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Anzac Creek Floodplain Risk Management Study and Plan

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Anzac Creek
Floodplain Risk Management Study and Plan

Prepared For:	Liverpool City Council
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Title :	Anzac Creek Floodplain Risk Management Study and Plan
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Synopsis :	This report documents the Anzac Creek Floodplain Risk Management Study and Plan which investigates and presents a flood risk management strategy for the catchment. The study identifies the existing flooding characteristics and canvasses various measures to mitigate the effects of flooding. The end product is the Floodplain Management Plan, which describes how flood liable lands within the Anzac Creek catchment are to be managed in the future.

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EXECUTIVE SUMMARY

Introduction

Anzac Creek is a small tributary of the Georges River with a catchment area of some 10.6 km^2 lying entirely within the Liverpool Local Government Area.

Urban development within the catchment mainly consists of the relatively recent residential developments of Wattle Grove and Anzac Village located to the south (upstream) of the M5 Motorway. To the north (downstream) of the M5 Motorway is an extensive area of industrial/commercial development within the Moorebank Industrial Area, generally located between Heathcote Road and Newbridge Road. On the fringes of this industrial estate are pockets of older residential development within the Moorebank locality. Approximately 35% of the catchment remains undeveloped, principally in the part of the catchment occupied by the Military Reserve and the bushland south of the East Hills railway line.

The Georges River Floodplain Risk Management Study (Bewsher Consulting, 2004) identified the Anzac Creek catchment as a potential flood problem area. At the time of completion of that study, no detailed flooding investigations of Anzac Creek had been undertaken, and the study recommended further detailed investigation of the flooding characteristics of Anzac Creek.

The Anzac Creek Flood Study was completed in December 2005 (Bewsher Consulting, 2005). The outcome of this study was the production of flood inundation and flood risk mapping for Anzac Creek, generated from detailed hydrologic and hydraulic modelling of the catchment. The flood study represents the initial stage in the floodplain management process and establishes the basis for the current floodplain risk management study.

The objectives of the Anzac Creek Floodplain Risk Management Study are to:

- Identify and assess measures for the mitigation of existing flood risk;
- Identify and assess planning and development controls to reduce future flood risks; and
- Present a recommended floodplain management plan that outlines the best possible measures to reduce flood damages in the Anzac Creek catchment.

The following provides an overview of the key findings and outcomes of the study, incorporating a review of design flood conditions within the catchment, assessment of potential floodplain management measures and a recommended Floodplain Management Plan.

Flooding Behaviour

Using detailed modelling of the hydrologic and hydraulic characteristics of the catchment, the Anzac Creek Flood Study (Bewsher Consulting, 2005) established peak flood levels, flows and inundation extents for a range of probabilistic design event magnitudes up to the probable maximum flood (PMF). These design flood characteristics were presented in a series of flood maps for the study area in association with flood risk maps defining low, medium and high hazard areas, which have been considered as the basis for investigating floodplain management options.

Upstream of the M5 Motorway, flooding is generally confined within the main channel of Anzac Creek. Effective conveyance of flood discharges in the main channel up to the 100-year ARI flood event results in very little floodplain inundation and no inundation of residential properties within the Wattle Grove development, located adjacent to Anzac Creek. The existing culverts through the M5 Motorway embankment adequately convey floods to the downstream reaches of the catchment without significant detention and backwater accumulation.

Downstream of the M5 Motorway there is extensive floodplain inundation for events in excess of the 5-year ARI, with flooding highly influenced by flood conditions in the Georges River. The backwater influence of Georges River flooding extends as far upstream as the M5 Motorway and results in extensive, albeit low velocity, inundation.

A flood damages databases has been developed to identify potentially flood affected properties and to quantify the extent of damages in economic terms for existing flood conditions. Key results from the database indicate:

- 1015 residential homes and 183 commercial/industrial buildings would be flooded above floor level in the PMF;
- 64 residential homes and 58 commercial/industrial buildings would be flooded above floor level in the 100-year ARI flood;
- The predicted flood damage costs in the 100-year ARI flood is of the order of $29.6M.

The properties identified as being flooded correspond to those occupying the lowest topography in the catchment and include residential property adjacent to Ernie Smith Reserve in Junction Rd/Gal Cr, residential property adjacent to Clinch's Pond in Swain St., Bradshaw Av. and Market St, industrial/commercial property in Seton Rd, Iraking Av and Kelso Cr (Moorebank Industrial Area) and industrial/commercial property along Centenary Av, between M5 and Heathcote Rd.

Community Consultation

Consultation with the community was undertaken, and was aimed at informing the community about the development of the floodplain management study and its likely outcome as well as improving the community's awareness and readiness for flooding. The consultation process provided an opportunity to collect information on the community's flood experience, their concern on flooding issues and to collect feedback and ideas on potential floodplain management measures and other related issues. The key elements of the consultation program ivolved:

- Meeting with, and presentations to, the Liverpool Floodplain Management Committee;
- Issuing a media release on the study and publishing a newspaper advertisement in local news papers and Council's web site about the study;
- Distribution of a short questionnaire with an introduction letter about the study to all landowners, residents and businesses which have a flood risk, followed up with a detailed questionnaire;
- Organisation of public workshops to discuss the findings of the study and obtain feedback from the community;

- Liaison with range of government agencies and interest groups who may have an interest and/or assets within the study area; and
- Public exhibition of the recommended floodplain risk management study and plan, prior to adoption by Council.

The key community concerns expressed through the questionnaires and workshops included:

- Stormwater flooding (local drainage) problems in the study area;
- Concern over future development in the catchment;
- Concern about the potential flood impact of rubbish, trees, shrubs and vegetation growth in the creek;
- Request for additional information on flooding and the flood study.

Input was sought from numerous government agencies and groups that may have assets, interests and /or infrastructure in the Anzac Creek catchment. No specific issues or comment was raised by these agencies and groups in relation to floodplain management in Anzac Creek.

Recommendations from the Georges River FRMS Relevant to Anzac Creek

Flooding in the lower part of the Anzac Creek catchment is dominated by the Georges River. Almost all of the identified flood affected properties within Anzac Creek are influenced by the Georges River. Therefore many of the floodplain management issues addressed by the Georges River FRMS (Bewsher Consulting, 2004) are applicable to Anzac Creek.

The recommendations made by the Georges River FRMS that are relevant to Anzac Creek include:

- *Adoption of consistent planning and development controls* - A Draft Consolidated DCP is currently in preparation, applicable for all development in the Liverpool LGA (except CBD) that embodies the recommendations from the Georges River FRMS. Accordingly this document will apply to the Anzac Creek catchment. Model DCP provisions provided in the Georges River Study apply to the whole LGA, with a matrix of development controls applied as a separate schedule to the DCP as floodplain management studies are undertaken for the various catchments in the LGA. These controls have been reviewed as part of the Anzac Creek study, and the controls previously recommended for the Georges River are recommended to also apply to the Anzac Creek catchment. Therefore the schedule just needs to be duplicated in the DCP.
- *Flood warning enhancements* - Flood warning system enhancements proposed by the Georges River FRMS would have direct benefit for the lower Anzac Creek catchment dominated by Georges River backwater flooding. Linking of the property databases to the existing flood warning system would improve dissemination of flood gauge and warning data, enabling rapid identification of 'at risk' properties and coordination of targeted emergency response activities. The database could be linked to a GIS system providing for enhanced flood warning prediction at a property by property level. The first stage of this work has been completed through a pilot project. The Anzac Creek part of the database could now be reviewed and updated where appropriate. However, the enhanced flood warning capability of the Georges River system does not provide any benefit for the additional flood risk property identified in the Anzac Creek study for the reaches upstream of the M5 Motorway. In the upper catchment, the flooding mechanisms are

not related to Georges River flooding. Sophisticated forecasting for locally derived flooding would have little benefit for the upper catchment of Anzac Creek considering the short warning and response times between significant rainfall and flooding.

- *Improved emergency management operations* - The Georges River FRMS recommended that the Local Flood Plan covering the Georges River is updated with additional flood information developed as part of the study. The majority of the flood affected properties in the lower Anzac Creek catchment are included in the Georges River databases. The additional detail on flood risk mapping, design flood conditions and the property database developed through the Anzac Creek FRMS should be used to update and supplement existing databases and to refine the Local Flood Plan where relevant. Also, given the potential for most of the major arterial roads to be cut early by floodwaters, and the large number of residents that could be affected during severe floods, an evacuation strategy study was recommended in the Georges River FRMS. The objectives of the study are to determine appropriate evacuation centres, numbers to be allowed for, evacuation routes and other evacuation methods. This study would encompass the majority of the flood affected areas of the Anzac Creek catchment without any additional scope.

- *Improved public awareness* – raising flood awareness in the community through the issue of flood certificates, community education programs, and the construction of historical flood markers. The relatively low response rate to the community questionnaires was a reflection of the lack of flooding experience and/or awareness held by the existing community, and highlighted a need for community education particularly in the recently developed areas of Wattle Grove and Anzac Village.

Other Floodplain Management Options Considered

The Anzac Creek Floodplain Management Study considered and assessed a number other floodplain management measures in addition to those recommended from the Georges River FRMS discussed above. The key findings are given below and summarised in Table S1.

Georges River Levee

Two breakouts from the right bank of the Georges River occur just upstream of Newbridge Road. These spills from the Georges River contribute additional flood flow to affected property in the Anzac Creek catchment, in particularly the residential area in the locality of Clinch's Pond. Modelling indicates that whilst a levee would be effective in eliminating these spills from the Georges River in this location, the net effect on flood levels in the Anzac Creek catchment is negligible given the backwater influence of the Georges River on flood conditions in this lower part of the Anzac Creek catchment. The levee would also result in minor increases in flood level on the left bank of the Georges River. This potential adverse impact and the negligible benefit for flood affected property in the Anzac Creek catchment confirms that this levee is not a viable mitigation option.

Channel Maintenance

Channel maintenance is a topical issue within the community with concerns of increased flooding because the creek flow is blocked by trees, vegetation, shrubs and other rubbish collected in the creek. The reach of Anzac Creek most affected by in-stream vegetation at present is the lower reach downstream of the M5 Motorway. The upper reach adjacent to the Wattle Grove residential

development is essentially free from any major vegetation growth that would restrict channel capacity. Modelling of increased channel roughness (simulating vegetation growth) indicates that channel condition does not have a major impact of flood levels, particularly downstream of the M5 Motorway where peak levels are controlled by backwater flooding.

Despite the little direct benefit in terms of flood inundation to property, a stream vegetation management program would nevertheless reduce the propensity for culvert blockage. Flood borne debris, particularly large woody debris, can easily build up at the upstream face of a culvert reducing the conveyance capacity of the structure. Other benefits not related to floodplain management may be achieved through stream clearing include aesthetic and environmental improvements. The vegetation removal may form a component of a more comprehensive creek rehabilitation and maintenance project. A channel maintenance program is not critical for Anzac Creek floodplain management, but has been recommended for further consideration at this stage.

M5 Culvert Blockage Protection

The M5 Motorway forms an embankment across the floodplain and under existing design flood conditions all of the Anzac Creek flow is conveyed through a set of culverts under the embankment. Substantial blockage of this structure can have a significant impact on upstream flood levels, particularly in the event of a full culvert blockage, including possible embankment collapse, where there is no alternative overland flow route for floodwaters.

As a result of a 100% M5 culvert blockage, an additional 130 properties would be subject to flood inundation compared with normal existing conditions for the 100-year ARI event (assuming no culvert blockage), resulting in additional estimated flood damage costs of $12M. Given the significant damage potential in the event of a major culvert blockage, preventative measures are therefore a potential flood mitigation option. A series of bollards may be installed at a suitable distance upstream of the culvert opening preventing large obstructions carried in the channel from blocking the culvert entrance. In the event of an obstruction at the bollards, sufficient channel/floodplain capacity can be maintained to convey floodwater around the obstruction allowing the culverts to operate normally.

Local Catchment Studies

In addition to channel maintenance, concerns over capacity and maintenance of stormwater drainage infrastructure was a popular issue in the community. Local catchment studies to address stormwater and overland flow issues are recommended for potential problem areas. The flooding analysis for the Anzac Creek catchment presented in this study is focused on mainstream flooding and does not consider local flooding behaviour in minor sub-catchments.

Upstream Detention

Flood detention basins provide additional temporary flood storage, thereby attenuating peak flood flows and reducing downstream flood impact. There is not a major flooding problem under existing conditions in the catchment upstream of the M5 Motorway, and downstream of the motorway flooding is dominated by Georges River flooding conditions. Therefore provision of additional upstream detention would have no major influence in reducing flood risk. Flood detention is therefore not considered appropriate for the catchment.

Channel Widening

The capacity of the watercourse to discharge flood flows can be increased by opening up the waterway area. No property upstream of the M5 motorway is identified within the 100-year flood envelope as the existing Anzac Creek channel and floodplain has sufficient flood capacity. Downstream of the M5 motorway, increasing channel conveyance will have little if any impact on peak flood conditions as flooding is predominantly governed by backwater conditions from the Georges River. Channel widening therefore is not considered appropriate for the catchment.

Flood Gates

Prevention of backwater flooding from the Georges River via flood gates or other hydraulic control structures could potentially reduced the number of flood affected properties. Flood gates at the M5 Motorway embankment would be a suitable control point, however, this would provide little benefit as there is minimal Georges River backwater influence upstream of this point. Other structures in downstream areas are not feasible given that many of the roads are overtopped such that flow control could not be achieved within the extensive inundation area.

Voluntary Purchase

Voluntary Purchase Schemes are generally applicable only to areas where flood mitigation is impractical and the existing flood risk is unacceptable. No property has been identified as suitable for voluntary purchase within the Anzac Creek catchment. Therefore there is no recommendation for such a scheme in the Floodplain Risk Management Plan.

Voluntary House Raising/Flood Proofing

Voluntary house raising is proposed as part of the Anzac Creek Floodplain Management Plan for those residential property that are below the 100 year ARI flood level, after other flood mitigation measures have been exhausted. A detailed list of individual properties suitable for house raising has not been developed, but would require a property floor level survey and consideration of individual property construction type. Therefore a scoping study is recommended in the first instance to determine the number of properties to be raised based on floor levels and construction type. The scoping study would investigate properties identified within the 100-year ARI flood envelope and include individual property surveys (floor levels and construction type). The final list of properties suitable for raising would determine the level of funding and administrative requirements to implement the scheme.

Flood proofing of ground floor blocks of units and commercial properties is also included in the Plan to minimise damage that may be sustained from flooding. These measures would be particularly suitable to the commercial/industrial properties in the Moorebank Industrial Area, and applicable for all new developments in this area.

Table S1: Summary of Floodplain Management Options Considered

Description	Report Section	Recommended
1. Review of Georges River Recommendations		
Planning and Development Controls	7.1	Yes
Flood Warning Enhancements	7.2	Yes
Emergency Management Operations	7.3	Yes
Public Awareness	7.4	Yes
2. Other Potential Floodplain Management Measures		
Georges River Levee	8.3.1	No
Channel Maintenance	8.3.2	Yes
Culvert Blockage Protection	8.3.3	Yes
Local Catchment Studies	8.3.4.1	Yes
Upstream Detention	8.3.4.2	No
Channel Widening	8.3.4.3	No
Flood Gates	8.3.4.4	No
Voluntary Purchase Scheme	8.3.4.5	No
Voluntary House Raising/Flood Proofing	8.3.4.6	Yes

The Recommended Floodplain Management Plan and Implementation

A recommended floodplain management plan showing preferred floodplain management measures for Anzac Creek is presented in Table 9-1 and Figure 9-1 in the main body of the report. The key features of the plan are outlined below.

Recommended options that modify flood behaviour include:

- Culvert blockage protection at the upstream side of the M5 Motorway embankment;
- Channel maintenance program to clear the creek corridors of debris, excessive vegetation and other man-made obstructions to maintain capacity of the existing channel and floodplain; and
- Local catchment (drainage/overland flows) studies to identify existing flooding problems and required upgrade works to the existing stormwater drainage system.

Recommended options that modify property include:

- Initial scoping study to identify suitable property for voluntary house raising leading to subsidised program of house raising;
- Flood proofing of individual buildings (particularly Moorebank Industrial Area); and
- Controls on new development through a planning matrix approach that provides guidance on appropriate land uses and other development controls.

Recommended options that modify flood response include:

- Improved flood awareness through issue of flood information (Council and SES);
- Update of local flood plans with current design flood information; including additional flood risk areas identified upstream of M5 motorway; and
- Update emergency evacuation procedures in Local Flood Plan based on revised flooding information.

The steps in progressing the floodplain management process from this point forward are as follows:

1. Council allocates priorities to components of the Plan, based on available sources of funding and budgetary constraints;
2. Council submits an application for funding assistance to DECC, and negotiates other sources of funding such as through the “Natural Disaster Mitigation Package” (NDMP); and
3. as funds become available, implementation of the Plan proceeds in accordance with established priorities.

The Plan should be regarded as a dynamic instrument requiring review and modification over time. The catalyst for change could include new flood events and experiences, legislative change, alterations in the availability of funding or changes to the area’s planning strategies. In any event, a thorough review every five years is warranted to ensure the ongoing relevance of the Plan.

As much of the Plan is linked with the Georges River FRMP, it is imperative that a review of the Anzac Creek FRMP is considered in conjunction with any review of the Georges River FRMP.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 The Floodplain Management Process

The State Government's Flood Prone Land Policy is directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas. Policy and practice are defined in the Government's Floodplain Development Manual (2005).

Under the Policy the management of flood liable land remains the responsibility of Local Government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government through the following four sequential stages:

Table 1-1 Stages of Floodplain Management

	Stage	Description
1	Flood Study	Determines the nature and extent of the flood problem.
2	Floodplain Risk Management Study	Evaluates management options for the floodplain in respect of both existing and proposed developments.
3	Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4	Implementation of the Floodplain Risk Management Plan	Construction of flood mitigation works to protect existing development. Use of environmental plans to ensure new development is compatible with the flood hazard.

Liverpool City Council is responsible for local planning and land management within the Liverpool Local Government Area (LGA) including the management of the floodplain of the Anzac Creek catchment.

The first stage of the process, The Anzac Creek Flood Study (Bewsher Consulting, 2005) defines the existing flood behaviour and establishes the basis for future floodplain management activities.

The Anzac Creek Floodplain Risk Management Study and Plan (this document) constitutes the second and third stages of the management process. It has been prepared for Liverpool City Council and the Liverpool Floodplain Management Committee to provide the basis for future management of flood liable land within the catchment. **The study has been commissioned by Liverpool City Council with funding assistance from the NSW Department of Environment and Climate Change (DECC).**

1.2 The Study Area

Anzac Creek is a small tributary of the Georges River, and lies entirely within the Liverpool LGA. The catchment covers an area of approximately 10.6 km^2 and is shown in Figure 1-1.

Anzac Creek commences in the Military Reserve between Chatham Village and Holsworthy Village. The creek drains in a northerly direction beside Wattle Grove and Anzac Village to Heathcote Road, and through Moorebank to Newbridge Road, where it ultimately joins Lake Moore and the Georges River.

Approximately 35% of the catchment remains undeveloped, principally in the part of the catchment occupied by the Military Reserve and the bushland south of the East Hills railway line.

The principal urban development within the catchment consists of the relatively recent residential developments of Wattle Grove and Anzac Village located to the south (upstream) of the M5 Motorway. To the north (downstream) of the M5 Motorway is an extensive area of industrial/commercial development within the Moorebank Industrial Area, generally located between Heathcote Road and Newbridge Road. On the fringes of this industrial estate are pockets of older residential development within the Moorebank locality.

The lower catchment is traversed by a number of significant transport routes, including the M5 Motorway, Heathcote Road, and Newbridge Road. These routes represent important transport connections between Liverpool (and the outer west) and the southern Sydney suburbs.

Further detail on the Anzac Creek catchment is given in Section 2.1.

1.3 Study Background and Objectives

The Georges River Floodplain Risk Management Study (Bewsher Consulting, 2004) identified the Anzac Creek catchment as a potential flood problem area. Historical reports of flooding were associated with backwater flooding from the Georges River in the lower end of the catchment. At that stage, no detailed flooding investigations of Anzac Creek had been undertaken, and the study recommended a flood study of Anzac Creek and subsequent refinement of flood risk maps, particularly associated with Anzac Creek catchment runoff.

Following this recommendation, the Anzac Creek Flood Study was completed in December 2005 (Bewsher Consulting, 2005). The outcome of this study was the production of flood inundation and flood risk mapping for Anzac Creek, generated from detailed hydrologic and hydraulic modelling of the catchment. The flood study represents the initial stage in the floodplain management process and establishes the basis for the current floodplain management study.

Floodplain management in NSW is driven by the State Government's Flood Prone Land Policy and the Floodplain Development Manual. The principal objectives of the policy are:

- Reducing the impact of flooding and flood liability on individual owners and occupiers of flood prone land property; and
- Reducing the private and public losses resulting from floods.

