorities Branch</td>
</tr>
<tr>
<td>Guelke, L.</td>
<td>11/10/80</td>
<td>Professor: Dept. of Geography, University of Waterloo, Ontario</td>
</tr>
<tr>
<td>Mather, G.</td>
<td>22/7/80</td>
<td>Engineer: MTRCA</td>
</tr>
<tr>
<td>Mitchell, B.</td>
<td>16/10/80</td>
<td>Professor: Dept. of Geography, University of Waterloo, Ontario</td>
</tr>
<tr>
<td>Murriss, Ms.</td>
<td>21/10/80</td>
<td>Ontario Municipal Board</td>
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<td></td>
<td>21/10/80</td>
<td>Ontario Land Compensation Board</td>
</tr>
<tr>
<td>Nagong, E.</td>
<td>1/10/80</td>
<td>Senior Planner: Metro Toronto Council</td>
</tr>
<tr>
<td>Prince, D.</td>
<td>22/7/80</td>
<td>Head of property section: MTRCA</td>
</tr>
<tr>
<td>Regier, H.</td>
<td>1/9/80</td>
<td>Professor: Institute for Environmental Studies, University of Toronto</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and other occasions</td>
</tr>
<tr>
<td>Sane, Mr.</td>
<td>1/10/80</td>
<td>Planner: Metro Toronto Council</td>
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<tr>
<td>Name</td>
<td>Date</td>
<td>Position/Title</td>
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<tr>
<td>SARDESAI, G.</td>
<td>15/10/80</td>
<td>Head, Hydrology &amp; Registration Unit: Ontario Ministry of Natural Resources, Conservation Authorities Branch</td>
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<tr>
<td>Interviews conducted in the USA</td>
<td></td>
<td></td>
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<tr>
<td>BAILEY, L.</td>
<td>per com.</td>
<td>15/2/81 Federal Emergency Management Agency, Chicago, IL.</td>
</tr>
<tr>
<td>CURTIS, J.K.</td>
<td>14/8/80</td>
<td>Engineer: Floodplain Management Services Branch, Tennessee Valley Authority</td>
</tr>
<tr>
<td>DEVINE, P.</td>
<td>1/11/80</td>
<td>1/11/80 Research Officer: Corps. of Engineers, Los Angeles Office</td>
</tr>
<tr>
<td>(and other members of the Division)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRUNTFEST, E.</td>
<td>26/10/80</td>
<td>Professor: Dept. of Geography, University of Colorado, Colorado Springs</td>
</tr>
<tr>
<td>HOLBOURNE, N.</td>
<td>28/10/80</td>
<td>Professor: Dept. of Geography, University of Colorado, Boulder</td>
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<tr>
<td>KING, J.</td>
<td>per com.</td>
<td>9/9/80 Chief, Floodplain Management Services Branch: Tennessee Valley Authority</td>
</tr>
<tr>
<td>PALM, R.</td>
<td>28/10/80</td>
<td>Dept. of Geography, University of Colorado, Boulder</td>
</tr>
<tr>
<td>WHITE, G.F.</td>
<td>28/10/80</td>
<td>Director: Natural Hazards Center, Institute of Behavioral Sciences, University of Colorado, Boulder</td>
</tr>
</tbody>
</table>
APPENDIX F

HOUSE CONDITION CLASSIFICATION

a) POOR CONDITION

Advanced decay, perhaps aggravated by vandalism
Little sign of recent maintenance
Chipped wall paint, rusty roof, rusty and leaking guttering
Floors or walls warped
Crumbling brickwork
Grounds unkempt and untidy

b) FAIR CONDITION

Static maintenance condition, decaying naturally but not well advanced
Wall paint ageing and dirty but still affording adequate protection
Roof and gutters not leaking although patches of rust may be evident
Grounds tidy

c) GOOD CONDITION

Natural decay reduced by good maintenance, obvious improvements
Newly painted walls, roof and guttering
Parts of building likely to have been renewed and possible new additions
Grounds well kept

HOUSE SIZE CLASSIFICATION

SMALL: Less than 80m² (8.6 squares). Generally 1 or 2 bedrooms.

MEDIUM: Greater than 80m² to 150m² (8.6 - 16 squares). 3 bedrooms.

LARGE: Greater than 150m² (16 squares). 4 or more bedrooms.
APPENDIX G

Development subsidies available to local government in NSW.
(major source: PEC, 1980).