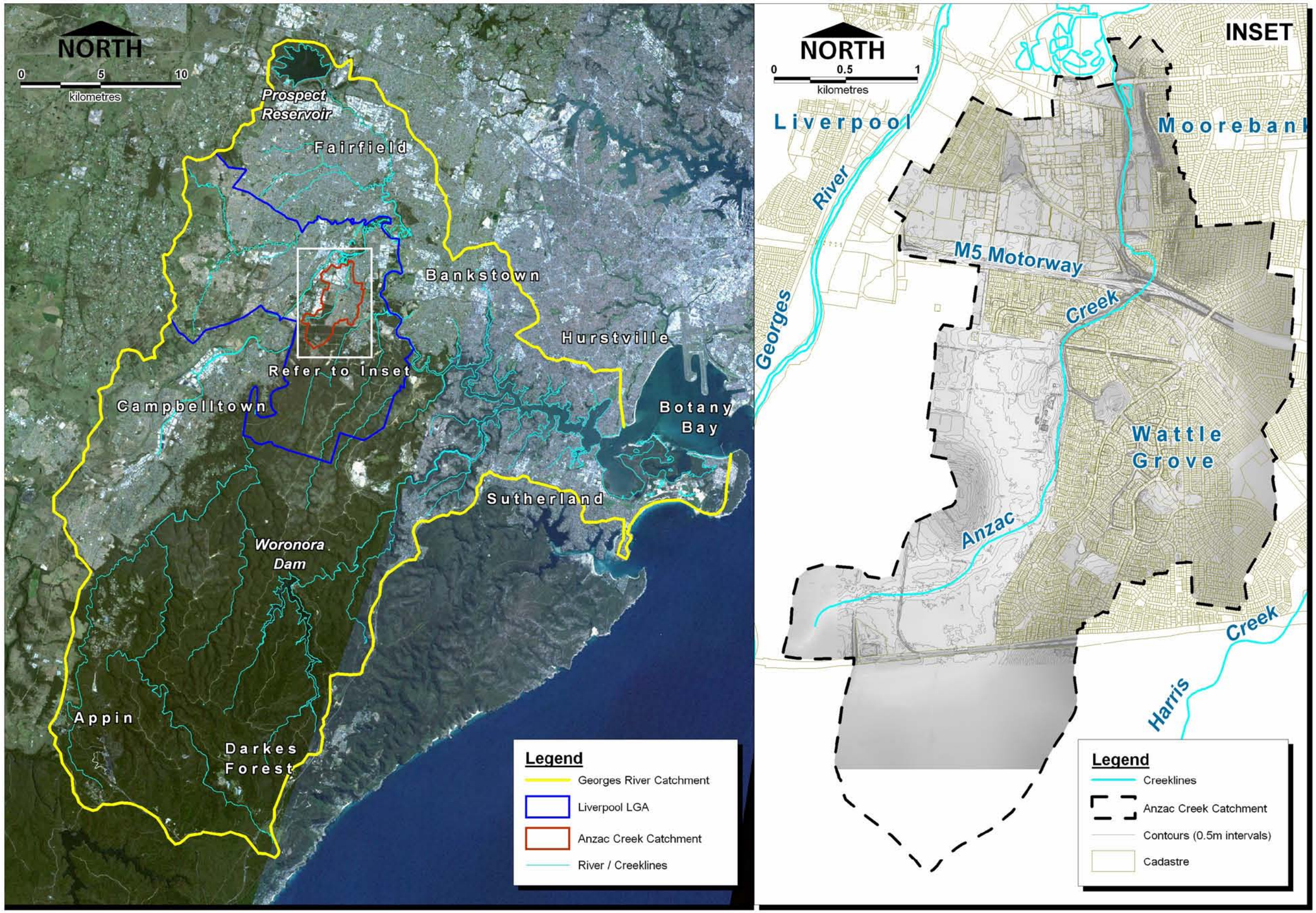

Figure 1-1 The Study Area

A Flood Risk Management Study describes how particular areas of flood prone land are to be used and manage to achieve defined objectives (NSW Floodplain Development Manual, 2005). The principal objective of the flood risk management strategy is to ensure suitable and sustainable use of development of land within the catchment. The Floodplain Management Study seeks to fully identify the flood problem and canvass various measures to mitigate the effects of flooding. The end product is the Floodplain Management Plan, which describes how flood liable lands are to be managed in the future.

In this context, the Anzac Creek Floodplain Risk Management Study is required to:

- Identify and assess measures for the mitigation of existing flood risk;
- Identify and assess planning and development controls to reduce future flood risks; and
- Present a recommended floodplain management plan that outlines the best possible measures to reduce flood damages in the Anzac Creek catchment.

This Floodplain Management process requires community interaction to ensure that the proposals are fully understood and supported. The success of a Floodplain Management Plan hinges on its acceptance by the community, residents within the study area, and other stake holders. This is best be achieved by engaging with the local community and stakeholders at all stages of the decision-making process.

1.4 About This Report

This report documents the Study's objectives, results and recommendations.

Section 1 introduces the study.

Section 2 provides some background information.

Section 3 outlines the community consultation program undertaken.

Section 4 details the modelling approach and presents design flood results.

Section 5 provides a summary of the flood damages assessment.

Section 6 provides a review of relevant existing planning measures and controls.

Section 7 provides an overview of recommendations from the Georges River FRMS relevant to the Anzac Creek catchment.

Section 8 details the assessment of other potential floodplain management measures.

Section 9 presents the recommended measures and an implementation plan.

2 BACKGROUND

2.1 Catchment Description

The extent of the Anzac Creek catchment is shown in Figure 2-1.

The key feature physical features of the catchment include:

- located entirely within the Liverpool LGA;
- catchment covers an area of approximately 10.6 km^2;
- extends from the Military Reserve upstream of the East Hills railway line in the south to Lake Moore on the Georges River in the north;
- covers parts of the suburbs of Wattle Grove, Anzac Village and Moorebank;
- incorporates parts of the Moorebank Military Reserve and the Defence National Storage and Distribution Centre;
- mainstream length of approximately 5km;
- traversed by the M5 Motorway corridor and other major transport routes including Heathcote Road and Newbridge Road; and
- has no significant tributaries.

The land use within the catchment is predominantly residential, though there are significant pockets of commercial/industrial property. A significant proportion of the catchment remains undeveloped including protected bushland and other environmentally significant areas. Whilst no formal plans for future development within the catchment exist, some areas have been identified for future development that are discussed further in Section 6.6.

The land use distribution in the catchment is shown in Figure 2-2.

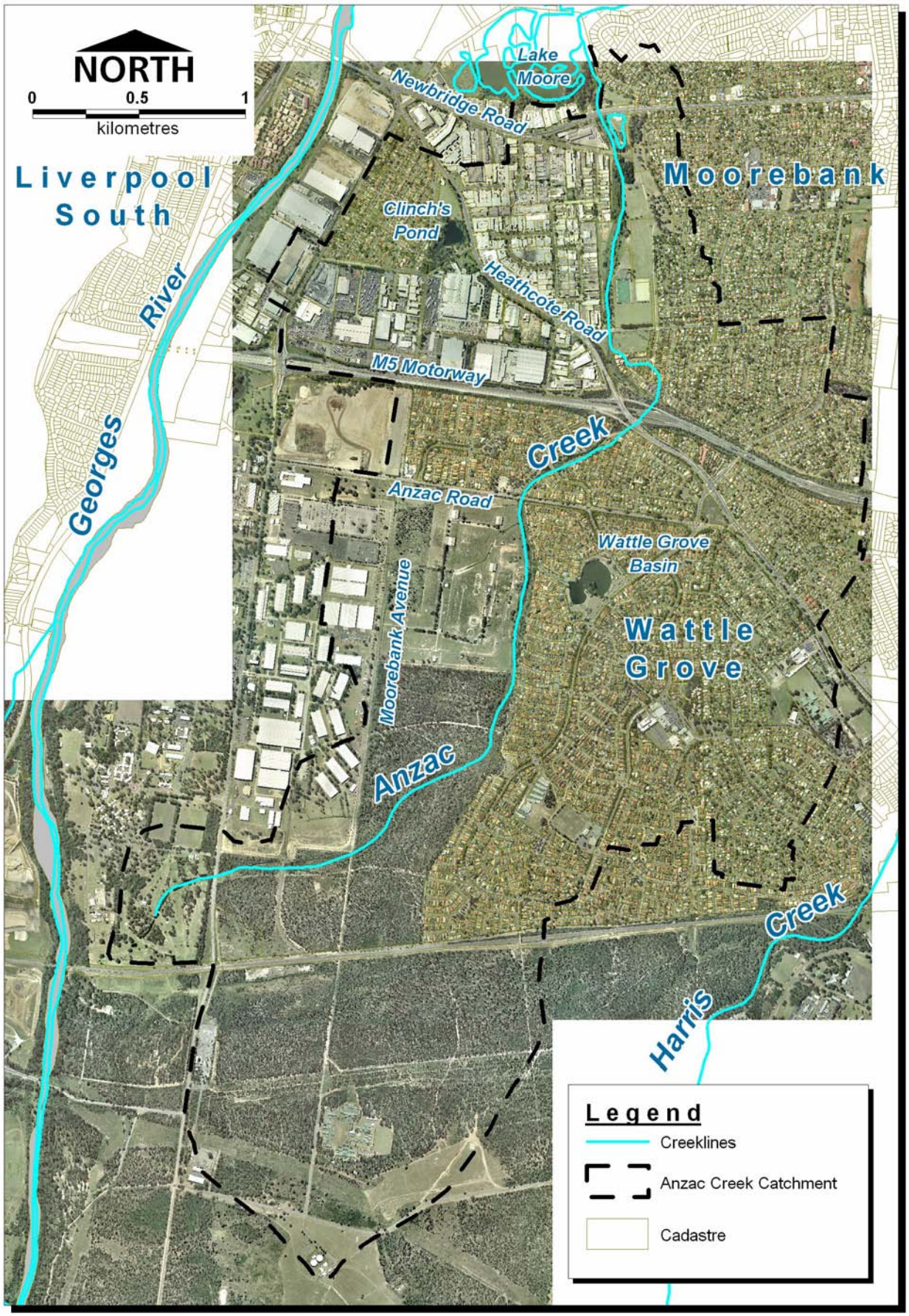

Figure 2-1 Anzac Creek Catchment

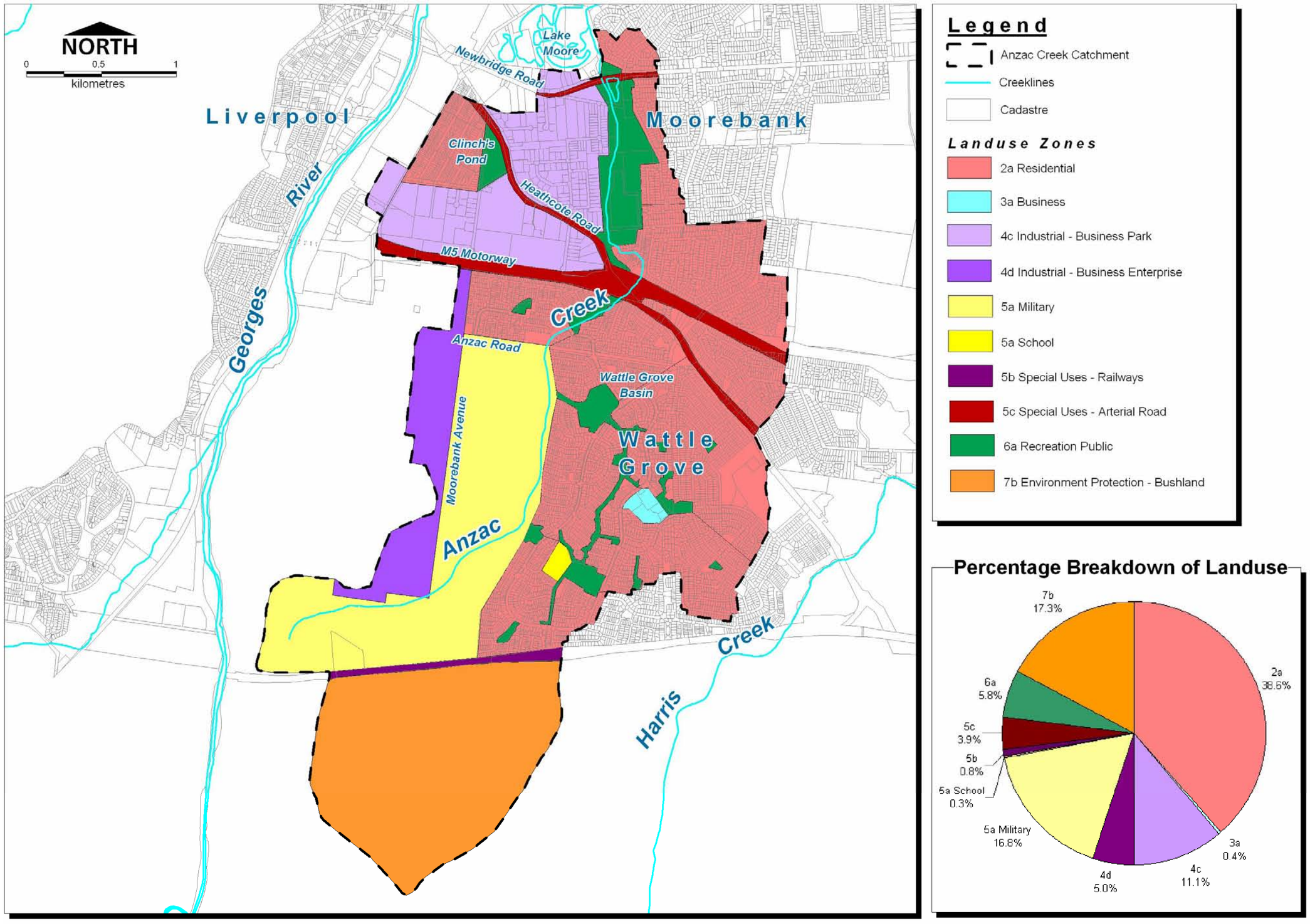

Figure 2-2 Land Use Zoning in the Anzac Creek Catchment

2.2 Flood History

The Georges River has a well recorded flood history, including relatively recent flood events in August 1986 and April 1988. The largest flood to occur in the 1900's was the February 1956 flood, with the largest flood on record occurring in February 1873. Other significant flood events reported include 1887, 1889, 1898, 1933, 1950 and 1964.

Given the interaction of the Georges River and Anzac Creek floodplains this historical flooding has significance in the context of the lower reaches of Anzac Creek. By contrast, historical flooding information further upstream in the Anzac Creek catchment is somewhat scarce.

During the course of the Anzac Creek Flood Study (Bewsher Consulting, 2005), a questionnaire was distributed to residents within the Anzac Creek catchment. Very little feedback was received on experiences of flooding of their own property or observations of flooding elsewhere in the study catchment. Bewsher Consulting identified the lack of historical flood information for the Anzac Creek catchment, citing that this was not surprising given that:

- Recent floods along the Georges River (e.g. August 1986, April 1988) were a product of long duration storms that produced only minor problems, if any, in the smaller Georges River tributaries;
- The Wattle Grove residential development in the upper catchment is a relatively new development with dedicated flood corridor along the watercourse; and
- The residential and industrial estates in Moorebank are generally set back from the creek.

The lack of historical flood detail for Anzac Creek is again reflected in the community responses to the questionnaires distributed for the Floodplain Risk Management Study. Further detail on the responses received is provided in Section 3 and Appendix B, however generally most residents were yet to experience any major flooding, including longer-term residents (40years+).

Significant flooding of the Anzac Creek catchment has tended to coincide with Georges River Flood events. Figure 2-5 to Figure 2-4 show photographs depicting flooding in the lower Anzac Creek catchment for the 1986 and 1988 events.

Figure 2-3 and Figure 2-4 show significant inundation during the 1986 flood event in the Moorebank Industrial area, in the vicinity of Iraking Rd and Seton Rd. Within the Anzac Creek catchment, the Moorebank Industrial area is perhaps the worst locality in regard to flooding frequency and inundation depth. This is due to the low lying topography in close proximity to Anzac Creek and the influence of backwater flooding from the Georges River.

Figure 2-5 and Figure 2-6 show flooding during the 1988 flood event in the area around Junction Road. Junction Road has been inundated in numerous recent events, including the 1988 event as shown in Figure 2-5. There are a number of residential properties in Junction Road/Gal Crescent, adjacent to the Ern Smith playing fields, which are relatively low lying and have been subject to inundation during previous events. Figure 2-6 shows sand bagging at a residential property during the 1988 event, in an attempt to limit inundation of the property as floodwaters rose. This is an example of the type of activities typically undertaken by the SES flood emergency response teams.

Figure 2-3 Iraking Avenue Looking South from Seton Road Corner (August 1986)

Figure 2-4 Iraking Avenue looking North from Seton Road Corner (August 1986)

Figure 2-5 Junction Road Looking West from Renton Avenue Corner (April 1988)

Figure 2-6 SES Sandbags at No.79 Junction Road (April 1988)

(Photographs in Figure 2-5 and Figure 2-6 courtesy of Mr. Bob Berg)

2.3 Previous Studies

A number of previous investigations have investigated flooding conditions in Anzac Creek and more widely in the Georges River floodplain. Some of the studies with particular relevance to the current study are discussed briefly below.

- Anzac Creek Flood Study (Bewsher Consulting, 2005) – This study incorporates a detailed analysis through numerical modelling of the hydrologic and hydraulic characteristics of the Anzac Creek catchment. The report documents the flood levels, flows and extents of inundation for the 5-year ARI, 20-year ARI, 50-year ARI, 100-year ARI and probable maximum flood (PMF) events. The study findings form the basis for the current floodplain management investigations.

- Georges River Floodplain Risk Management Study (Bewsher Consulting, 2004) – This study was undertaken for the Georges River catchment encompassing the Liverpool, Fairfield, Bankstown and Sutherland LGA's. The study incorporated the development of a detailed Mike-11 numerical model of the Georges River from Cambridge Avenue Glenfield to Botany Bay.

  Being a tributary of the Georges River, the Anzac Creek catchment was to some degree addressed in the study, predominantly the lower reaches in the vicinity of the confluence. A key finding of the study was the lack of flooding information for the upper reaches Anzac Creek and therefore the unknown potential flood risk. This lead to the recommendation to undertake the Anzac Creek Flood Study.

- Georges River Flood Study (Public Works Department, 1991) – This study used a physical scale model of the Georges River to simulate flood conditions between Picnic Point and Liverpool. Results obtained from this study were used for calibration of the Mike-11 numerical model developed for the Georges River FRMS.

3 COMMUNITY CONSULTATION

3.1 Community Consultation Process

Community consultation has been an important component of the current study. The consultation has aimed to inform the community about the development of the floodplain management study and its likely outcome as well as improving the community's awareness and readiness for flooding. It has also provided an opportunity to collect information on their flood experience, their concern on flooding issues and to collect feedback and ideas on potential floodplain management measures and other related issues.

The key elements of the consultation process have been as follows:

- Meeting with, and presentations to, the Liverpool Floodplain Management Committee;
- Issuing a media release on the study and publishing a newspaper advertisement in local news papers and Council's web site about the study;
- Distribution of a short questionnaire with an introduction letter about the study to all landowners, residents and businesses which have a flood risk, followed up with a detailed questionnaire;
- Organisation of public workshops to discuss the findings of the study and obtain feedback from the community;
- Liaison with range of government agencies and interest groups who may have an interest and/or assets within the study area; and
- Public exhibition of the recommended floodplain risk management study and plan, prior to adoption by Council.

These elements are discussed in detail below.

3.2 Liverpool Floodplain Management Committee

The study has been overseen by the Liverpool Floodplain Management Committee (Committee). The Committee has assisted and advised Council in the development of the Anzac Creek Floodplain Risk Management Study and Plan. Members of the Liverpool Floodplain Management Committee include representatives from the following:

- Staff from Liverpool City Council;
- Staff from DECC (formerly DNR) Sydney Region;
- Staff from Camden, Bankstown, Campbelltown and Fairfield City Council;
- A representative from the State Emergency Service (SES); and
- Four community representatives.

The Committee is responsible for recommending the outcomes of the study for formal consideration by Council.

3.3 Community Survey

On the 4th May 2007, a short questionnaire with a letter introducing the study was sent to all landowners, residents and businesses located within the Anzac Creek floodplain, up to the probable maximum flood level. The questionnaire was sent to approximately 2400 property holders. Council received 116 responses, a response rate of 4.8 percent. This response rate is relatively low, and likely reflects the lack of flooding experience or awareness held by the existing community

3.3.1 Short Questionnaire

The short questionnaire asked three questions:

1. Would you like to be sent a detailed Questionnaire regarding flooding?
2. Would you like to participate in a workshop?
3. Are there any issues that you would like the study to consider?

The majority of the respondents were residential owners of Wattle Grove, a relatively new suburb located between M5 Motorway and East Hills Railway line. A fewer number of respondents were from the suburb of Moorebank, which is an established residential and industrial area in the study area.

Out of 116 responses, 97 expressed their willingness to participate in the study and 19 did not wish to take any part. The results to three questionnaires were summarised in Table 3-1.

Table 3-1 Short Questionnaire Results

Question	Total "yes" Response	Rate
Would you like to be sent a questionnaire?	97	84%
Would you like to participate in a workshop	46	40%
Are there any issues that you would like the study to consider?	41	35%

The complete list of issues and or other comments that were raised is included in Appendix B. The most common issues raised include:

- Concern about rubbish, trees, shrubs and vegetation growth in the creek and request to clean the creek in order to reduce the flood (11 responses);
- Concern over various stormwater issues (8 responses); and
- Request for additional information on flooding and the flood study (14 responses).

3.3.2 Detailed Questionnaire

Detailed questionnaires were distributed to the property owners (97 respondents) that requested one in the short questionnaire response. Questionnaires were also made available through Council's website. A total of 51 Questionnaires were completed and returned to Council, representing a response rate of about 53%.

The questionnaire was divided into a number of parts, dealing with flood experience, opinion on floodplain risk management measures, Council's controls on development and other details. Results from the questionnaire are summarised below, with further details on individual responses provided in Appendix B.

3.3.2.1 PART A: About Your Property

The majority of property owners who responded to the detailed questionnaires were residential owners (45) with a house in the study area. Response to the survey from businesses was very poor with only 8 respondents.

It is to be noted that the majority of the respondents (i.e. 67%) were from the suburb of Wattle Grove.

3.3.2.2 PART B: Your Flood Experience

The majority of the respondents (80%) have never experienced flooding on their properties. Only eight respondents had some local flooding experience. Three residents in Moorebank had experienced the 1986/88 floods. Four residents had experienced flooding above floor level.

Even though the majority of respondents had no flood experience on their properties, most of them (67%) think that their properties could be flooded in the future. Most think their property could be flooded because the creek flow is potentially blocked by trees, vegetation, shrubs and other rubbish collected in the creek.

The proportion of respondents who consider their property at risk flooding would appear relatively high, particularly where very few people had previous flooding experience. It is envisaged that this perception of flood risk is based on the proximity of recent development (Wattle Grove and Anzac Village) to Anzac Creek.

3.3.2.3 PART C: Your Opinion on Floodplain Risk Management Measures

Property owners were asked to identify any measures carried out by Council/owner which reduce flood risk at the property. The majority were not aware of any such measures. Only 30% of respondents were aware of measures such as design of floor levels at specified level and enlarging the capacity of the creek.

The most popular and strongly proposed measure (46%) was to remove all blockages and clean the creek of vegetation growth, trees and all other waste and to develop and maintain a scheduled maintenance program for the creek.

A small number of residents (10%) proposed enlarging the creek capacity. A number of residents were concerned about an increase in flooding on Anzac Creek in the event of future development of

the west bank of the creek and requested that appropriate measures be taken so that the flood risk is not increased. Some were also concerned about the restricted size of drains under the M5 Motorway and ensuring the openings are kept clear. A number of residents apparently situated some distance from Anzac Creek, requested to have improved and well maintained stormwater drainage system in the area.

Other measures proposed by a small number of respondents included dredging the creek, maintenance of detention ponds, encouraging rainwater tanks and increased levels of awareness of flood evacuation routes.

3.3.2.4 PART D: Your Opinion on Council's Controls on Development

Owners were asked their opinion on level of control that Council should place on new development to minimise flood related risks. 38% of respondents believed that Council should stop all new development on land with any potential to flooding. A similar number of respondents also believed that new development should be stopped only in the most dangerous areas of the floodplain.

It appeared that most respondents (48%) were in favour in placing restrictions on development such as minimum floor levels and /or the use of flood compatible building materials. A lower number of respondents also believed that Council should advise people of the flood risks, but individuals should be allowed to choose how they would reduce flood damage on their properties.

Owners were also asked what notification they consider Council should give about the potential for flooding of individual properties. The majority of respondents (64%) were in favour of advising every resident and property owner on a regular basis of the known potential flood threat. A significant number of residents (47%) also believed that prospective purchasers should be advised of the known flood threat to the property. Only a few (15%) believed that Council should advise only those who enquire about the flood potential on the property.

3.3.2.5 PART E: Other Information

Owners were asked to provide their contact details in order to clarify any information provided. 78% of respondents provided their details.

3.3.2.6 Supplementary Questions for Businesses

The detailed questionnaire included some supplementary questions only for businesses operating on the property. Respondents from businesses were very low, only 8%. All the respondents had flood experience on their premises in the past. Their businesses were closed or disturbed for one to two days in the biggest flood, however, the flood did not cause any damage to the property or the stores.

3.4 Liaison with Government Agencies and Groups

As an important component of the Floodplain Risk Management Study, input was sought from numerous government agencies and groups that may have an assets, interests and /or infrastructure in the Anzac Creek catchment. Each agency or organisation was sent an introductory letter, a special questionnaire, and a map of the study area showing the extent of the floodplain. Organisations that were contacted include:

- NSW Department of Environment and Climate Change
- NSW Department of Commerce
- NSW Department of Planning
- Sydney Water Corporation
- NSW Department of Primary Industries (Fisheries)
- NSW Department of Primary Industries (Forests)
- NSW National Parks and Wildlife Services
- Roads & Traffic Authority
- Interlink Roads Pty Ltd
- State Rail Authority
- Rail Infrastructure Corporation
- Rail Corp
- State Emergency Services
- Bureau of Meteorology
- NSW Aboriginal Housing Office
- Gandangara Aboriginal Land Council
- Energy Australia
- Integral Energy Australia
- A.G.L Gas Company
- Telstra
- Optus
- Department of Housing
- Department of Defence
- Defence Housing Authority
- School of Military Engineering
- Chipping Norton Lakes Authority
- Southern Sydney Catchment Management Board
- The Australian Conservation Foundation

A formal response was received from 4 of the 32 organisations contacted. Issues raised by the organisations are summarised below.

3.4.1 The Bureau of Meteorology

The Bureau of Meteorology indicated that there is no flood warning services available specifically for Anzac Creek, but there is for Georges River from Liverpool to Picnic Point. It is noted that warnings for Anzac Creek would be covered only by general weather warning services, such as severe thunderstorm warning, severe weather warning and Flood Watches.

3.4.2 NSW Department of Primary Industries (Fisheries)

NSW Department of Primary Industries (Fisheries) noted that there are no assets or services that could have a potential flood impact in Anzac Creek and no future work is planned within the catchment. It is noted that fish passage in Anzac Creek should not be restricted by flood mitigation work.

3.4.3 RailCorp

RailCorp advised of potential flood damage to assets from floods. This includes potential damage to:

- RailCorp Signalling Equipment and Housings along the rail corridor, which will not operate if flooded. The damage would cost $100,000 to $200,000 and repair would take 3 days to 3 weeks and delays to East Hill line trains could be expected.
- Railway Track along the rail corridor. Track bollards could be washed away from the flood costing approximately $500. Any repairs would take up to one week and cause delays to train service on the East Hill Line.

It is noted that there is no possible future work on the railway line that could affect flood behaviour.

3.4.4 NSW Department of Primary Industries (Forest NSW)

NSW Department of Primary Industries (Forest NSW) informed that they do not have any assets that would be damaged by floods, or services which would have an impact on flooding.

3.4.5 Group of Industrial Entrepreneurs in Moorebank

The group includes Pelsant Pty Ltd, Pan Pacific Construction Pty Ltd and Parilla Pty Ltd who own industrial development in and around Iraking Ave, Moorebank. A representative on behalf of the group provided flood related observation in the area for the past 30years.

The lower end of Iraking Avenue was invariably flooded and impassable. The cul de sac end of Kelso Crescent was also flooded. The easement running back of Pan Pacific Construction Pty Ltd (Seton Road) is silted impeding free flow of storm water. The two exit pipes to Anzac Creek from the easement are full of silt causing flooding of the lower end of Iraking Ave. It is emphasised the need of immediate attention to this issue.

It has been commended Council decision to take floodplain management study for Anzac Creek and however emphasised the need of remedial work for risk prevention or minimisation following the study.

3.5 Workshops

Two community workshops were held at Liverpool City Council Administrative Building in the evening of Wednesday 1 August (within Eastern Neighbourhood Forum) and Thursday 2 August 2007 (within Central Neighbourhood Forum) to:

- Provide the community with an overview of the study and results of computer modelling including flood risk maps for Anzac Creek;
- Provide the local community with the preliminary results and recommendations of the study; and
- Provide the study team with a means to obtain feedback from the local community before the recommend draft Floodplain Risk Management Plan was presented to the Liverpool Floodplain Management Committee.

To advertise the workshops, a newspaper article was published in the local newspaper and invitations were sent to all the respondents (totalling 47) who expressed their willingness to participate in the workshops during the community survey. Council also placed an advertisement on Council website.

The workshop was supported with approximately 15 attendees each day. Other than Council staff & study team, a SES representative was also present.

The majority of the issues raised were dealt with successfully at the workshops. The main issues raised included:

- Stormwater flooding problems in the study area;
- Funding and sources of funding for proposed works;
- Concern over future development in the catchment;
- Whether the '1933 flood' was considered in this study;
- Whether the damages other than physical damages were considered in the study;
- Timing for finalising the study, commencing of recommended works and prioritisation of work;
- Available recorded information on 1933 flood, 1956 flood and 1873 flood;
- Incorporation of scientific levels and known level marking in the study;
- Possibility of diversion of Anzac Creek to Harris Creek to minimise the flooding risk on lower part of Anzac Creek; and
- Emphasised urgency to implement the management study.

A brochure on 'Frequently Asked Question on Floodplain Risk Management Studies', a feedback form and flood brochures from SES were made available to participants at the community workshops.

3.6 Public Exhibition

A draft copy of Anzac Creek Floodplain Risk Management Study & Plan was placed on public exhibition from 23 January to 26 March 2008. An advertisement of the exhibition was published on Council's website as well as in local newspapers on 23 January and 12 March.

Copies of the report were exhibited at the Administrative Centre of Liverpool City Council and Council libraries in Liverpool and Moorebank. A flood risk map and study details were exhibited along with an executive summary that was available for people to take away. The study report on CD was sent to various stake holders for their comments.

The exhibition did not generate a significant level of response from the community. Three submissions were received (included in Appendix B), and are summarised below:

- **RailCorp**

RailCorp indicated that there are no additional comments to earlier input. (refer Sec 3.4.3).

- **NSW Department of Primary Industries**

NSW Department of Primary Industries informed that officers of the Department reviewed the document and consider its content to be adequate in the light of policies and provisions under the Fisheries Management Act 1994. It is advised that a dredging and reclamation permit may be required from the Department for the proposed installation of bollards near the M5 culvert and the removal of aquatic vegetation from the waterway.

- **NSW State Emergency Service**

NSW State Emergency Service is the combat agency for floods and storms in NSW. The SES provided comment in relation to the Response Modification Measures discussed in the FRMS and recommended as part of the FRM Plan. Specifically, these comments related to flood warning systems and emergency response, and community awareness initiatives. The partnering role of Council and the SES in developing appropriate community education programs was reinforced. The comments provided by the SES have been addressed in the final FRMS&P.

4 EXISTING FLOOD BEHAVIOUR

The Anzac Creek Flood Study was undertaken by Bewsher Consulting (2005) on behalf of Liverpool City Council, to quantify the flood risk in the Anzac creek catchment. This arose from concerns of potential flood impacts within this tributary of the Georges River. With no previous detailed flood analysis in the Anzac Creek catchment, the existing flood risk had not been quantified.

Through detailed analysis of the hydrologic and hydraulic characteristics of the catchment, the flood study established flood levels, flows and inundation extents for a range of design event magnitudes up to the probable maximum flood (PMF). These design flood characteristics were presented in a series of flood maps for the study area in association with flood risk maps defining low, medium and high hazard areas.

The existing flooding characteristics derived from the flood study establish the basis for the floodplain management activities investigated in the Floodplain Risk Management Study and a number of sensitivity assessments addressing channel maintenance (refer Section 8.3.2) and culvert blockage (refer Section 8.3.3). The following sections of the report provide a review of the flood study methodology and key outputs.

4.1 Summary of Modelling Approach

4.1.1 Software

The hydraulic modelling for the study was undertaken using the TUFLOW software. TUFLOW is an Australian written 2D floodplain software package. It is ideal where the hydrodynamic behaviour in floodplains and urban drainage environments have complex 2D flow patterns that would be difficult to represent using traditional 1D network models.

Furthermore, the following considerations were taken into account in selecting the appropriate modelling approach for the study:

- Overland flows through urban areas follow multiple paths with interconnections controlled by a range of constructed and natural features. Individual flow paths (and their relationship with others) are not always easily definable due to the flat topography within developed areas. In accordance with this it was necessary to develop a fully two dimensional (2D) hydraulic model of the study area.

- There are numerous culvert crossings and structures (including natural and man made levees) within the study area. The adopted hydraulic model was able to simulate a range of structures and flow controls.

- Clinch's Pond is connected to Anzac Creek via an underground (trunk) stormwater drainage connection that can potentially convey a considerable portion of the flows during certain events. Therefore, it was important to incorporate this link into the model to simulate the transfer of excess water from Clinch's Pond to Anzac Creek.

- Effective modelling of a range of floodplain management options can be most readily undertaken using a 2D modelling approach. 1D and quasi-2D models tend to be inflexible in their ability to comprehensively represent a complete range of structural management options with varying spatial configurations. The adopted 2D modelling approach is able to reliably simulate a range of management options and their impact on flooding.

- Community input and ownership is critical to the development of an effective Floodplain Management Plan. An important part of this process involves conveying the results of complex hydraulic modelling assessments in a simple and non-technical manner (e.g. through the use of visual animations and plans). Flood model outputs from the 2D model are combined with GIS to provide the most effective means of conveying flood simulation results to the community.

4.1.2 Extents and DEM

The hydraulic model of Anzac Creek extends from the East Hills railway line to the Georges River confluence. The model utilises a linked 1D-2D approach where the main channel of Anzac Creek is represented by a 1D reach defined by a series of surveyed cross sections of the main channel. The model incorporates some 5km of channel of Anzac Creek and associated floodplain.

The Georges River has a significant impact on flooding at the lower end of the Anzac Creek catchment. Therefore model representation of the interaction of the Georges River and Anzac Creek is essential. The Anzac Creek Flood Study model incorporates a 5km reach of the Georges River from just upstream of the M5 Motorway to approximately 1km downstream of the confluence of Anzac Creek at the Lake Moore wetlands.

The floodplain of the Anzac Creek is represented using a grid cell size of 5m x 5m. Within TUFLOW, elevation points are recorded at each grid cell centre, all grid corners and mid-way between corners. This means a 5m grid cell size adopts DEM on a 2.5m grid. The floodplain (2D model areas) is dynamically linked to the main channel simulating the interaction of mainstream flooding and floodplain inundation as the flood wave propagates through the catchment.

The floodplain topography is represented by a Digital Elevation Model (DEM) derived for the catchment using Council's Airborne Laser Survey data.

It is important to note that the Anzac Creek Flood Study has considered mainstream flooding only, and does not consider in detail local catchment flooding characteristics. Therefore there is no consideration of local overland flooding beyond the mainstream flood extents. During the community consultation, a number of questionnaire respondents held concerns with the capacity of local stormwater drainage systems and a few had identified existing flooding/drainage problems, particularly within the Wattle Grove area. Assessment of these local flooding issues would require a detailed assessment of local stormwater drainage infrastructure and overland flow routes, which was beyond the scope of the flood study. Overland flow flooding problems are currently being investigated by Council across the LGA. Catchments are being addressed on a priority basis.

4.1.3 Significant Structures

The majority of flood flow within the catchment is conveyed within the main channel and associated floodplain of the Anzac Creek. However, there are numerous other hydraulic features within the

floodplain that interact/impact on main channel flow and require discrete representation within the hydraulic model. These structures include:

- Wattle Grove Basin and swale connection to Anzac Creek;
- Anzac Creek culverts/bridges including Anzac Road, Delfin Drive, M5 Motorway (incorporating Heathcote Road on/off ramps), Junction Road, Kelso Crescent and Newbridge Road;
- Anzac Road Tributary Channel incorporating culvert crossings at Delfin Drive; and
- Clinches Pond and trunk connection to Anzac Creek.

4.1.4 Boundary Conditions

Hydrologic modelling utilising RAFTS-XP software was used to derive catchment inflows to Anzac Creek. RAFTS-XP is a rainfall-runoff model which simulates a catchments response to rainfall. The hydrological model relies on the specification design rainfall depths and temporal patterns, storage and infiltration losses, and a number of routing parameters dependent on the physical characteristics of the sub-catchment.

The Anzac Creek catchment was subdivided into numerous sub-catchments corresponding to key inflow points to the main channel system. At each of these sub-catchment outlets, design inflow hydrographs were derived as inputs to the hydraulic model.

Boundary conditions for the reach of the Georges River included in the model domain were derived from previous flood studies. Inflow hydrographs were applied at the upstream boundary of the Georges River reach based on the simulated hydrograph from the previous study at the corresponding location.

A stage-discharge relationship was applied at the downstream Georges River model boundary. This relationship was also derived using the results of the previous modelling investigations. The use of appropriate boundary conditions for the Georges River reach provides the opportunity for a more realistic representation of the interaction of the Anzac Creek and Georges River floodplains and provides some consistency with previous studies.

4.1.5 Calibration

Calibration and validation of hydrologic and hydraulic models is generally achieved using an iterative process, which seeks to find the best combination of hydrologic and hydraulic parameters to fit observed conditions for historical flood events within the catchment.

A conventional calibration and verification exercise for the Anzac Creek catchment was not possible considering:

- the lack of historical flood level information; and
- the absence of appropriate rainfall records for historical flood events.

A check for consistency in estimated design flow rates for the catchment with results from the Georges River study confirmed the general appropriateness of the peak design flow estimates. In

addition, calibration parameters for both hydrologic and hydraulic models have been kept within conventional bounds and are considered appropriate for the study.

4.1.6 Design Runs

Design events modelled included the 5-year ARI, 20-year ARI, 50-year ARI, 100-year ARI and the PMF. A range of storm durations were simulated to determine the critical duration for peak flood conditions within the catchment. A critical storm duration of 9 hours was found to be generally applicable across the catchment for the range of design events considered, except for the PMF in which a 1 hour critical duration was identified.

The lower parts of Anzac Creek are dominated by flooding in the Georges River. As such, the design event modelling assumes coincident flooding within the Georges River and Anzac Creek. The Georges River design flood hydrographs representing the critical duration were applied at the model boundary such that the peak of the Georges River design flood and the Anzac Creek design flood coincide.

4.2 Flooding Behaviour

Predicted flood inundation extents for the range of design flood magnitudes considered (5-year ARI up to PMF) are shown in Figure 4-1. The flooding regimes in the upper and lower catchments are very different.

Upstream of the M5 Motorway, flooding is generally confined within the main channel of Anzac Creek. Even up to the 100-year ARI flood event there is very little floodplain inundation. This effective conveyance of flood discharges in the main channel results in no flood inundation of properties within the Wattle Grove residential development, located adjacent to Anzac Creek. The existing culvert provisions through the M5 Motorway embankment adequately convey floods to the downstream reaches of the catchment without significant detention and backwater accumulation. Given the impedance to floodplain flows of the M5 Motorway embankment, the potential impact of culvert blockage was investigated in the floodplain management study as detailed in Section 8.3.4.

Downstream of the M5 Motorway there is extensive floodplain inundation for events in excess of the 5-year ARI, with flooding highly influenced by flood conditions in the Georges River. The backwater influence of Georges River flooding extends as far upstream as the M5 Motorway and results in an area of extensive, albeit low velocity, inundation.

The backwater flooding is made possible through the flow path connections to the Lake Moore wetlands. Anzac Creek itself flows directly into Lake Moore and the influence of the Georges River extends well upstream in the main channel. In major events, additional overland flow paths become interconnected, for example through Clinch's Pond as well as some direct spills form the right bank of the Georges River into the Anzac Creek floodplain. Almost all the properties affected by the 100-year ARI flood within the Anzac Creek catchment are located downstream of the M5 Motorway and are largely influenced by the backwater inundation from the Georges River.

Design flood depth and flood velocity maps for the 5-year ARI, 20-year ARI, 50-year ARI, 100-year ARI and PMF events are included in Appendix A.

REFER TO COUNCIL FOR FIGURE DETAILS

Figure 4-1 Anzac Creek Design Flood Inundation Extents

4.3 Flood Risk Mapping

Flood risk, or hazard, is a measure of the overall potential adverse impact of flooding that considers threat to life, danger and difficulty in evacuating people and possessions, and the potential for damage, social disruption and loss of production. The degree of flood risk varies across a catchment. The following categorisation has been adopted in the study to identify relative risk within the catchment and to guide planning controls appropriate for the different flood risk categories:

- High Flood Risk – land below the 100-year flood that is either subject to a high hydraulic hazard (as defined in Figure L2 of the Floodplain Development Manual) or where there are significant evacuation difficulties.
- Medium Flood Risk – Land below the 100-year flood level that is not subject to high hydraulic hazard and where there are no significant evacuation difficulties
- Low Flood Risk – All land within the floodplain (i.e. within the PMF extent) but not identified as either in a high or medium flood risk area.

The **high flood risk** area is where high flood damages, potential risk to life, or evacuation problems are anticipated. Most development should be restricted in this area.

The **medium flood risk** area is where there is still significant risk of flood damage, but where these damages can be minimised by the application of appropriate development controls.

The **low flood risk area** is that area above the 100-year ARI flood, where the risk of damage is low based on the likelihood of flooding alone (see Section 4.3.1 below). Most land uses would be permitted within this area.

4.3.1 Consideration of Flooding in Low Risk Areas

The flood prone land above the 100-year ARI flood up to the Probable Maximum Flood (PMF) inundation extent is categorised as low risk flood precinct. This area is identified as low risk considering the low probability of occurrence of a flood of this magnitude.

In certain areas, adopting higher risk categories for areas above the 100-year ARI flood may be appropriate where the consequences of flooding are high, for example catchment diversions, overtopping of levees and other conditions that may result in dangerous flood behaviour or unacceptable damage to property.

During floods greater than the 100year ARI and up to the PMF, there is potential for significant damage and hazard to properties and human life to occur in certain areas of the Anzac Creek catchment identified as low risk. This is particularly the case in the lower reaches of the catchment where the Georges River influence results in PMF levels several metres higher than the 100-year ARI.

Future review of the Georges River Flood Risk Management Study should consider modelling larger floods such as the 200-year ARI and 500-year ARI events. The flood risk characteristics of these intermediate events between the 100-year ARI and PMF floods may subsequently warrant a review

of the adopted flood risk precincts and Anzac Creek Floodplain Risk Management Study. In this regard, any future assessment of possible management strategies to limit potential building structure and contents damage in this zone will need to be based on the impact of significant individual flood events above the Flood Planning Level flood (e.g. 200-year ARI and 500-year ARI events).

Flood Risk Precincts for the Anzac Creek catchment are shown in Figure 4-2 and a summary of the number of properties identified within each flood risk precinct is shown in Table 4-1.

Table 4-1 Number of Properties within Each Flood Risk Precinct

Property Type	Flood Risk Precinct			
	High Risk	Medium Risk	Low Risk	Total
Residential	50	281	1360	1691
Industrial / Commercial	85	76	38	199
Total	135	357	1398	1890

4.4 Road Inundation

Road inundation during a flood can result in substantial disruption and inconvenience. More critical however, road access is an important issue for the planning of emergency management operations and evacuations in extreme flood events. The following major road links within the Anzac Creek catchment are identified as potentially flood affected.

- Newbridge Road –inundated in the 100-year ARI event from approximately 300m east of the Georges River in the vicinity of the Heathcote Road intersection. The inundation length is some 400m with a maximum depth of 1.5m.

- Heathcote Road - possibly cut in events as low as 20-year ARI adjacent to Clinches Pond and Junction Road. Adjacent to Clinch's Pond the 100-year ARI inundation length is approximately 250m with a maximum depth of 1.5m. Adjacent to Junction Road the 100-year ARI inundation length is approximately 150m with a maximum depth of 1.5m.

- Junction Road –possibly cut in events as low as 20-year ARI over Anzac Creek crossing. The 100-year ARI inundation length is over 400m with a maximum depth of 2m.

Other minor (local access) roads may also be subject to flood inundation, either by Anzac Creek flooding or by overflows from the local stormwater system (not considered as part of this study).

REFER TO COUNCIL FOR FIGURE DETAILS

Figure 4-2 Anzac Creek Catchment Flood Risk Map

5 FLOOD DAMAGES

A flood damage assessment has been undertaken to quantify the extent of damages in economic terms for existing flood conditions and to assess the relative merit of proposed flood mitigation options by means of benefit-cost analysis.

The general process for undertaking a flood damages assessment incorporates:

- Identifying properties subject to flooding;
- Determining depth of inundation above floor level for a range of design event magnitudes;
- Defining appropriate stage-damage relationships for various property types/uses;
- Estimating potential flood damage for each property; and
- Calculating the total flood damage for a range of design events.