<table>
<thead>
<tr>
<th>Subsidy Available for:</th>
<th>Administrating Body</th>
<th>Extent of Subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performing Arts Centres</td>
<td>Cultural Grant Advisory Council</td>
<td>50% of cost provided on a $ for $ basis.</td>
</tr>
<tr>
<td>Art Galleries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual arts and crafts centres and workshops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community art centres and museums or the cultural component of multi-purpose centres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baby health centres</td>
<td>Health Commission of NSW</td>
<td>75% of the cost of the building and equipment</td>
</tr>
<tr>
<td>Fluoridation plants</td>
<td>Health Commission of NSW</td>
<td>50% of cost</td>
</tr>
<tr>
<td>Improvements to Crown Reserves and Showgrounds of which the Council is a Trustee</td>
<td>Dept. of Lands</td>
<td>Grant and/or loan. Both are on a $ for $ basis. Loans up to $10,000 over 10 years at 5% interest</td>
</tr>
<tr>
<td>Libraries</td>
<td>Premiers Dept. &amp; Library Council of NSW</td>
<td>1$ per head of population on a $ for $ basis. Also special grants are available for the regionalisation of services</td>
</tr>
<tr>
<td>Sewerage &amp; Water Supply Schemes</td>
<td>Public Works Dept</td>
<td>Available where the expected per capita annual rate for approved schemes exceeds $26. The subsidy may reduce the rate to $26 up to a maximum of 50% of the total cost. Also the PWD will meet the first $10,000 of the initial investigation and report</td>
</tr>
<tr>
<td>Subsidy Available for:</td>
<td>Administrating Body</td>
<td>Extent of Subsidy</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------</td>
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</tr>
<tr>
<td>Breakwater construction and land reclamation for the fishing industry and pleasure craft</td>
<td>Dept of Public Works</td>
<td>Grants are available for work which exceeds the resources of local councils</td>
</tr>
<tr>
<td>Works to mitigate flooding (tidal areas) and to improve/protect beaches and associated facilities</td>
<td>Dept. of Public Works</td>
<td>This grant need not be matched</td>
</tr>
</tbody>
</table>
| Flood mitigation (non-tidal areas) | Water Resources Commission | (i) Urban areas - up to half the cost  
(ii) Rural (farming areas) - up to 2/3 of the cost |
| Construction of depots, and equipment to enable Councils to carry out various plant eradication | Soil Conservation Service | This grant need not be matched |
| Facilities for sport, recreation, and tourism | Dept. of Sport, Recreation and Tourism | $ for $ basis |
| Roads and bridges | Dept. of Main Roads | (i) Full cost of approved road and bridge work on main roads and highways  
(ii) half the cost on secondary and tourist roads. (Special provisions apply to the County of Cumberland) |
| Developmental roads and works | Dept. of Main Roads and Federal Government | Full cost of new construction |
**DEVELOPMENT SUBSIDIES**

<table>
<thead>
<tr>
<th>Subsidy Available for:</th>
<th>Administrating Body</th>
<th>Extent of Subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural and urban local roads</td>
<td>Dept. of Main Roads and Federal Government</td>
<td>Commonwealth Grants (i) Urban: grant formula takes account of total length of urban roads and the Council area's population (ii) Rural: bridges on a $ for $ basis.</td>
</tr>
<tr>
<td>Footpaths</td>
<td>Dept. of Main Roads</td>
<td>$ for $ for foot-paths on existing bridges on all main, secondary and tourist roads</td>
</tr>
</tbody>
</table>

**GENERAL FINANCIAL ASSISTANCE**

<table>
<thead>
<tr>
<th>General resources:</th>
<th>Local Government Grants Commission Administering the Commonwealth Revenue Sharing Fund</th>
<th>Assessed individually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistance to Councils for such purposes as Councils see fit</td>
<td>Local Government Assistance Fund</td>
<td>Assessed individually</td>
</tr>
<tr>
<td>Ministers Grant and Aid</td>
<td>At the Minister's personal discretion discretion</td>
<td></td>
</tr>
<tr>
<td>Subsidy Available for:</td>
<td>Administering Body</td>
<td>Extent of Subsidy</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Restoration of Council owned works or assets following storms, floods or bushfires</td>
<td>Dept. of Public Works</td>
<td>(i) $ for $ basis (ii) where a natural disaster area is declared 75% of the first $10,000 and 100% of the balance</td>
</tr>
<tr>
<td>Restoration of roads and bridges following floods etc.</td>
<td>Dept. of Main Roads</td>
<td>Conditions for grants are under constant review. Initial grants may be issued to meet estimated costs of essential emergency works for communication reestablishment and for passage of emergency supplies and services</td>
</tr>
</tbody>
</table>