5.1 Property Data

5.1.1 Location

Property locations have been derived from Council's cadastre information and associated detailed aerial photography of the catchment. Linked within a GIS system, this data enables rapid identification and querying of property details.

A property database has been developed detailing individual properties subject to flood inundation, i.e. within the predicted flood envelopes discussed in Section 4.2.

5.1.2 Land Use

For the purposes of the flood damage assessment, property was considered as either residential or industrial/commercial. No distinction between industrial and commercial premises was made. It is noted however, that the majority of the commercial/industrial properties affected by flooding up to the 100-year ARI event within the study area are industrial properties and are concentrated in the Moorebank industrial are between Heathcote Road and Newbridge Road.

There is very little mixed land use within the Anzac Creek floodplain. This has enabled a more simplified process of assigning land use type to individual properties within flood affected regions.

5.1.3 Ground and Floor Level

The DEM generated for the hydraulic model was based on available ALS survey as discussed in Section 4.1.2. A representative ground level for each individual property was determined by a point inspection of the DEM at a property reference point, taken as the centroid of the property area as defined by the cadastral boundaries.

There is limited floor level survey available for flood affected areas in the catchment. In the absence of surveyed data, floor levels were estimated utilising the average ground surface of the lot and adding a nominal 0.5m to the ground level. The nominal "height above ground level" of 0.5m was considered appropriate as an average value based on local site inspections and is also consistent with the approach adopted in the Georges River FRMS.

5.1.4 Flood Level

The design flood levels across the catchment were adopted from the Anzac Creek Flood Study as discussed in Section 4. The flood modelling results, derived on a 5m x 5m grid, were used to generate a continuous flood profile across the floodplain. Flood levels calculated from the TUFLOW model were queried from TUFLOW's GIS output at each property reference point. The resulting output was used to identify flooding characteristics such as the frequency of inundation, the depth of inundation, number of properties affected, number of properties within each flood risk precinct, etc.

5.2 Property Inundation

A summary of the number of properties affected by flooding for a range of flood magnitudes is shown in Table 5-1. The table distinguishes between residential property and industrial/commercial enterprise. Furthermore, the table identifies flooded property (i.e. flood level above ground level) and flooded building (i.e. flood level above floor level) counts for each flood magnitude.

Table 5-1 Number of Properties Affected by Flooding

Design Return Period	Residential		Commercial / Industrial	
	Property	Building	Property	Building
5-year ARI	0	0	1	0
20-year ARI	21	0	27	5
50-year ARI	107	23	64	33
100-year ARI	196	64	97	58
PMF	1355	1015	185	183

All of the properties affected by flooding up to the 100-year ARI event are located downstream of the M5 Motorway in the lower reaches of Anzac Creek where flooding is controlled by backwater flooding from the Georges River. The flood affected properties for the 100-year ARI and PMF events are shown in Figure 5-1 and Figure 5-2. The properties identified as being flooded correspond to those occupying the lowest topography in the catchment. These areas include:

- Industrial/Commercial property along Centenary Av, between M5 and Heathcote Rd
- Residential property adjacent to Ernie Smith Reserve in Junction Rd/Gal Cr
- Residential property adjacent to Clinch's Pond in Swain St., Bradshaw Av. and Market St
- Industrial/Commercial property in Seton Rd, Iraking Av and Kelso Cr (Moorebank Industrial Area)

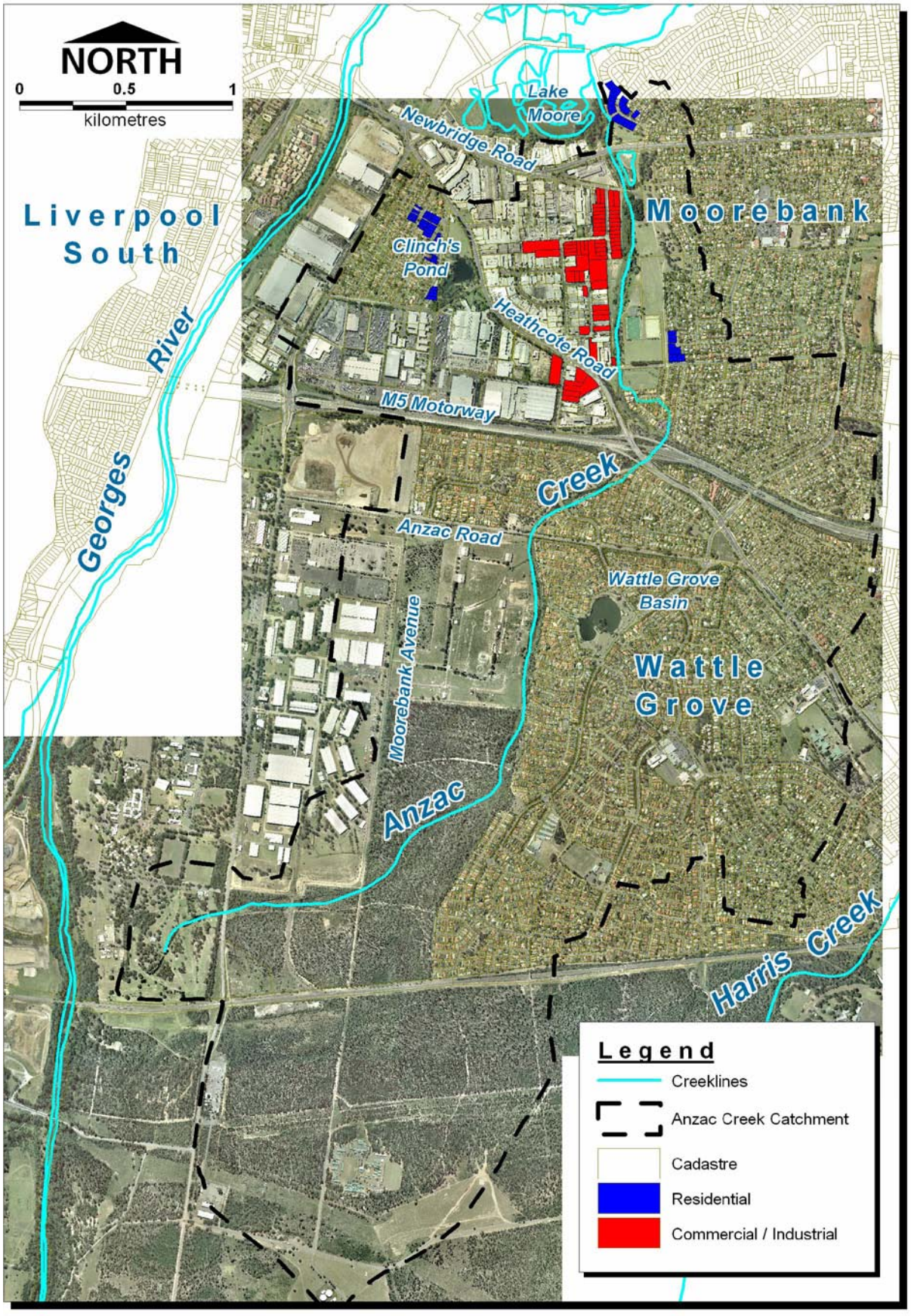

Figure 5-1 Properties with Buildings Inundated Above Floor Level from a 100-year ARI Flood Event

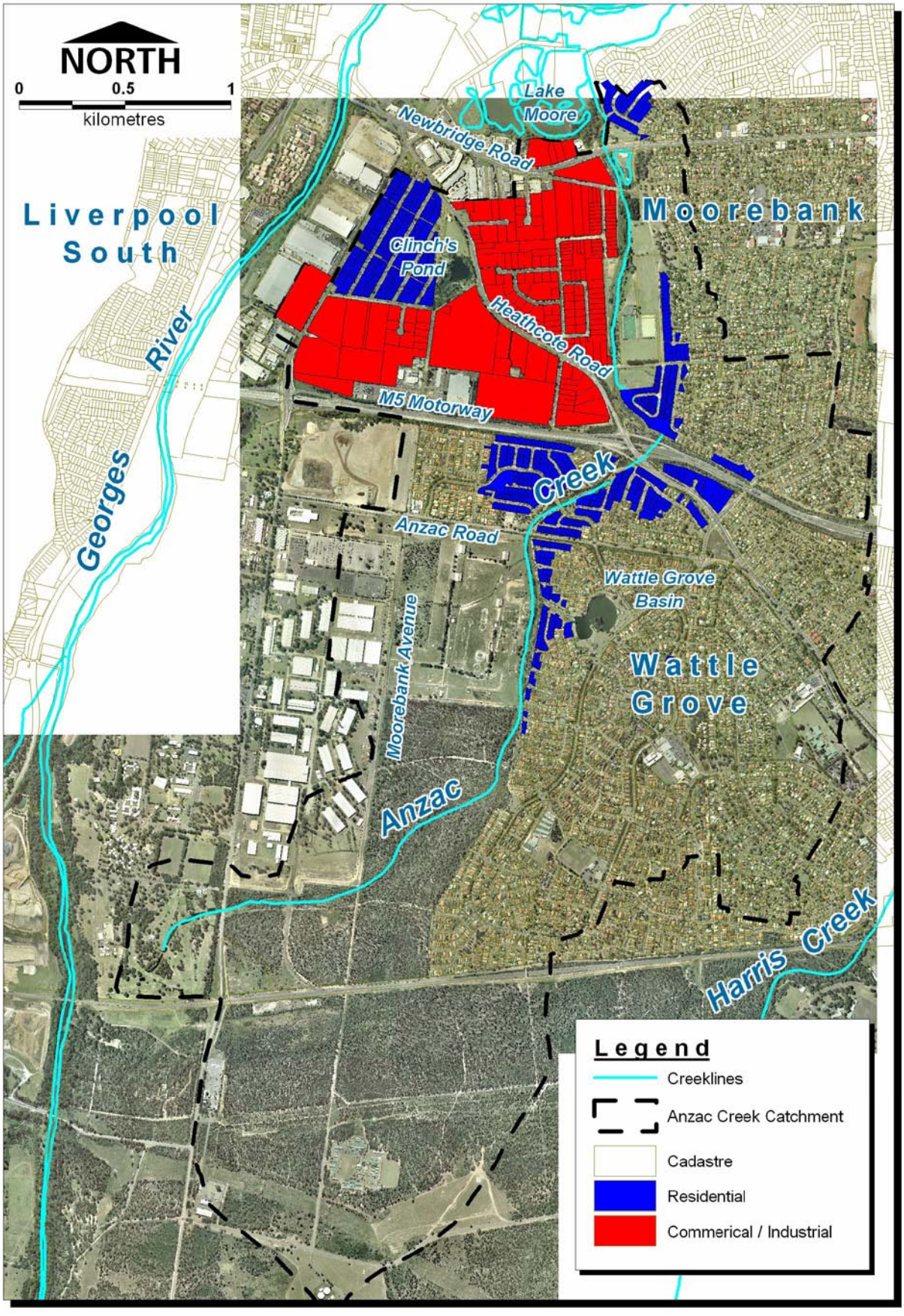

Figure 5-2 Properties with Buildings Inundated Above Floor Level from a PMF Flood Event

5.3 Damage Data

5.3.1 Types of Flood Damage

The definitions and methodology used in estimating flood damage are summarised in the Floodplain Development Manual. Figure 5-3 summarises all the “types” of flood damages examined in this study. The two main categories are 'tangible' and 'intangible' damages. Tangible flood damages are those that can be more readily evaluated in monetary terms, while intangible damages relate to the social cost of flooding and therefore are much more difficult to quantify.

Tangible flood damages are further divided into direct and indirect damages. Direct flood damages relate to the loss, or loss in value, of an object or a piece of property caused by direct contact with floodwaters. Indirect flood damages relate to loss in production or revenue, loss of wages, additional accommodation and living expenses, and any extra outlays that occur because of the flood.

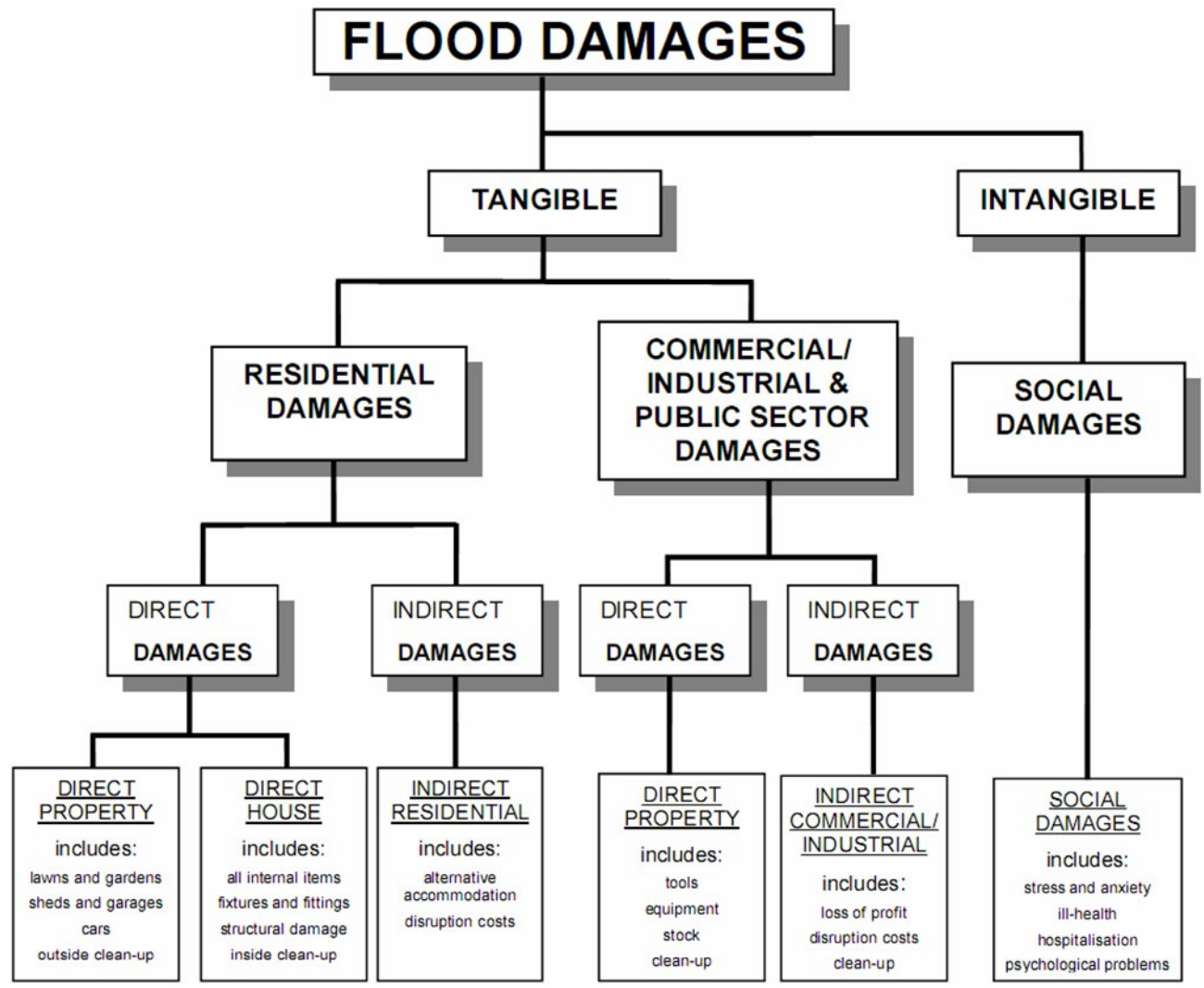

Figure 5-3 Types of Flood Damage

5.3.2 Basis of Flood Damage Calculations

Flood damages have been calculated using the data base of potentially flood affected properties and a number of stage-damage curves derived for different types of property within the catchment. These curves relate the amount of flood damage that would potentially occur at different depths of inundation, for a particular property type.

The stage-damage curves for Anzac Creek have been based on specific consideration of the types of development within the catchment, information available from previous investigations, and flood damage surveys undertaken following recent major floods in Coffs Harbour (1996); Inverell (1991); Forbes (1990); Nyngan (1990); and the Georges River (1986).

The curves for commercial and industrial property are consistent with those used for the flood damage calculations associated with the Georges River Floodplain Management Study (Bewsher Consulting, 2004). Residential damage curves are based on the DECC guideline stage-damage curves for residential property.

Different stage-damage curves for direct property damage have been derived for:

- Residential dwellings (categorised into small, typical or raised categories);
- Commercial premises (categorised into low, medium or high damage categories); and
- Industrial premises (categorised into low, medium or high damage categories).

Apart from the direct damages calculated from the derived stage-damage curves for each flood affected property, other forms of flood damage include:

- Indirect residential, commercial and industrial damages, taken as a percentage of the direct damages;
- Infrastructure damage, based on a percentage of the total value of residential and business flood damage; and

Intangible damages relate to the social impact of flooding and include:

- inconvenience,
- isolation,
- disruption of family and social activities,
- anxiety, pain and suffering, trauma,
- physical ill-health, and
- psychological ill-health

The damage estimates derived in this study are for the tangible damages only. Whilst intangible losses may be significant, these effects have not been quantified due to difficulties in assigning a meaningful dollar value.

The adopted stage damage curves and other flood damages assumptions are shown in Appendix C.

5.3.3 Summary of Flood Damages

The peak depth of flooding was determined at each property for the 5, 20, 50 and 100 -year ARI events and the associated cost estimated from the stage-damage relationships. Total damages for each flood event were determined by summing the predicted damages for each individual dwelling.

Table 5-2 provides a summary of the flood damages calculations for the Anzac Creek catchment.

The Average Annual Damage (AAD) is the average damage in dollars per year that would occur in a designated area from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the AAD provides a basis for comparing the effectiveness of different floodplain management measures (i.e. the reduction in the AAD).

Table 5-2 Predicted Flood Damages for Existing Conditions

Damage Sector	Damage in Flood Event ($)				Average Annual Damage
	20-year ARI	50-year ARI	100-year ARI	PMF	
Direct Residential	$560,000	$3,580,000	$7,470,000	$102,710,000	$700,000
Indirect Residential	$80,000	$540,000	$1,120,000	$15,410,000	$110,000
Direct Industrial and Commercial	$250,000	$3,880,000	$9,150,000	$67,650,000	$530,000
Indirect Industrial and Commercial	$140,000	$2,130,000	$5,030,000	$37,210,000	$290,000
Infrastructure and Public Sector	$310,000	$3,040,000	$6,830,000	$66,890,000	$490,000
Total	$1,330,000	$13,160,000	$29,610,000	$289,860,000	$2,110,000

The total expected flood damage to occur in a 100-year ARI flood event is $29.6M, whereas the PMF would result in $290M worth of damage (2007 dollars).

The different components of flood damage in Anzac Creek are shown in Figure 5-4.

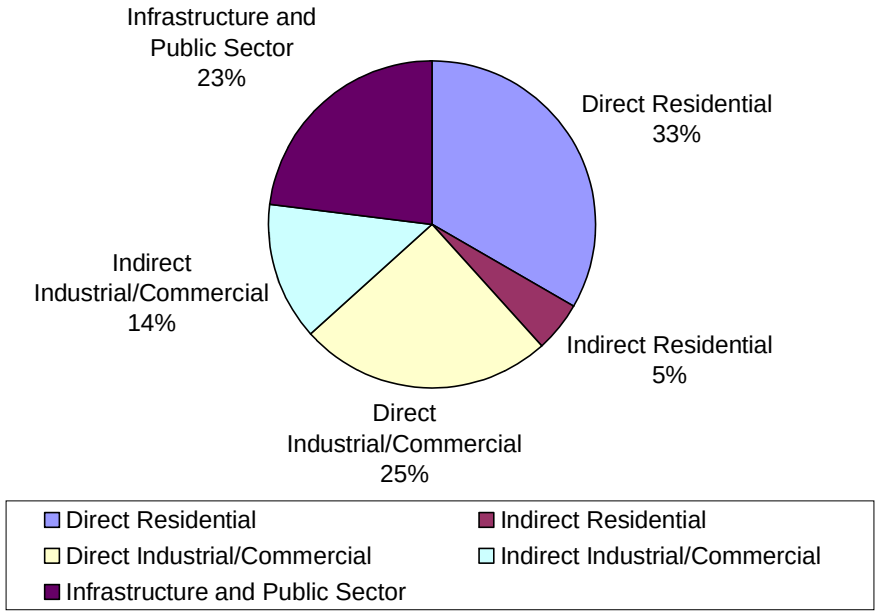

Figure 5-4 Flood Damage Components for Anzac Creek (Average Annual Damage)

6 REVIEW OF EXISTING PLANNING PROVISIONS

6.1 Introduction

Land use planning and development controls are key mechanisms by which Council can manage some of the flood related risks within flood-affected areas of the Anzac Creek catchment (as well as across the wider LGA).

A detailed review of existing planning controls was undertaken by Don Fox Planning in association with Bewsher Consulting in undertaking the Georges River FRMS (Bewsher Consulting, 2004). The key objectives of the previous planning review were to:

- review the existing planning and development controls framework relevant to the formulation of planning instruments and the assessment of development applications in the Georges River floodplain, and
- make specific planning recommendations in regards to flood risk management, including an outline of suggested planning controls.

Don Fox Planning (Bewsher Consulting, 2004) provided recommendations aimed to ensure that appropriate and consistent planning controls are in place with specific reference to floodplain management and included:

- A specific Draft Floodplain Risk Management DCP;
- Amendments to the Georges River REP; and
- Amendments to current LEP Provisions.

A brief summary of existing planning controls relevant to the Georges River floodplain, and Anzac Creek in particular, is provided hereunder. This is based on the information provided in Volume 2 of the Georges River FRMS (Bewsher Consulting, 2004) that includes a detailed review of planning instruments.

6.2 State Environmental Planning Policies (SEPP)

A State Environmental Planning Policy (SEPP) is a planning document prepared in accordance with Part 3 Division 2 of the NSW Environmental Planning and Assessment (EP&A) Act 1979 by the Department of Planning and approved by the Minister, which deals with matters of significance for environmental planning for the State. Existing SEPP's that have relevance to development within the Study Area include SEPP No.5 (Housing for the Aged or Disabled Persons), SEPP No.19 (Bushland in Urban Areas), and SEPP No.21 (Caravan Parks). There is no SEPP dealing specifically with the issue of flooding.

6.3 Regional Environmental Plans (REP)

A Regional Environmental Plan (REP) is prepared in accordance with Part 3 Division 3 of the EP&A Act 1979 and provides objectives and controls for environmental planning for a region.

The Anzac Creek catchment, being a tributary of the Georges River, is covered by the Greater Metropolitan Regional Environmental Plan No. 2 – Georges River Catchment (Georges River REP). The Georges River REP aims to protect the water quality of the Georges River and its tributaries and the environmental quality of the whole catchment. The objectives of the plan are to be achieved through coordinated land use planning and development control. The plan establishes the framework within which local, State and Federal agencies will consult so that there is a consistent approach to planning and development within the catchment.

The Georges River FRMS recommended changes to the Georges River REP to provide definitions consistent with current best practice and the Floodplain Development Manual, provide an objective which is specifically focused on floodplain risk management, and review planning controls to be consistent with controls adopted by Councils through the floodplain management process. Recommended changes are detailed in Appendix A of Georges River FRMS Volume 2.

6.4 Local Environmental Plan (LEP)

A Local Environmental Plan (LEP) is prepared in accordance with Part 3 Division 4 of the EP&A Act 1979 and operates as a local planning instrument that establishes the framework for the planning and control of land uses. The LEP defines zones, permissible land uses within those zones, and specific development standards and special considerations with regard to the use or development of land.

The Liverpool LEP was gazetted in 1997 with various amendments into its current form.

Clause 21 of the LEP relates to development on flood liable land. The LEP defines “flood liable land” as that being inundated by the 1% (100-year ARI) probability flood event. The LEP provisions incorporate general considerations in regard to development of flood liable land. These provisions require the approval process to consider the impact of proposed development on local flood behaviour, the impact of flooding on the development and the requirements of adopted Floodplain Management Plans that are applicable. A number of other clauses make reference to flooding.

The Georges River FRMS recommended changes to the Liverpool LEP to provide a consistent framework for more detailed controls to be provided in a DCP. Recommended changes are detailed in Appendix B of Georges River FRMS Volume 2.

As for all Council’s in NSW, Liverpool City Council is required to review and amend their LEP to make it consistent with a standardised LEP template (Local Environmental Plan (Standard Instrument), NSW Government, 2006).

6.4.1 Land Use Zoning

The Liverpool LEP identifies a number of broad land use zones including Rural, Residential, Business, Industrial, Special Uses, Recreation, Environment Protection and National Parks/Nature

Reserves. The distribution of various land use categories within the Anzac Creek catchment was shown in Figure 2-2.

There is no specific zoning category related to flooding. However the main channel/drainage corridors within the Anzac Creek catchment are principally zoned Special Uses 5(a) Drainage zone and Recreation/Open Space.

The new LEP template introduces a new suite of pre-defined land use zoning categories, aimed at providing consistency from one LGA to the next. Council will be required to assign land use zonings to all areas within the LGA, including existing and future development areas, based on stated objectives for each zoning and provisions made for each zoning. Amended LEP's need to be approved by the Minister for Planning before they can be enforced.

6.5 Development Control Plans (DCPs)

A Development Control Plan (DCP) is established under the provisions of Part 3 Division 6 of the EP&A Act 1979. A DCP provides more detailed provisions with respect to development in particular areas, and is to be considered by Council in determining development applications.

At present, Liverpool City Council does not have a specific floodplain risk management DCP and relies on interim policy provisions. However, a Draft Consolidated DCP is currently being prepared, applicable for all development in the Liverpool LGA (except CBD) that embodies recommendations from previous studies related to flood planning, most notably the Georges River FRMS.

The objectives of the DCP in relation to flooding are:

a) Minimise the potential impact of development and other activity upon the aesthetic, recreational, and ecological value of the waterway corridors;

b) Ensure essential services and land uses are planned in recognition of all potential floods;

c) Reduce the risk of loss to human life and damage to property caused by flooding through controlling development on land affected by potential floods;

d) Limit developments with high sensitivity to flood risk (e.g. critical public utilities) to land with minimal risk from flooding;

e) Permit development with a lower sensitivity to the flood hazard to be located within the floodplain, subject to appropriate design and siting controls;

f) Ensure that development should not detrimentally increase the potential flood impacts on other development or properties either individually or in combination with the cumulative impact of development that is likely to occurring the same floodplain; and

g) Ensure that development does not prejudice the economic viability of any Voluntary Acquisition scheme.

Model DCP provisions provided in the Georges River Study apply to the whole LGA, with a matrix of development controls applied as a separate schedule to the DCP as floodplain management studies are undertaken for the various catchments in the LGA. These controls have been reviewed as part of

the Anzac Creek study, and the controls previously recommended for the Georges River are recommended to also apply to the Anzac Creek catchment. Therefore the schedule just needs to be duplicated in the DCP.

Section 7.1 presents in further detail the planning control matrix. The matrix contains a graded set of planning controls for different land uses relative to different levels of flood risk, for assessing individual development applications.

6.6 Future Catchment Development

Whilst no firm plans for future catchment development have been formulated, Council has advised that future development may comprise the following:

- Land currently zoned Military (5a) that is east of the land zoned 4(d) Business Park has been identified as future residential land. This land does not include any of the land that has the "environmentally significant land" hatching.
- Land west of this potential residential land i.e. land zoned 4(d) Business Park will likely operate as industrial use.
- Land that has "Environmentally Significant Land" hatching in the southern part of the catchment is unlikely to be developed.

The areas nominated above are shown in Figure 6-1.

New development would need to comply with existing planning controls related to flood risk management. The majority of the area identified for development lies above the 100-year flood envelope and not subject to any significant flood risk. However developments would need to comply with appropriate controls to ensure that new development does not result increase in catchment runoff that may exacerbate flooding elsewhere.

Liverpool City Council currently does not have any significant plans for redevelopment of land in the catchment that has already been developed. As such, all existing development should see minimal changes in the foreseeable future.

Future development in the wider Georges River catchment has the potential to increase flood impacts in the lower reaches of Anzac Creek. This issue is not addressed in the current study; however appropriate consideration of future development would be addressed under the Georges River Floodplain Risk Management Plan.

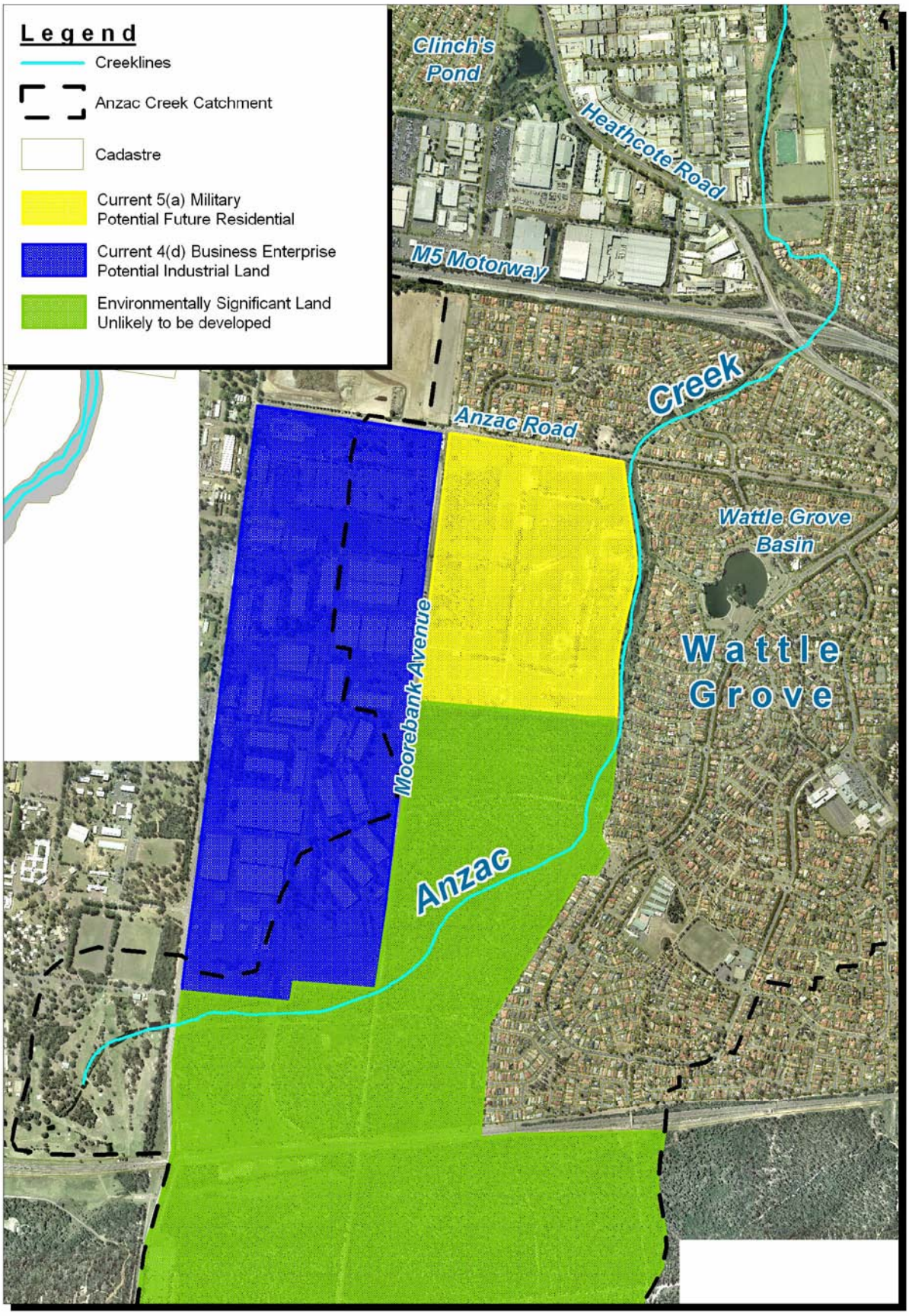

Figure 6-1 Future Catchment Development

7 RECOMMENDATIONS FROM THE GEORGES RIVER FRMS RELEVANT TO ANZAC CREEK

Flooding in the lower part of the Anzac Creek catchment is dominated by the Georges River. Almost all of the identified flood affected properties within Anzac Creek are influenced by the Georges River. Therefore many of the floodplain management issues addressed by the Georges River FRMS are applicable to Anzac Creek.

The principal components of the recommended floodplain management plan of the Georges River FRMS that may also be relevant to Anzac Creek include:

- Adoption of consistent planning and development controls;
- Flood warning enhancements to link flood warning predictions with a property database;
- Improved emergency management operations; and
- Improved public awareness and information on flooding through the issue of flood certificates, Section 149 notifications and the construction of flood markers to indicate the levels of historical floods.

Further details of these floodplain management recommendations from the Georges River FRMS, that are applicable to the Anzac Creek catchment, are presented in the following sections.

7.1 Planning and Development Controls

Land use planning and development controls are key mechanisms by which Council can manage flood-affected areas within the Georges River study area (including the Anzac Creek catchment). Such mechanisms will influence future development (and redevelopment) and therefore the benefits will accrue gradually over time. Without comprehensive floodplain planning, existing problems may be exacerbated and opportunities to reduce flood risks may be lost.

7.1.1 Revised Development Control Plans

Specific amendments to existing planning controls have been proposed and revised development control plans (DCP's) recommended for the four councils (Bankstown, Fairfield, Liverpool and Sutherland), in order to provide consistent planning controls for floodplains across the Georges River study area. The proposed floodplain risk management DCP's have been prepared in a generic form to allow their application across the entire LGA of each Council area.

The general approach to floodplain planning and detailed discussion on proposed planning document amendments are presented in "Volume 2 – Planning Issues" of the Georges River FRMS. In summary, the recommended planning issues include:

a) That the Floodplain Management Committee endorses the planning approach outlined within the study. This approach requires a graded set of planning controls for different land uses

relative to different levels of flood risk within the study area, be adopted, consistent with the requirements of the NSW Floodplain Management Manual.

b) That the Committee formally endorses the recommended changes to the Georges River REP for referral to Department of Planning.

c) That each Council considers amending their LEP to provide a consistent framework for more detail controls to be provided in a DCP.

e) That Council adopt or amend their current DCP's and/or Policies to generally accord with the Model DCP's appended to the Volume 2 Georges River FRMS.

f) That each Council incorporates notations upon Section 149(2) Certificates, the wording subject to consideration by each Council, consistent with the approach discussed above and summarised in the Volume 2 Georges River FRMS.

The Georges River FRMS concludes that the above recommendations provide appropriate responses to the issues raised and evaluated within the context of the floodplain risk management plan and the legislative framework associated with planning. Also, that the above measures can be implemented now at minimal cost, and should be pursued by Council with a high priority.

A Draft Consolidated DCP is currently in writing, applicable for all development in the Liverpool LGA (except CBD) that embodies recommendations outlined above. Accordingly this document will apply to the Anzac Creek catchment.

7.1.2 The Planning Matrix

A matrix of planning controls for use in the assessment of individual development applications has been formulated specifically for the Georges River floodplain. A second matrix of planning controls was also formulated for application to other floodplains within the LGA, as well as areas affected by local overland flooding, pending the development of specific matrices for other areas through other floodplain risk management studies. These would be appended to the DCPs as additional matrices once the other studies have been completed.

The lower reach of Anzac Creek lies with the flood planning outline of the Georges River FRMS. The dominant flooding mechanism within this reach of Anzac Creek is flooding from the Georges River and therefore the identified planning controls for the Georges River are applicable.

The upper Anzac Creek catchment is defined as upstream of the M5 motorway, which essentially lies outside the influence of mainstream Georges River flooding. The recommendations from the Georges River FRMS would apply the second planning control matrix as interim controls prior to completion of a catchment specific Floodplain Risk Management Plan.

The matrices provide a graded set of planning controls tailored to the proposed land use and flood level, and which recognise flood risks up to and including the probable maximum flood. The matrix of planning controls proposed for the Georges River floodplain is shown in Figure 7-1. The matrix proposed for other areas (including areas affected by stormwater overland flow) is shown in Figure 7-2. These planning matrices should be monitored and reviewed and updated as future floodplain management plans are prepared or existing ones reviewed.

GEORGES RIVER FLOODPLAIN
Planning & Development Controls

	Flood Risk Precincts (FRP's)																									
	Low Flood Risk								Medium Flood Risk								High Flood Risk									
Planning Consideration	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development
Floor Level		3		2&,7	5&,7	2&,7	1,&	4,7				2&,7	5&,7	2&,7	1,&	4,7							1,&	4,7
Building Components		2		1	1	1	1	1				1	1	1	1	1							1	1
Structural Soundness		3		2	2	2	2	2				1	1	1	1	1							1	1
Flood effects		2	2	2	2	2	2	2			1	2	2	2	2	2							1	1
Car Parking and Driveway Access		1,3,5, 6,7		1,3,5, 6,7	1,3,5, 6,7	1,3,5, 6,7	2,4,6, 7	6,7,8				1,3,5, 6,7	1,3,5, 6,7	1,3,5, 6,7	2,4,6, 7	6,7,8							2,4,6, 7	6,7,8
Evacuation		2,3,4	6	2,3	1 or 2,3	2,3	4,3	2,3			6	2,3	1,3	2,3	4,3	2,3							4,3	2,3
Management and Design		4,5	1		2,3,5	2,3,5	2,3,5	2,3,5			1		2,3,5	2,3,5	2,3,5	2,3,5							2,3,5	2,3,5

COLOUR LEGEND: Not Relevant; Potentially Unsuitable Land Use

General Notes

1	*Freeboard* equals an additional height of 500mm.
2	The relevant environmental planning instruments (generally the Local Environmental Plan) identify development permissible with consent in various zones in the LGA. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. This matrix identifies where flood risks are likely to determine where certain development types will be considered "potentially unsuitable" due to flood related risks.
3	Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.
4	Refer to Section 2.5 of the DCP for planning considerations for proposals involving only the erction of a fence. Any fencing that forms part of a proposed development is subject to the relevant flood effects and Structural Soundness planning considerations of the applicable landuse category.
5	Refer to section 2.7 of the DCP for special considerations such as for house raising proposals and development of properties identified for voluntary acquisition.
6	Terms in italics are defined in the glossary of this plan and Schedule 2 specifies development types included in each land use category. These development types are generally as defined within Environmental Planning Instruments applying to the LGA.
7	From time to time, Council may adopt mapping showing the *Boundary of Significant Flow* and/or *Flood Storage Areas* for this floodplain. Refer to Council to find out if these areas have been defined and mapped for this floodplain.

Floor Level

1	All floor levels to be no lower than the 20 year flood unless justified by site specific assessment.
2	*Habitable floor* levels to be no lower than the 100 year flood level plus *freeboard*.
3	*Habitable floor* levels to be no lower than the *PMF* level plus freeboard. Non-*habitable floor* levels to be no lower than the *PMF* level unless justified by a site specific assessment
4	Floor levels to be no lower than the *design floor level*. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the floor level of existing buildings, or the need for access for persons with disabilities, a lower floor level may be considered. In these circumstances, the floor level is to be as high as practical, and, when undertaking alterations or additions, no lower than the existing floor level.
5	The level of *habitable floor areas* to be equal to or greater than the 100 year flood level plus *freeboard*. If this level is impractical for a development in a Business zone, the floor level should be as high as possible.
6	Non-*habitable floor* levels to be no lower than the 20 year flood level unless justified by site specific assessment
7	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest *habitable floor area* is elevated more than 1.5m above finished ground level, confirming that the undercroft area is not to be enclosed.

Building Components Method

1	All structures to have *flood compatible building components* below the 100 year flood level plus *freeboard*.
2	All structures to have *flood compatible building components* below the *PMF* level.

Structural Soundness

1	Engineer's report to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus *freeboard*.
2	Applicant to demonstrate that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus *freeboard*. An engineer's report may be required.
3	Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a *PMF*. An engineer's report may be required.

Flood Effects

1	Engineer's report required to certify that the development will not increase flood effects elsewhere, having regard to: (I) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood *conveyence*; and (iii) the cumulative impact of multiple potential developments in the floodplain.
2	The flood impact of the development to be considered to ensure that the development will not increase flood effects elsewhere, having regard to: (I) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood *conveyance*; and (iii) the cumulative impact of multiple potential developments in the floodplain. An engineer's report may be required.

Note: (1) If a *Boundary of Significant Flow* has been defined for this floodplain, any development inside this area will normally be unacceptable as it will reduce flood conveyance and increase flood effects elsewhere. (2) If a *Flood Storage Area* has been defined for this floodplain, any filling of the floodplain inside this area (except where this occurs by compensatory excavation), will normally be unacceptable as it will reduce the volume of flood storage available on the floodplain and increase flood effects elsewhere. (3) Even where a *Boundary of Significant Flow* and/or a *Flood Storage Area* have been defined, development outside these areas may still increase flood effects elsewhere and therefore be unacceptable.

Car Parking and Driveway Access

1	The minimum surface level of open car parking spaces or carports shall be as high as practical, but no lower than the 20 year flood or the level of the crest of the road at the location where the site has access. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 20 year flood.
2	The minimum surface level of open car parking spaces, carports or garages, shall be as high as practical.
3	Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or *enclosed car parking*, must be protected from inundation by floods equal to or greater than the 100 year flood.
4	The driveway providing access between the road and parking space shall be as high as practical and generally rising in the egress direction.
5	The level of the driveway providing access between the road and parking space shall be no lower than 0.3m below the 100 year flood or such that the depth of inundation during a 100 year flood is not greater than either the depth at the road or the depth at the car parking space. A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.
6	*Enclosed car parking* and car parking areas accommodating more than 3 vehicles (other than on Rural zoned land), with a floor level below the 20 year flood or more than 0.8m below the 100 year flood level, shall have adequate warning systems, signage and exits.
7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year flood.
8	Driveway and parking space levels to be no lower than the *design ground/floor levels*. Where this is not practical , a lower level may be considered. In these circumstances, the level is to be as high as practical, and, when undertaking alterations or additions, no lower than the existing level.

Note: (1) A flood depth of 0.3m is sufficient to cause a typical vehicle to float. (2) *Enclosed car parking* is defined in the glossary and typically refers to carparks in basements.

Evacuation

1	Reliable access for pedestrians or vehicles required during a 100 year flood.
2	Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel.
3	The development is to be consistent with any relevant *flood evacuation strategy*, *Flood Plan adopted by Council* or similar plan.
4	The evacuation requirements of the development are to be considered. An engineers report will be required if circumstances are possible where the evacuation of persons might not be achieved within the *effective warning time*.
5	Reliable access for pedestrians or vehicles required to a publicly accessible location above the *PMF*.
6	Applicant to demonstrate that evacuation in accordance with the requirements of this DCP is available for the potential development flowing from the subdivision proposal.

Management and Design

1	Applicant to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this DCP.
2	*Site Emergency Response Flood Plan* required where floor levels are below the *design floor level*, (except for single dwelling-houses).
3	Applicant to demonstrate that area is available to store goods above the 100 year flood level plus *freeboard*.
4	Applicant to demonstrate that area is available to store goods above the *PMF* level.
5	No storage of materials below the *design floor level* which may cause pollution or be potentially hazardous during any flood.

Figure 7-1 Proposed Planning Matrix – Georges River Floodplain

ALL OTHER FLOODPLAINS INCLUDING AREAS AFFECTED BY LOCAL OVERLAND FLOODING

Planning & Development Controls

	Flood Risk Precincts (FRP's)																							
	Low Flood Risk								Medium Flood Risk								High Flood Risk							
Planning Consideration	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development	Critical Uses and Facilities	Sensitive Uses and facilities	Subdivision	Residential	Commercial and Industrial	Tourist Related Development	Recreation and Non-Urban	Concessional Development
Floor Level		3		2,6	1,5,6	2,6	1	4,6				2,6	1,5,6	2,6	1	4,6							1	4,6
Building Components		2		1	1	1	1	1				1	1	1	1	1							1	1
Structural Soundness		3		2		2		2				1	1	1	1	1							1	1
Flood effects		2	2		2	2					1	2	2	2	2	2							1	1
Car Parking and Driveway Access		1,3,5, 6,7		1,3,5, 6,7	1,3,5, 6,7	1,3,5, 6,7	2,4,6, 7	1,3,5, 6,7				1,3,5, 6,7	1,3,5, 6,7	1,3,5, 6,7	2,4,6, 7	1,3,5, 6,7							2,4,6, 7	1,3,5, 6,7
Evacuation		2,3,4	2,3,4, 5	2,3	1,2,3	2,3					2,3,4, 5	2,3	1,2,3	2,3	4	2,3							4	2,3
Management and Design		4,5	1								1		2,3,5	2,3,5	2,3,5	2,3,5							2,3,5	2,3,5

COLOUR LEGEND: Not Relevant; Potentially Unsuitable Land Use

General Notes

1	*Freeboard* equals an additional height of 500mm.
2	The relevant environmental planning instruments (generally the Local Environmental Plan) identify development permissible with consent in various zones in the LGA. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. This matrix identifies where flood risks are likely to determine where certain development types will be considered "potentially unsuitable" due to flood related risks.
3	Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.
4	Refer to section 2.7 of the DCP for special considerations such as for house raising proposals and development of properties identified for voluntary acquisition.
5	Refer to Section 2.5 of the DCP for planning considerations for proposals involving only the erction of a fence. Any fencing that forms part of a proposed development is subject to the relevant flood effects and Structural Soundness planning considerations of the applicable landuse category.
6	Terms in italics are defined in the glossary of this plan and Schedule 2 specifies development types included in each land use category. These development types are generally as defined within Environmental Planning Instruments applying to the LGA.

Floor Level

1	All floor levels to be no lower than the 20 year flood unless justified by site specific assessment.
2	*Habitable floor* levels to be no lower than the 100 year flood level plus *freeboard*.
3	*Habitable floor* levels to be no lower than the *PMF* level plus freeboard. Non-*habitable floor* levels to be no lower than the *PMF* level unless justified by a site specific assessment
4	Floor levels to be no lower than the *design floor level*. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the floor level of existing buildings, or the need for access for persons with disabilities, a lower floor level may be considered. In these circumstances, the floor level is to be as high as practical, and, when undertaking alterations or additions, no lower than the existing floor level.
5	The level of *habitable floor areas* to be equal to or greater than the 100 year flood level plus *freeboard*. If this level is impractical for a development in a Business zone, the floor level should be as high as possible.
6	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest *habitable floor area* is elevated more than 1.5m above finished ground level, confirming that the undercroft area is not to be enclosed.

Building Components Method

1	All structures to have *flood compatible building components* below the 100 year flood level plus *freeboard*.
2	All structures to have *flood compatible building components* below the *PMF* level

Structural Soundness

1	Engineer's report to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus *freeboard*.
2	Applicant to demonstrate that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus *freeboard*. An engineer's report may be required.
3	Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a *PMF*. An engineer's report may be required.

Flood Effects

1	Engineer's report required to certify that the development will not increase flood effects elsewhere, having regard to: (I) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood *conveyance*; and (iii) the cumulative impact of multiple potential developments in the floodplain.
2	The flood impact of the development to be considered to ensure that the development will not increase flood effects elsewhere, having regard to: (I) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood *conveyance*; and (iii) the cumulative impact of multiple potential developments in the floodplain. An engineer's report may be required.

Car Parking and Driveway Access

1	The minimum surface level of open car parking spaces or carports shall be as high as practical, but no lower than the 20 year flood or the level of the crest of the road at the location where the site has access. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 20 year flood.
2	The minimum surface level of open car parking spaces, carports or garages, shall be as high as practical.
3	Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or *enclosed car parking*, must be protected from inundation by floods equal to or greater than the 100 year flood.
4	The driveway providing access between the road and parking space shall be as high as practical and generally rising in the egress direction.
5	The level of the driveway providing access between the road and parking space shall be no lower than 0.3m below the 100 year flood or such that the depth of inundation during a 100 year flood is not greater than either the depth at the road or the depth at the car parking space. A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.
6	*Enclosed car parking* and car parking areas accommodating more than 3 vehicles (other than on Rural zoned land), with a floor level below the 20 year flood or more than 0.8m below the 100 year flood level, shall have adequate warning systems, signage and exits.
7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year flood.
	Note: (1) A flood depth of 0.3m is sufficient to cause a typical vehicle to float.

Evacuation

1	Reliable access for pedestrians or vehicles required during a 100 year flood.
2	Reliable access for pedestrians or vehicles is required from the building, commencing with a minimum level equal to the lowest *habitable floor* levelto an area of refuge above the *PMF* level, or a minimum of 40% the gross floor area of the dwelling to be above the *PMF* level.
3	The development is to be consistent with any relevant *flood evacuation strategy*, *Flood Plan adopted by Council* or similar plan.
4	The evacuation requirements of the development are to be considered. An engineers report will be required if circumstances are possible where the evacuation of persons might not be achieved within the *effective warning time*.
5	Reliable access for pedestrians or vehicles required to a publicly accessible location above the *PMF*.

Management and Design

1	Applicant to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this DCP.
2	*Site Emergency Response Flood Plan* required where floor levels are below the *design floor level*, (except for single dwelling-houses).
3	Applicant to demonstrate that area is available to store goods above the 100 year flood level plus *freeboard*.
4	Applicant to demonstrate that area is available to store goods above the *PMF* level.
5	No storage of materials below the *design floor level* which may cause pollution or be potentially hazardous during any flood.

Figure 7-2 Proposed Planning Matrix – Other Floodplains

7.2 Flood Warning Enhancements

Flood warning is an important part of floodplain management. It provides advice on impending flooding so that people and relevant agencies can take action to minimise the impacts of flooding.

Flood warning systems usually monitor rainfall and river gauges in the upper catchment in real time and, through hydrologic/hydraulic models, predict the resulting flow, flood levels and flood peak timing in the lower catchment. The Bureau of Meteorology provides an excellent flood warning system for the Georges River. However, other flood intelligence data concerning the number and location of properties likely to be affected by a particular flood is not currently available. The Georges River FRMS identified the following enhancements to the existing system:

- Development of a property database system that is able to link a flood warning prediction for one or more gauges on the Georges River with affected property to improve emergency management operations.

- Software could be quite readily developed that links information from the flood damages database developed as part of the Georges River FRMS with flood warning advice issued by the Bureau of Meteorology. This could directly link flood warning predictions on the Georges River to a specific flood level at individual properties within the database. A determination can then be made on which properties are likely to be directly affected by the flood warning prediction. The information can be tabulated on a locality basis to allow the State Emergency Service to direct personnel to evacuate or otherwise assist those residents that are likely to be affected by flooding. If flood warning predictions are revised, a new list of potentially affected residents could be readily generated.

- The database could be linked to a GIS system providing for enhanced flood warning prediction on a property by property level. The first stage of this work has been completed. The Anzac Creek part of the database could now be reviewed and updated where appropriate.

A pilot project incorporating the above recommendations has subsequently been completed for the Georges River catchment.

As flood affected properties within the Anzac Creek catchment are predominantly located in the lower catchment, and dominated by major flooding in the Georges River, the flood warning system enhancements proposed by the Georges River FRMS and developed through the pilot study would have direct benefit for the lower Anzac Creek catchment.

Flooding and property database details from the Anzac Creek FRMS would be incorporated into the system development and update the existing databases from the Georges River FRMS. However, it should be noted that the majority of additional flood risk properties identified through the Anzac Creek FRMS are located upstream of the M5 Motorway beyond the backwater influence of the Georges River. Therefore, in the upper Anzac Creek catchment, flooding mechanisms are not linked to the Georges River system and benefits in upgrading the Georges River flood warning system would not be realised in this locality.

7.2.1 Improving Flood Awareness through a Flood Warning System

The Georges River FRMS identified that there is also scope to extend the flood warning system as a flood awareness initiative, by providing advice to individual residents on the critical gauge heights that will affect their property. With this knowledge, residents will be better able to appreciate the likely magnitude of a particular flood warning prediction and whether or not they are likely to be directly affected. It will allow increased time for residents to take appropriate action to reduce their personal risks and to minimise the potential flood damage to their homes.

The nearest gauge would need to be related to some point within the property, preferably the floor level of the building. The information could be attached to the inside of the meter box of each house or building below the PMF. As the majority of floor levels contained in the database have been estimated, floor levels should be confirmed by survey prior to fixing this advice.

The database would also need to be reviewed and updated from time to time to account for development or redevelopment within the study area. Most changes are likely to be confined to the area above the 100 year flood, where planning controls will be less restrictive. The database should be reviewed and updated at say 5 -10 year intervals. Responsibility for this will need to be determined between the State Emergency Service and Council.

This initiative would benefit the residents in the lower Anzac Creek subject to backwater flooding from the Georges River. The absence of rainfall and flow gauges in the upper Anzac Creek catchment and subsequently no flood warning system, excludes any potential benefit in this regard for the upper catchment.

7.3 Emergency Management Operations

The State Emergency Service (SES) has formal responsibility for emergency management operations in response to flooding. Other organisations normally provide assistance, including the Bureau of Meteorology, the various councils, police, fire brigade, ambulance and community groups.

As many organisations have important roles to play, it is imperative that there is a clear understanding of the role and responsibilities of each organisation. This should be defined, agreed, understood and acted upon in a flood situation according to a predetermined flood action plan. The plan needs to be continually updated, as new information on flood behaviour becomes available and as lessons are learnt from other flood experiences.

Emergency management operations in relation to flooding are outlined in Local Flood Plans that are developed by the SES.

7.3.1 Update of Local Flood Plan

The Georges River FRMS recommended that the Local Flood Plan covering the Georges River is updated with additional flood information developed as part of the study. This included:

- mapping of the different flood risk areas;
- details of residential property affected by flooding;

- details of commercial and industrial property affected by flooding;
- inundation depths for houses in the 100 year flood;
- inundation depths for other buildings in the 100 year flood;
- details of main arterial roads likely to be affected by flooding;
- other flooding characteristics, such as rate of rise of floodwaters and duration of flooding; and
- results from the evacuation strategy study (see recommendation below).

Additionally, information from the flood damages database will also provide valuable data on specific properties that are affected for a range of floods up to the PMF. The database includes estimated ground, floor and flood levels for every property within the Georges River study area.

The above details will assist the SES develop an improved Local Flood Plan for the Georges River, comprising flood preparedness measures, the conduct of response operations, and the coordination of immediate recovery measures. The Georges River Floodplain Management Committee would be an ideal group to help progress the development of the Local Flood Plan and to enlist the support of other authorities.

The majority of the flood affected properties in the lower Anzac Creek catchment are included in the Georges River databases. The additional detail on flood risk mapping, design flood conditions and the property database developed through the Anzac Creek FRMS should be used to update and supplement existing databases and to refine the Local Flood Plan where relevant.

7.3.2 Georges River Evacuation Study

Given the potential for most of the major arterial roads to be cut early by floodwaters, and the large number of residents that could be affected during severe floods, an evacuation strategy study was recommended in the Georges River FRMS. The objectives of the study are to determine appropriate evacuation centres, numbers to be allowed for, evacuation routes and other evacuation methods. The cost of the evacuation study was estimated to be about $50,000.

This study would encompass the majority of the flood affected areas of the Anzac Creek catchment without any additional scope.

Evacuation procedures, particularly in the lower part of the Anzac Creek catchment are a very important aspect of the flood emergency response. Under the existing flood risk categorisation, the majority of the flood liable land above the 100-year ARI flood up to the PMF is in low risk precinct. However, as discussed in Section 4.3.1, given that PMF levels can be several metres higher than the 100-year ARI levels in some areas, there is a high risk associated with significant flood depths for intermediate magnitude events. The depth and extent of inundation to the PMF level would result in significant isolation of existing property in the lower catchment and obstruction to safe evacuation routes and the potential requirement for vertical evacuation. Evacuation planning considering the updated flooding analysis should be pursued as high priority as recommended in the Georges River FRMS.

In the upper Anzac Creek catchment, the nature and extent of flooding up to the PMF level upstream of the M5 Motorway is such that evacuation routes should be available to existing property.

7.4 Flood Awareness

Raising and maintaining flood awareness will provide residents with an appreciation of the flood problem and what can be expected during floods. It will provide them with an opportunity to plan what to do to reduce potential flood damage and to avoid personal risk during future floods.

There are many means of raising and maintaining flood awareness within the community. These measures include:

- the issue of Section 149 Certificates;
- the issue of flood certificates;
- the construction of flood markers; and
- community education programs.

Effective community education strategies should be pursued through a partnership of Council and the SES. There are numerous opportunities for community consultation that can be targeted to the local demographic with appropriate consideration of relative flood risk. The consultation undertaken in this study highlighted in particular the lack of flood awareness within the residential areas of Anzac Village and Wattle Grove, principally given the relatively recent development and lack of historical flood experience. This is perhaps in contrast to the Moorebank Industrial area with previous major flood experience, e.g. 1986 and 1988, where a level of flood awareness has been retained. Nevertheless, community education and flood awareness programs are an ongoing component of the floodplain management plan. An appropriate methodology of community consultation needs to be developed between Council and the SES to determine a workable, partnered community education strategy into the future.

7.4.1 Flood Certificates

The NSW Government's Floodplain Development Manual recommends that Councils promote community flood readiness by supplying flood data and advice, which can readily be achieved by the use of flood certificates.

A flood certificate issued to individual property owners would inform them of the flood situation at their particular property. The certificate would contain vital information such as the expected flood levels in a range of design floods. It would also provide information on ground and floor levels where this information is available, which would allow an assessment of the depths of flooding over the property and building. Where property levels are unknown, residents could be encouraged to obtain these levels using a registered surveyor. Much of this data is currently available from the flood damages database developed as part of the Floodplain Risk Management Study. The database would need to be incorporated into Council's GIS computer based system and mechanisms to keep the data up-to-date. It would be relatively simple to print out a flood certificate for one or more properties once this link is established.

Different certificates would be produced where information on floor levels are either known or unknown. The certificate could be attached to Section 149 certificates and also posted out with Council Rates Notices every 1 – 2 years. The certificate could also be provided on request for a nominal fee.

The design flood and property database details derived for the Anzac Creek FRMS provides the most complete and recent flood and property information to be used in any notifications.

The majority of questionnaire respondents in Anzac Creek (64%) were in favour of Council advising every resident and property owner on a regular basis of the known potential flood threat.

7.4.2 Historical Flood Markers

The construction of one or more flood markers within the Georges River floodplain was recommended in the Georges River FRMS. Flood markers can be constructed in parks, reserves or along low points in roads. Newbridge Road, adjacent to the Liverpool voluntary purchase area, was identified as an appropriate location where a flood marker might be considered. This is a particularly flood prone area where there are already flood depth indicators to show the depth of floodwater over the road. The height of different probability floods could also be shown, along with heights of previous flood events, such as the 1988, 1956 and 1873 floods.

Suitable flood marker locations within the Anzac Creek catchment are somewhat limited. Potential sites where significant inundation occurs are Junction Road and a location within the Moorebank Industrial area such as Iraking Avenue/Seton Road. Whilst in locations of the most significant flooding within the Anzac Creek catchment, only a very localised benefit is perceived in terms of raising public awareness. Therefore additional flood markers within the Anzac Creek catchment are not considered to provide notable value to the community.

8 FLOODPLAIN MANAGEMENT MEASURES FOR ANZAC CREEK

8.1 Types of Floodplain Measurement Measures

Measures which can be employed to mitigate flooding and reduce flood damages can be separated into three broad categories:

Flood modification measures: modify the flood's physical behaviour (depth, velocity) and includes flood mitigation dams, retarding basins, on-site detention, channel improvements, levees, floodways or catchment treatment.

Property modification measures: modify land use including development controls. This is generally accomplished through such means as flood proofing (house raising or sealing entrances), planning and building regulations (zoning) or voluntary purchase.

Response modification measures: modify the community's response to flood hazard by informing flood-affected property owners about the nature of flooding so that they can make informed decisions. Examples of such measures include provision of flood warning and emergency services, improved information, awareness and education of the community and provision of flood insurance.

8.2 Existing Measures in Anzac Creek

There is no current floodplain management plan specifically for Anzac Creek. However, there is a number of existing floodplain management measures in place following the Georges River FRMS with the objective of reducing flood risk within the catchment.

8.2.1 Local Catchment Detention Basins

There are two existing basins in the catchment being Wattle Grove Basin and Clinch's Pond. These structures provide for additional temporary flood storage in the catchment, thereby providing some attenuation of local runoff to Anzac Creek.

Both of the existing basins have a direct connection to the main channel of Anzac Creek: Wattle Grove Basin via a grassed swale, and Clinches Pond via a trunk drainage line. In major events, the performance of the basins may be impacted upon by backwater effects from flooding in the main channel.

8.2.2 Planning Controls

A review of existing planning provisions was provided in Section 6. In terms of floodplain management some of the key planning instruments are the development control policies which aim to limit the flood impact of future development (and re-development) within the catchment.

Controls on future development were seen as an important issue from the responses received in the community consultation. There was significant support among respondents to the questionnaires for Council to apply restrictions on development in high flood risk areas of the floodplain and for building controls (such as minimum floor levels, use of flood compatible materials) in flood affected areas.

As discussed in Section 7.1, under interim policy provisions the relevant planning controls for Anzac Creek apply the Georges River planning matrix for the lower part of the catchment.

The planning matrix approach classifies land uses in the floodplain and controls development to minimise the consequences of flooding. Using this approach, a matrix of development controls can be developed, based on land use type and exposure to flood risk. Planning controls for the Anzac Creek catchment are discussed below.

Identification of Flood Risk Zones

The following categorisation has been adopted in this study to identify relative risk within the catchment and to guide appropriate planning controls appropriate for the different flood risk categories:

- **High Flood Risk** – Land below the 100-year flood that is subject to a high hydraulic hazard. The high flood risk area is where high flood damages, potential risk to life, or evacuation problems are anticipated. Most development should be restricted in this area.

- **Medium Flood Risk** – Land below the 100-year flood level that is not subject to high hydraulic hazard and where there are no significant evacuation difficulties. The medium flood risk area is where there is still significant risk of flood damage, but where these damages can be minimised by the application of appropriate development controls.

- **Low Flood Risk** – All land within the floodplain (i.e. within the PMF extent) but not identified as either in a high or medium flood risk area. This includes the area above the 100-year ARI flood where the risk of damage is low. Most land uses would be permitted within this area

The delineation of flood risk zones in accordance with the above categorisations was presented in Section 4.3. This has been based on detailed modelling of the catchment and it is recommended that the zones be adopted for floodplain management and development planning.

Flood Planning Levels (FPL's)

The flood planning level (FPL), previously known as the 'designated flood' level or 'flood standard', is the flood level selected for planning purposes. Current floodplain management practice utilises a graded set of controls that do not rely on the definition of a single FPL across the catchment. This indeed is the basis for the planning control matrices discussed above. The approach makes use of a range of FPL's with regard to various land uses within each flood risk zone. Key FPL's recommended for Anzac Creek are discussed below.

Lower Anzac Creek

The Lower Anzac Creek catchment (downstream of the M5 Motorway) is encompassed within the Georges River planning area. The 100-year flood level (plus freeboard) is retained as the principal floor level control for residential land uses in the study area.

It is proposed to retain the existing Georges River planning controls (refer to Figure 7-1) for the Lower Anzac Creek catchment without modification.

Upper Anzac Creek

The majority of the developable part of the catchment, which is beyond the creek corridor, lies within the Low Risk Flood Zone or outside the flood planning area (i.e. above the PMF). This includes existing developed areas of Wattle Grove and Anzac Village. Significantly, this poses little restriction in terms of appropriate land use type for future development. However, any development within the flood planning area is subject to appropriate controls for Low Flood Risk Zone developments.

The existing controls in place for the lower Anzac Creek can be extended to the upper catchment. In this context the Low Flood Risk Zone category controls would in general apply. More stringent controls for higher flood risk categories would not generally be triggered, therefore not imposing any unduly restrictive controls on development within the upper catchment.

Principal components of the development control matrix for the Anzac Creek catchment include:

- Establishment of flood risk zones in accordance with Section 4.3 of this study;
- The principal floor level control for residential development to be maintained as the 100-year flood level plus 500mm freeboard;
- Limitations of floodplain filling via control of earthworks and fill that changes land surface levels; and
- Controls on incremental flood impact of new developments (e.g. developed area run-off).

The recommended planning controls would appear to support many of the community responses from the questionnaires in regard to planning and development controls. Most respondents were in favour in placing restrictions on development such as minimum floor levels and /or the use of flood compatible building materials. A lower number of respondents also believed that Council should advise people of the flood risks, but individuals should be allowed to choose how they would reduce flood damage on their properties.

It is recommended that the planning matrix of controls for Anzac Creek is incorporated into the Draft Consolidated DCP (or existing interim policy). These controls would mirror the adopted planning controls within the Georges River catchment. It is also recommended that interim policies for overland flooding (refer to Figure 7-2) be retained until further local investigations are completed.

8.2.3 Flood Warning in Anzac Creek

The formal flood warning service for the Georges River provided by the Bureau of Meteorology benefits the residents in the lower Anzac Creek affected by backwater flooding from the Georges River. Elsewhere in the catchment there is no site specific flood warning system, however there are a number of general warning services provided by the Bureau including:

- **Flood Watches –** typically provide 24-48 hour notice. These are issued by the NSW Flood Warning Centre providing initial warnings of potential flooding based upon current catchment conditions and future rainfall predictions.

- **Severe Thunderstorm Warnings –** typically provide 0.5 to 2 hours notice. These short range forecasts are issued by the Bureau's severe weather team and are based upon radar, data from field stations, reports from storm spotters as well as synoptic forecasts.

- **Severe Weather Warnings –** for synoptic scale events that cause a range of hazards, including flooding. Examples of synoptic scale events are the deep low pressure systems off the NSW coast which produced the 1986, 1988 and 1990 floods in the Georges River catchment.

Sophisticated forecasting approaches for locally derived flooding within the Anzac Creek catchment would have limited benefit to residents given that:

- There is little existing property affected by flooding within the upper Anzac Creek catchment up to the 100 year event;

- Response time between significant rainfall and flooding is short due to the small catchment size, such that warning times would be short; and

- The relatively short warning time for local catchment generated flows would not provide for any significant evacuation response in advance of flooding.

8.3 Other Potential Flood Mitigation Options for Anzac Creek

8.3.1 Georges River Levee

(Not Recommended in Floodplain Management Plan)

Two breakouts from the right bank of the Georges River occur just upstream of Newbridge Road. These spills from the Georges River contribute additional flood flow to affected property in the Anzac Creek catchment, in particularly the residential area in the locality of Clinch's Pond. The breakouts become active in flood events of 50-year ARI magnitude and greater.

A levee of some 400m length and approximately 0.5 high would be sufficient to control these particular breakouts from the Georges River and prevent direct flow to the affected areas downstream. A model simulation for this levee configuration was undertaken for a 100-year ARI flood event.

Figure 8-1 shows the flood inundation in the vicinity of the potential levee location and the flood affected property downstream. Both existing conditions (no levee) and conditions with the levee in place are shown for comparison. The location of the spills from the Georges River upstream of Newbridge Road is evident for existing conditions. This spillage contributes to the flooding of a small number of properties within the lower Anzac Creek floodplain.

The flood inundation map shows that whilst the levee is effective in eliminating the spills from the Georges River in this location, the net effect on flood levels in the Anzac Creek catchment is negligible. This result again confirms the backwater influence of the Georges River on flood conditions in this lower part of the Anzac Creek catchment. Little change in inundation patterns are

predicted as the flood water level is controlled by water levels from the Georges River via overland flow path connections to the Lake Moore wetlands.

The levee would also result in minor increases in flood level on the left bank of the Georges River. The impact of these flood level increases on property has not been investigated. This potential adverse impact and the negligible benefit for flood affected property in the Anzac Creek catchment confirms that this levee is not a viable mitigation option.

REFER TO COUNCIL FOR FIGURE DETAILS

Figure 8-1 Impact of Potential Georges River Levee (U/S Newbridge Road)

8.3.2 Channel Maintenance

(Recommended for further consideration)

Channel maintenance is a topical issue within the community. Many respondents to the questionnaires were concerned that their property could be flooded because the creek flow is blocked by trees, vegetation, shrubs and other rubbish collected in the creek. The most popular and strongly proposed mitigation measure from questionnaire respondents was to remove all blockages and clean the creek of vegetation growth, trees and all other waste and to develop and maintain schedule maintenance program for the creek.

The reach of Anzac Creek most affected by in-stream vegetation at present is the lower reach downstream of the M5 Motorway. The upper reach adjacent to the Wattle Grove residential development is essentially free from any major vegetation growth that would restrict channel capacity. Figure 8-2 and Figure 8-3 show representative images of the main channel condition of Anzac Creek for the reaches upstream and downstream of the M5 Motorway respectively.

The design flood conditions presented have utilised a Manning's 'n' value for the Anzac Creek channel of 0.06, representative of considerable weed growth in the channel. Under these design conditions for events up to the 100 year return period, there is no significant flooding simulated upstream of the M5 Motorway (refer to Figure 4-1). Downstream of the M5, a significant amount of overbank flooding is simulated (e.g. Ern Smith Playing Fields), however, as previously discussed the dominant mechanism for this overbank flooding is the backwater influence of the Georges River.

Given this backwater influence, the impact of Anzac Creek channel condition on peak flood levels is somewhat limited, downstream of the M5 Motorway. Irrespective of the Anzac Creek channel condition, the peak flood level is controlled by peak levels in the Georges River.

To fully appreciate the influence of Anzac Creek channel conditions on peak flood levels, particularly downstream of the M5 motorway, a flood condition has been simulated without the Georges River backwater influence. For this scenario, an Anzac Creek 100 year ARI catchment event has been simulated with a 5 year ARI flood condition in the Georges River. Table 8-1 shows the impact of increased channel roughness in Anzac Creek (Manning's 'n' value of 0.10) for the 100-year flood event in the Anzac Creek catchment. Two results are presented representing simulations using the 5-year and 100-year ARI Georges River boundary condition.

Table 8-1 Increase in 100 year ARI Flood Levels with Increase in Channel Roughness (n=0.06 vs n=0.10)

Location	Georges River Boundary Condition	
	5 year ARI	100 year ARI
Wattle Grove Basin	0.35	0.35
Anzac Road	0.46	0.43
U/S M5 Motorway	0.35	0.30
Junction Road	0.21	0.01
Kelso Crescent	0.06	0.0

Figure 8-2 Anzac Creek Channel Upstream of Anzac Road

Figure 8-3 Anzac Creek Channel Vegetation at Junction Road

Table 8-1 shows some significant increases in peak flood levels as a result of highly constricted channel conditions (simulating vegetation). When considering backwater inundation from the Georges River, however, the increase in flood levels downstream of the M5 Motorway are minimal.

Whilst Table 8-1 shows there are increases in peak flood water levels assuming a more vegetated channel, under the design flood conditions no existing property is adversely affected by such a change. Figure 8-4 shows a flood inundation map for the 100 year ARI Anzac Creek catchment event with a 5 year ARI Georges River boundary condition, assuming increased channel roughness conditions. The majority of flow remains in-bank for Anzac Creek, or where overbank flooding occurs, the inundation is typically shallow and doesn't encroach upon existing property. Therefore stream maintenance within Anzac Creek is not expected to yield significant benefit in terms of reducing the extents of flooding and associated flood risks.

Despite the little direct benefit in terms of flood inundation to property, a stream vegetation management program would nevertheless reduce the propensity of culvert blockage. Flood borne debris, particularly large woody debris, can easily build up at the upstream face of a culvert reducing the conveyance capacity of the structure. The impact of culvert blockage on flood levels in the Anzac Creek catchment is discussed further in Section 8.3.3.

Other benefits not related to floodplain management may be achieved through stream clearing include aesthetic and environmental improvements. Some examples include removal of in-stream rubbish that has become an eyesore, better water quality and improved habitat values of the existing ecosystem. The vegetation removal may form a component of a more comprehensive creek rehabilitation and maintenance project.

There are a number of methods that may be employed to remove in-stream vegetation such as mechanical excavation (including specialised in-stream harvesters) and herbicide control. The appropriate method is dependent on local site conditions and objectives, and should consider potential threats/nuisances such as rapid regrowth, disturbance to the stream bed and banks resulting in erosion, disturbance to non-target aquatic plants, weed propagation and affect on aquatic/semi-aquatic animals.

A channel maintenance program is not critical for Anzac Creek floodplain management, but has been recommended for further consideration at this stage given that:

- There is no immediate adverse impact on flooding conditions in flood affected areas as a result of reduced channel capacity caused by excessive vegetation growth;
- Continued growth may increase the opportunity for potential culvert blockages; and
- Non-flooding related benefits such as environmental and aesthetic values may be achieved.

The cost of such a program is highly variable depending on the technique used for vegetation removal, the reach length to be addressed and maintenance cycle. At present the worst affected reach is the 1.5km between the M5 Motorway and Newbridge Road. An annual cycle of fairly rudimentary mechanical excavation from the stream bank for this reach could be of the order of $30,000.

REFER TO COUNCIL FOR FIGURE DETAILS

Figure 8-4 100 year ARI Inundation Map with Increased Channel Roughness

8.3.3 Culvert Blockage Protection

(Recommended for further consideration)

Structure blockage due to flood debris can result in significant increases to flood levels and redistributions of flood flows. Blockages are more common in urban areas due to the following factors:

- Small openings;
- Litter grates; and
- Quick responsive catchments with high velocities.

By example, the Fairy and Cabbage Tree Creek catchments in Wollongong experienced a major flood in August 1998. During this flood, many large culverts were either completely blocked or partially blocked. This lead Wollongong City Council to develop a blockage policy for flood assessments. In basic terms, the policy states that culverts with a diagonal opening of less than 6m will be considered to be potentially fully blocked in design simulations. Larger openings will have a 25% blockage assumption.

Liverpool City Council at present has no set policy in respect to culvert blockage assumption for design flood analysis. However, in most studies blockage analysis is undertaken within model sensitivity testing.

The potential for culvert blockage in major flood events has been reinforced in the recent June 2007 flood event in Newcastle. Figure 8-5 shows a major culvert blockage that occurred during the Newcastle flood. The image shows vehicles that have been swept into the stormwater channel providing for almost 100% blockage of the affected culvert. In other areas, culverts were blocked by tree debris (as the flooding coincided with near-record winds), wheelie bins, and even shipping containers, which had a major impact on flood behaviour. Blockage of large culverts can have a major impact in redistributing flow and exacerbating flood impact.

There are numerous culverts along Anzac Creek as discussed in Section 4.1. The potential for blockage at each of these culverts would vary depending on their configuration. A scenario to simulate the worst case, may involve blockage of some culverts and no blockage of other culverts. Blockage of the M5 Motorway culvert has been identified as having the greatest potential impact on flooding in the Anzac Creek catchment. This is principally due to the elevated road embankment which effectively blocks overland floodplain flows. Therefore in the event of 100% culvert blockage, the road embankment would effectively dam the floodwaters until upstream water levels were sufficient to overtop of the road crest.

The M5 Motorway culvert consists of a 4 cell 3m width x 3m height box culvert (note that the diagonal span of each cell is therefore 4.2m). Figure 8-6 shows the M5 Motorway culvert looking at the upstream entrance through the Heathcote Road on ramp.

Figure 8-5 Culvert Blockage, Newcastle June 2007

Figure 8-6 Anzac Creek Culverts at M5 Motorway (Heathcote Rd On-Ramp)

Given that the motorway embankment is elevated above the floodplain and that under existing design flood conditions all of the Anzac Creek flow is conveyed through the culvert, substantial blockage of this structure can have a significant impact on upstream flood levels. In the event of a full culvert blockage, including possible embankment collapse, there is no alternative overland flow route for floodwaters.

Model simulations were undertaken to determine the relative impact of various scenarios for blockages of the M5 Motorway culverts, including 25%, 50% and 100% blockage assumptions, on predicted existing 100-year ARI flood levels. Table 8-2 summarises the relative increase in design flood levels from existing conditions at key locations upstream of the M5 Motorway for the blockage scenarios considered.

Table 8-2 Simulated Increases in Flood Level for Culvert Blockage Scenarios

Location	Increase in Design Flood Level (100-year ARI)		
	25% Blockage	50% Blockage	100% Blockage
U/S Side of M5 Motorway	+0.27	+0.43	+2.4
Delfin Drive	+0.28	+0.42	+1.4
Anzac Road	+0.21	+0.35	+1.2
Wattle Grove Basin	+0.05	+0.12	+0.65

Table 8-2 indicates that a 100% blockage of the culvert would result in substantial increases in peak flood levels upstream of the motorway. The relative impact is greatest at the upstream face of the embankment and gradually decreases with distance upstream. The predicted afflux for the 25% and 50% blockages is substantially less than the 100% blockage values as some flood conveyance is maintained through the culverts.

A flood depth inundation map for the 100-year ARI 100% culvert blockage scenario is presented in Figure 8-7. The existing condition (i.e. no culvert blockage) 100-year ARI flood outline is presented for comparison. The extent of additional property inundation that would occur for total culvert blockage is evident.

As a result of a 100% M5 culvert blockage, an additional 130 properties would be subject to flood inundation compared with normal existing conditions for the 100-year ARI event. The affected properties are generally located between Anzac Road and the M5 Motorway. Further upstream, including the Wattle Grove residential areas, most property would remain unaffected given the reducing afflux further away from the Motorway and freeboard in the existing Anzac Creek channel in this area. The additional estimated flood damage in monetary terms is $12M for the 100-year ARI event 100% blockage scenario.

A 100% blockage scenario is an extreme condition. It is noted that even with a substantial 50% blockage of the M5 Motorway culverts, sufficient culvert capacity is maintained to convey the

floodwater through the motorway embankment with flood levels remaining in-bank and no additional inundation of neighbouring property.

Given the significant damage potential in the event of a major culvert blockage, preventative measures are therefore a potential flood mitigation option. A series of bollards may be installed at a suitable distance upstream of the culvert opening preventing large obstructions carried in the channel from blocking the culvert entrance. In the event of an obstruction at the bollards, sufficient channel/floodplain capacity can be maintained to convey floodwater around the obstruction allowing the culverts to operate normally. Some local increase in flooding in the immediate vicinity of the bollards may be expected depending on the degree of blockage.

Detailed design of any bollard configuration should include optimal spacing and height of bollards and the foundations/anchoring must be able to withstand substantial impact from flood borne debris.

Bollards located in the stream channel will be susceptible to the accumulation of debris. Therefore any such construction would require regular inspection and maintenance to ensure the channel capacity is not unduly reduced due to debris build-up on the bollards. As a component of the design configuration, machine access to the bollards from the banks of Anzac Creek would be required to enable necessary maintenance.

The construction of bollards at the entrance to the M5 Motorway culverts (U/S Heathcote Rd on ramp) is recommended for further consideration in the Floodplain Risk Management Plan. The bollards would provide protection against severe blockage of the existing culverts and the subsequent additional inundation in comparison with normal flood conditions (assuming zero culvert blockage). There are ongoing maintenance requirements to remove accumulated debris.

The cost of investigation, design and construction of the bollards, including a suitable working platform for maintenance machinery is approximately $84,000. A preliminary cost-estimate is provided in Appendix D. General site access can be gained from Blamey Road or Colo Circuit.

Other considerations to limit potential for major culvert blockage include:

- Channel maintenance – regular inspections for abandoned vehicles and prompt removal of any major obstructions that are in the channel or floodplain; and
- Temporary construction works – items such as temporary works buildings, skips and shipping containers should not be stored within existing flood limits, unless they can be fixed in place and not subject to mobilisation during extreme flood conditions.

REFER TO COUNCIL FOR FIGURE DETAILS

Figure 8-7 Impact of Culvert Blockage on Design 100-year ARI Flood Depths

8.3.4 Other Measures

8.3.4.1 Local Catchment Studies (stormwater drainage)

(Recommended in Floodplain Management Plan)

In addition to channel maintenance, concerns over capacity and maintenance of stormwater drainage infrastructure was a popular issue in the community.

Local catchment studies to address stormwater and overland flow issues are recommended for potential problem areas. The flooding analysis for the Anzac Creek catchment presented in this study is focused on mainstream flooding and does not consider local flooding behaviour in minor sub-catchments.

Two locations within the study area have initially been identified for further investigation of local catchment/overland flooding, being:

- Centenary Avenue – small industrial area just downstream of local catchment culvert through the M5 motorway embankment; and
- Freda Place – small area of residential development just upstream of the M5 Motorway.

8.3.4.2 Upstream Detention

(Not Recommended in Floodplain Management Plan)

Flood detention basins provide additional temporary flood storage, thereby attenuating peak flood flows and reducing downstream flood impact. There is not a major flooding problem under existing conditions in the catchment upstream of the M5 Motorway, and downstream of the motorway flooding is dominated by Georges River flooding conditions. Therefore provision of additional upstream detention would have no major influence in reducing flood risk. Flood detention is therefore not considered appropriate for the catchment.

Nevertheless, this should not preclude any requirements for future development to provide for on-site detention to address potential increases in local stormwater run-off.

8.3.4.3 Channel Widening

(Not Recommended in Floodplain Management Plan)

The capacity of the watercourse to discharge flood flows can be increased by opening up the waterway area. No property upstream of the M5 motorway is identified within the 100-year flood envelope as the existing Anzac Creek channel and floodplain has sufficient flood capacity. Downstream of the M5 motorway, increasing channel conveyance will have little if any impact on peak flood conditions as flooding is predominantly governed by backwater conditions from the Georges River.

Channel widening therefore is not considered appropriate for the catchment.

8.3.4.4 Flood Gates

(Not Recommended in Floodplain Management Plan)

Prevention of backwater flooding from the Georges River via flood gates or other hydraulic control structures could potentially reduced the number of flood affected properties. Flood gates at the M5 Motorway embankment would be a suitable control point, however, this would provide little benefit as there is minimal Georges River backwater influence upstream of this point. Other structures in downstream areas are not feasible given that many of the roads are overtopped such that flow control could not be achieved within the extensive inundation area.

8.3.4.5 Voluntary Purchase Schemes

(Not Recommended in Floodplain Management Plan)

Voluntary Purchase Schemes are generally applicable only to areas where flood mitigation is impractical and the existing flood risk is unacceptable. No property has been identified as suitable for voluntary purchase within the Anzac Creek catchment. Therefore there is no recommendation for such a scheme in the Floodplain Risk Management Plan.

8.3.4.6 Flood Proofing

(Recommended in Floodplain Management Plan)

Flood proofing can be undertaken on a property by property basis, as described below:

- Voluntary house raising - Raising floor levels where practical to elevate habitable floor levels to required levels above the flood planning level. Not all houses are suitable for raising. Houses of brick construction or slab on ground construction are generally not suitable for house raising due to expense and constriction difficulty. Generally this technique is limited to weatherboard type structures constructed on piers.

  Fairfield Council has undertaken a successful house raising program within the Prospect Creek catchment from which experience has shown average costs to be of the order of $50,000 for a house to be raised 1-2m. Voluntary house raising programs incorporated into the Floodplain Management Plan may be eligible for State Government funding.

- Flood Resistant Construction - using appropriate construction techniques and material able to withstand inundation, debris and buoyancy forces can be an effective measure to reduce potential flood damages. Generally these works would be undertaken on a property by property basis at no cost to Council. These measures would be particularly suitable to the commercial/industrial properties in the Moorebank Industrial area, and applicable for all new developments in this area.

- Construction of bunds or diversion banks – these type of structures are small local earthworks constructions which have the same effect of larger levee systems to deflect floodwater away from residences. Typically the backwater flooding is of long duration with minimal velocity. Protection by bunds or banks would require enclosure of the property with the works tied into higher ground. Earth mounding and landscaping can be a practical solution, particularly adjacent to parks or

reserves. Consideration needs to be given to the interaction with the stormwater drainage system and local overland flows to ensure effective drainage and prevent nuisance ponding behind the bunds and banks.

Existing residential properties where these may be considered are concentrated in two localities, surrounding Clinches Pond and Junction Road/Gal Crescent adjacent to Ern Smith playing fields. All of these properties are affected by low velocity backwater flooding from the Georges River within flood storage areas.

Around Clinches Pond including Swain St, Bradshaw Ave, Market St, Cooper Ave and Moorebank Ave, much of the residential property lies within the medium flood risk precinct, below the 100-year ARI flood level but with a low hydraulic hazard. Also, most of these properties are not affected for events below the 50-year ARI.

In the Gal Cr/Junction Rd locality, 12 properties are located in the medium flood risk precinct with 4 properties in the high flood risk zones – due to significant inundation depth for the 100-year ARI event.

A detailed list of individual properties suitable for house raising has not been developed, but would require a property floor level survey and consideration of individual property construction type. Therefore a scoping study is recommended in the first instance to determine the number of properties to be raised based on floor levels and construction type. The scoping study would investigate property identified within the 100-year ARI flood envelope and include individual property survey (floor levels and construction type). The final list of properties suitable for raising would determine the level of funding and administrative requirements to implement the scheme.

8.4 Summary of Floodplain Management Measures Considered

The previous sections of this report have investigated various floodplain management measures for potential adoption in the Anzac Creek FRMP. Significantly, many of the measures have been identified and assessed in the Georges River FRMS. The flood planning area of the Georges River and Anzac Creek overlap in the lower Anzac Creek catchment (downstream of the M5 Motorway). As such, floodplain management in the Georges River and Anzac Creek should be considered commensurately. Floodplain management measures that have been considered in this study are summarised in Table 8-3.

Table 8-3 Summary of Potential Floodplain Management Measures

Description	Report Section	Recommended
1. Review of Georges River Recommendations		
Planning and Development Controls	7.1	Yes
Flood Warning Enhancements	7.2	Yes
Emergency Management Operations	7.3	Yes
Public Awareness	7.4	Yes
2. Other Potential Floodplain Management Measures		
Georges River Levee	8.3.1	No
Channel Maintenance	8.3.2	Yes
Culvert Blockage Protection	8.3.3	Yes
Local Catchment Studies	8.3.4.1	Yes
Upstream Detention	8.3.4.2	No
Channel Widening	8.3.4.3	No
Flood Gates	8.3.4.4	No
Voluntary Purchase Scheme	8.3.4.5	No
Voluntary House Raising/Flood Proofing	8.3.4.6	Yes

9 RECOMMENDED FLOODPLAIN MANAGEMENT PLAN

A draft Floodplain Management Plan showing preferred floodplain management measures for Anzac Creek is presented in this Chapter. The preferred measures have been determined from the range of available measures that were discussed in Section 7.

The draft Floodplain Management Plan is presented in Table 9-1, and is also represented on Figure 9-1. The key components of the Plan are discussed below.

Timing of the proposed works will depend on Council's overall budgetary commitments, and the availability of funds from other sources. Funding may be available through a number of sources, as identified in Table 9-1.

9.1 Options to Modify Flood Behaviour

Installation of culvert blockage protection at the entrance to the M5 Motorway culverts has been recommended for further consideration. Under normal conditions the capacity and performance of the existing culvert is not a flooding concern. However, given the significant impact of potential failure of this culvert in major flood events, precautionary works to address potential culvert blockage is recommended for further consideration, possibly in the form of a series of in-stream bollards.

An initial program to clear the creek corridors of existing debris and other man-made obstructions is also included for further consideration in the Plan. This is recommended to maintain capacity of the existing channel and floodplain, although some reduction in channel capacity is not expected to result in an increase in flood affected properties. Such a scheme would have additional benefits beyond a floodplain management perspective, such as environmental and ecological benefits.

The preparation of local catchment studies to address stormwater and overland flow issues in potential problem areas has been recommended. The findings of local catchment studies may include upgrade/modification works to existing stormwater infrastructure.

The potential to lower flood levels in the Georges River, and consequently the lower reaches of Anzac Creek was addressed in the Georges River FRMS. No specific measures that would influence flood levels in the Anzac Creek floodplain were recommended. Future recommendations for reaches of the Georges River upstream of the Anzac Creek confluence may have some bearing on future flood levels.

9.2 Property Modification Options

Controls on new development and redevelopment at residential/commercial properties will ensure that the flooding problem is not exacerbated and that the development itself is not unduly affected by flooding. A review of flood related planning controls has been undertaken for Anzac Creek. Specific amendments to existing planning controls are recommended as part of the Floodplain Management Plan.

The approach to flood risk management proposed in the Georges River Study has been reviewed and is considered to be appropriate for the Anzac Creek catchment. The specific planning controls for

the Georges River catchment are also considered appropriate and could be duplicated in the Anzac Creek catchment.

It is not economically feasible to offer a complete level of protection for the whole catchment that may be expected by the community. For this reason, property modification options including voluntary house raising and flood proofing are proposed to provide additional protection where required within the catchment.

Flood proofing of ground floor blocks of units and commercial properties is also included in the Plan to minimise damage that may be sustained from flooding. Funding assistance for these works is not usually provided by the Government.

Voluntary house raising is proposed as part of the Anzac Creek Floodplain Management Plan for those residential property that are below the 100 year ARI flood, after other flood mitigation measures have been exhausted.

A scoping study is proposed to determine the number of properties to be raised. The study (estimated cost $30,000) would incorporate an individual property survey (floor level and construction type) for those properties identified within the 100-year ARI flood extent (or medium and high risk flood precincts). It is estimated that the average cost of raising an individual property is of the order of $80,000. State Government funding is available for house raising where it is demonstrated to be economically justifiable A provision is provided in the Plan for raising 20 homes, subject to review following completion of the aforementioned scoping study.

As an alternative to the full subsidy arrangements for homes formally identified for house raising, a partial subsidy may be made available. This may act as an incentive for individuals to redevelop their homes to a higher level. The partial subsidy may be particularly useful in cases where there is marginal economic benefit from house raising given either the infrequency or flooding or high cost of house raising. This type of funding arrangement could be further explored as a part of the scoping study.

9.3 Options to Modify People's Response to Flooding

Raising the community's awareness of flooding can potentially reduce the impacts of flooding. Analysis within the current study has shown this to be a viable option, and was strongly supported by the community.

Key features of the proposed flood awareness program include:

- issuing Section 149 Certificates;
- issuing flood certificates to property owners on a regular basis; and
- establishing a community education program.

Details of community education initiatives should be developed through a Council and SES partnership, and form part of an on-going strategy to develop and maintain flood awareness, and improve overall flood readiness within the community.

Flood warning enhancements make better use of the existing flood warning for the Georges River. An improved flood warning system, in conjunction with additional information on flood behaviour, will allow the SES to improve their existing emergency management and response procedures during floods. A pilot project has been completed in the Georges River catchment in this regard involving the creation of an enhanced flood intelligence system linking GIS based property data and flood level predictions. No formal recommendations for further enhancement of these systems are identified for Anzac Creek; however, established data bases should be updated with new design flood information established in the study.

Finally, the Plan encourages the preparation of flood action plans for flood affected buildings. Ideally these would be prepared for blocks of units, townhouses or commercial property, but could also apply to individual residential buildings. These plans would be simple instructions informing people what to do, who to contact, and where to go, in the event of a flood. It should be cautioned, however, that private flood action plans should not be used as a basis for permitting future development in areas that otherwise would be considered unsuitable. Nor should the preparation of flood action plans nullify or negate the planning provisions and development controls proposed, as described in Section 7.1.

9.4 Funding and Plan Implementation

Although much of the Plan may be eligible for Government assistance, external funding cannot be guaranteed. Government funds are allocated annually on a competitive basis throughout the State. Options that receive Government funding must be of significant benefit to the community. Funding of investigation and design activities as well as any works and ongoing programs such as voluntary house raising, is normally considered for funding. Maintenance, however, would be the responsibility of Council.

The steps in progressing the floodplain management process from this point are as follows:

- Council allocates priorities to components of the Plan, based on available sources of funding and budgetary constraints;
- Council submits an application for funding assistance to DECC, and negotiates other sources of funding such as through the “Natural Disaster Mitigation Package” (NDMP); and
- as funds become available, implementation of the Plan proceeds in accordance with established priorities.

9.5 On-going Review of Plan

The Plan should be regarded as a dynamic instrument requiring review and modification over time. The catalyst for change could include new flood events and experiences, legislative change, alterations in the availability of funding or changes to the area’s planning strategies. In any event, a thorough review every five years is warranted to ensure the ongoing relevance of the Plan.

As much of the Plan is linked with the Georges River FRMP, it is imperative that a review of the Anzac Creek FRMP is considered in conjunction with any review of the Georges River FRMP.

Table 9-1 Recommended Floodplain Management Measures

Item	Description	Estimated Cost	Potential Funding Sources	Responsibility	Priority
Flood Modification Measures					
1	M5 Culvert blockage protection – recommended for further consideration	$80,000	Council, DECC	Council	Low
2	Channel maintenance program to clear creek of existing debris and obstructions – recommended for further consideration	$30,000 p.a.	Council	Council	Low
3	Stormwater/local catchment studies	TBA	Council, DECC	Council	Medium
Property Modification Measures					
4	Flood proofing/Voluntary House Raising individual properties a) Scoping study to identify suitable property b) Voluntary House Raising c) Flood proofing commercial/industrial property	$30,000 TBA N/A	Council, DECC Council, DECC N/A	Council Council Individual Owner	Medium Medium Medium
5*	Consistent planning and development controls a) Adopt Flood Risk Zones and associated levels b) Adopt Georges River flood planning matrix for Anzac Creek c) Revise LEP and DCP	Staff costs	Council	Council	High

Item	Description	Estimated Cost	Potential Funding Sources	Responsibility	Priority
Response Modification Measures					
6*	Flood Warning Enhancements				
	a) Link flood warning prediction with property database	($20,000)	Council, DECC, SES	SES	High
	b) Survey floor levels	($80,000)	Council, DECC,	Council	Low
	c) Advise residents with specific advice on prediction	($50,000)	Council, DECC, SES	SES	Low
7	Emergency Management Operations				
	a) Update Local Flood Plans for additional flood risk areas identified upstream of M5 motorway	Staff costs	Council, SES	SES	High
	b) Update emergency evacuation procedures in Local Flood Plan based on revised flooding information	Staff costs	Council, DECC, SES	SES	High
8	Improved Public Awareness				
	a) Update Council's GIS databases	Staff costs	Council	Council	High
	b) Issue flood certificates to property owners	Staff Costs	Council	Council	Medium
	c) Prepare flood action plans for individual properties	N/A	N/A	Council	Medium
	d) Community education initiatives	TBA	Council, DECC, SES	Council/SES	Medium

Item* - Linked to Georges River FRMP, Bracketed costs represent costs identified in Georges River FRMP covering the whole Georges River floodplain and includes relevant areas of Anzac Creek. Note that for Item 6a, a pilot project has been completed, and specific action for Anzac Creek FRMP relates to update of databases.

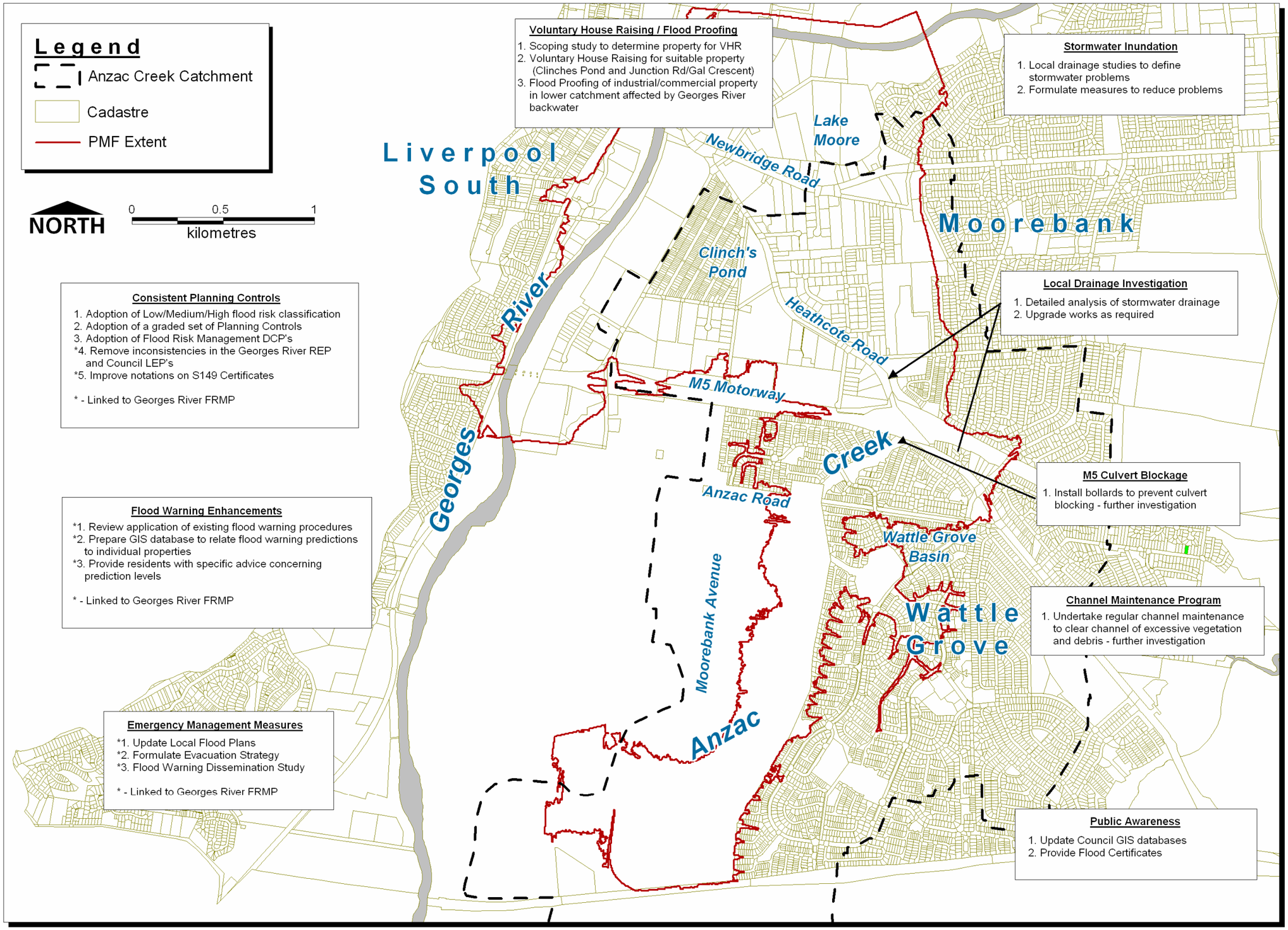

Figure 9-1 Recommended Floodplain Management Plan

10 REFERENCES

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2. Bewsher Consulting Pty Ltd. (2004). Cabramatta Creek Floodplain Management Study. October updated report. Commissioned by Liverpool City Council

3. Bewsher Consulting Pty Ltd. (2004). Georges River Floodplain Risk Management Study. Commissioned by Liverpool, Fairfield, Bankstown and Sutherland Councils. May Final Report

4. Bewsher Consulting Pty Ltd. (2005). Anzac Creek Flood Study. Commissioned by Liverpool City Council. December Final Report

5. NSW Government. (2005) Floodplain Development Manual. April.

6. NSW Government. (2006) Floodplain Risk Management Guideline Residential Flood Damages. March.

11 GLOSSARY

100 year flood	A flood that occurs on average once every 100 years. Also known as a 1% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).
50 year flood	A flood that occurs on average once every 50 years. Also known as a 2% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).
20 year flood	A flood that occurs on average once every 20 years. Also known as a 5% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).
afflux	The increase in flood level upstream of a constriction in flood flows. A road culvert, a pipe or a narrowing of the stream channel could cause the constriction.
annual exceedance probability (AEP)	The chance of a flood of a given size (or larger) occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (i.e. a 1 in 20 chance) of a peak discharge of 500 m^3/s (or larger) occurring in any one year. (see also average recurrence interval)
Australian Height Datum (AHD)	National survey datum corresponding approximately to mean sea level.
average annual damage (AAD)	The average damage per year that would occur from flooding over a very long period of time.
average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20yr ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (see also annual exceedance probability)
catchment	The catchment at a particular point is the area of land that drains to that point.
DECC	Department of Environment and Climate Change. Incorporates the floodplain management responsibilities of the former Department of Natural Resources (DNR).
Development Control Plan (DCP)	A DCP is a plan prepared in accordance with Section 72 of the Environmental Planning and Assessment Act, 1979 that provides detailed guidelines for the assessment of development applications.
design flood	A hypothetical flood representing a specific likelihood of occurrence (for example the 100yr ARI or 1% AEP flood).
development	Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.

discharge	The rate of flow of water measured in tems of vollume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and move their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
EP&A Act	Environmental Planning and Assessment Act, 1979..
flood	Relatively high river or creek flows, which overtop the natural or artificial banks, and inundate floodplains and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
flood awareness	An appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood behaviour	The pattern / characteristics / nature of a flood.
flood fringe	Land that may be affected by flooding but is not designated as floodway or flood storage.
flood hazard	The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods.
flood level	The height or elevation of floodwaters relative to a datum (typically the Australian Height Datum). Also referred to as “stage”.
flood liable land	see flood prone land
floodplain	Land adjacent to a river or creek that is periodically inundated due to floods. The floodplain includes all land that is susceptible to inundation by the probable maximum flood (PMF) event.
floodplain management	The co-ordinated management of activities that occur on the floodplain.
Floodplain Risk Management Plan	A document outlining a range of actions aimed at improving floodplain management. The plan is the principal means of managing the risks associated with the use of the floodplain. A floodplain risk management plan needs to be developed in accordance with the principles and guidelines contained in the NSW Floodplain Development Manual. The plan usually contains both written and diagrammatic information describing how particular areas of the floodplain are to be used and managed to achieve defined objectives.

Flood planning levels (FPL)	Flood planning levels selected for planning purposes are derived from a combination of the adopted flood level plus freeboard, as determined in floodplain management studies and incorporated in floodplain risk management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of landuse and for different flood plans. The concept of FPLs supersedes the "standard flood event". As FPLs do not necessarily extend to the limits of flood prone land, floodplain risk management plans may apply to flood prone land beyond that defined by the FPLs.
flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event. Under the merit policy, the flood prone definition should not be seen as necessarily precluding development. Floodplain Risk Management Plans should encompass all flood prone land (i.e. the entire floodplain).
flood storage	Floodplain area that is important for the temporary storage of floodwaters during a flood.
floodway	A flow path (sometimes artificial) that carries significant volumes of floodwaters during a flood.
freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determing the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
historical flood	A flood that has actually occurred.
hydraulics	The term given to the study of water flow in rivers, estuaries and coastal systems.
hydrodynamic	Pertaining to the movement of water
hydrograph	A graph showing how a river or creek's discharge changes with time.
hydrology	The term given to the study of the rainfall-runoff process in catchments.
local catchments	Local catchments are river sub-catchments that feed river tributaries, creeks, watercourses and channelise or piped drainage systems.
local overland flooding	Local overland flooding is inundation by local runoff within the local catchment.
overland flow path	The path that floodwaters can follow if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Floodwaters travelling along overland flow paths, often referred to as overland flows, may or may not re-enter the main channel from which they left – they may be diverted to another watercourse.

peak flood level, flow or velocity	The maximum flood level, flow or velocity that occurs during a flood event.
probable maximum flood (PMF)	An extreme flood deemed to be the maximum flood likely to occur.
probability	A statistical measure of the likely frequency or occurrence of flooding.
RAFTS	The software program used to develop a computer model that analyses the hydrology (rainfall-runoff processes) of the cathcmnet and calculates hydrographs and peak discharges. Known as a hydrological model.
reliable access	During a flood, reliable access means the ability for people to safely evacuate an area subject to imminent flooding within effective warning time, having regard to the depth and velocity of floodwaters, the suitability of the evacuation route. And other relevant factors.
REP	Regional Environmental Plan. A plan prepared in accordance with the EP&A Act that provides objectives and controls for a region, or part of a region. For example, the Georges River REP.
riparian	The interface between land and waterway. Literally means “along the river margins”
risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of this study, this is the likelihood and consequences arising from the interaction of floods, communities and the environment..
runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek.
SES	State Emergency Service of NSW.
stage	See flood level.
stage-damage curve	A relationship between different water depths and the predicted flood damage at that depth.
stage hydrograph	A graph of water level over time.
topography	The shape of the surface features of land
velocity	The speed at which the floodwaters are moving. A flood velocity predicted by a 2D computer flood model is quoted as the depth averaged velocity, i.e. the average velocity throughout the depth of the water column. A flood velocity predicted by a 1D or quasi-2D computer flood model is quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.
water level	See flood level.

APPENDIX A: DESIGN FLOOD MAPPING

- 5-year ARI Flow Depth
- 5-year ARI Velocity
- 20-year ARI Flow Depth
- 20-year ARI Velocity
- 50-year ARI Flow Depth
- 50-year ARI Velocity
- 100-year ARI Flow Depth
- 100-year ARI Velocity
- PMF Flow Depth
- PMF Velocity

Source: Hydraulic results, Bewsher Consulting (2005)

APPENDIX B: CONSULTATION MATERIAL

B1: Copies of Media Release and Newspaper Advertisement

B2: Community Survey – Covering Letter and Short Questionnaire

B3: Community Survey – Covering Letter and Detailed Questionnaire

B4: Liaison with Government Agencies and Groups

B5: Issues Raised though the Questionnaires

B6: Summary of Responses to Detailed Questionnaire

B7: Community Workshops Material

B8: Public Exhibition Responses

APPENDIX B1

COPIES OF MEDIA RELEASE AND NEWS PAPER ADVERTISEMENTS

A.1 ADVERTISEMENT INCLUDED IN COUNCIL'S INFORMATION PAGE ON 9, 16 & 23 MAY 2007 EDIDTION OF LIVERPOOL CITY CHAMPION AND SOUTH WESTERN RURAL ADVERTISER.

"Anzac Creek floodplain study

Council is seeking the community's input in the second phase of a Floodplain Risk Management Study for Anzac Creek.

The floodplain study is being conducted on behalf of Council by a team of consultants specialising in floodplain management. The study area covers the Anzac Creek catchment and extends from Newbridge Road to the north to the East Hills railway line in the south. Parts of Moorebank, Wattle Grove, Hammondville and Holsworthy will be covered in the study.

The study will look at various options to reduce the risks and damage caused by flooding along Anzac Creek. The study's recommendation will be brought together in the Anzac Creek Floodplain Management Plan, which will guide Council in managing the flood prone land now and into the future.

Landowners, residents and businesses are invited to participate in the study by completing a short questionnaire and returning it to Council by 23 may. The questionnaire is available online at www.liverpool.nsw.gov.au orby calling 1300 36 2170.

For more information on the Anzac Creek Floodplain Risk Management Study please contact Wali Siripala at Council on 9821 9251."

A.2 COUNCIL'S MEDIA RELEASE APPEARED ON 9 MAY 2007 IN LIVERPOOL CITY CHAHMPION.

"Community input sought in Anzac Creek floodplain study

Liverpool City Council is seeking the community's input in the second phase of a Floodplain Risk Management Study for Anzac Creek.

The floodplain study is being conducted on behalf of Council by a team of consultants specialising in floodplain management. The study area covers the Anzac Creek catchment and extends from Newbridge Road to the north to the East Hills railway line in the south. Parts of Moorebank, Wattle Grove, Hammondville and Holsworthy will be covered in the study.

Council's Corporate Manager Assets and infrastructure, Wayne Cooper, said the study would look at various options to reduce the risks and damage caused by flooding along Anzac Creek.

"The recommendation of the study will be brought together in the Anzac Creek Floodplain Management Plan, which will guide Council in managing the flood prone land now and into the future". Mr Cooper said.

"Owners and residents of land potentially affected by flooding will be given an opportunity to participate in the study. A letter, along with a short questionnaire, will be sent to landowners, residents and businesses seeking their views and interest in participation in the study.

Council welcomes public input on the study and invites comments," Mr Cooper added.

Under the State Government's Flood Policy, the management of flood prone land is the responsibility of local government.

People are urged to return the questionnaire to Council in reply paid envelope provided by 23 May 2007. The questionnaire can also be completed online at www.liverpool.nsw.gov.au.

For more information on the Anzac Creek study contact Wali Siripala at Council on 9821 9251".

A.3 COUNCIL WEB SITE

Following information about the study on was included on council web site www.liverpool.nsw.gove.au for three weeks from 9 May 2007."

"ANZAC CREEK FLOODPLAIN STUDY

Council is seeking the community's input in the second phase of a Floodplain Risk Management Study for Anzac Creek.

The floodplain study is being conducted on behalf of Council by a team of consultants specialising in floodplain management. The study area covers the Anzac Creek catchment and extends from Newbridge Road to the north to the East Hills railway line in the south. Parts of Moorebank, Wattle Grove, Hammondville and Holsworthy will be covered in the study.

The study will look at various options to reduce the risks and damage caused by flooding along Anzac Creek. The study's recommendation will be brought together in the Anzac Creek Floodplain Management Plan, which will guide Council in managing the flood prone land now and into the future.

Landowners, residents and businesses are invited to participate in the study by completing a short questionnaire and sent to them in the mail.

People are urged to complete the questionnaire and return it to Council in the reply paid envelope provided by 23 May 2007. The questionnaire is downloaded.

For more information on the Anzac Creek study contact Wali Siripala at Council on 9821 9251."

APPENDIX B2

COMMUNITY SURVEY
SHORT QUESTIONNAIRE AND COVERING LETTER

Our Ref: 2007/0930
Contact: W. Siripala
Date: 4 May 2007

Name/Company
Street Address
SUBURB & POSTCODE

Dear Name Or Sir/Madam,

RE: ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Under the NSW State Government Flood Policy and NSW Floodplain Development Manual-2005, Council has the responsibility to manage land that could be potentially affected by all floods, up to what is known as the "Probable Maximum Flood" (PMF).

In line with this responsibility, Liverpool City Council has completed a Flood Study for Anzac Creek which flows through the suburbs of Wattle Grove and Moorebank. The Flood Study has defined the flood behaviour of the creek and provided flood levels and flood extents along the creek for a range of flood events up to the PMF.

The Flood Study has now provided the basis for a **Floodplain Risk Management Study** for the Anzac Creek catchment. This study will look at various options to reduce the risks and damages caused by flooding along the creek. The assessment of these options will consider the opinion of local residents as well as environmental, social and engineering factors. The recommendations of the study will be brought together in the **Anzac Creek Floodplain Risk Management Plan**, which will guide Council in managing flood prone land into the future. This study will be undertaken by Council's consultants, WBM Pty Ltd combined with Bewsher Consulting.

The study area for the project extends from Newbridge Road in the north to the East Hills Railway line in the south and covers parts of suburbs Moorebank, Wattle Grove, Hammondville and Holsworthy.

As there is a potential that your property could be affected by flooding, Council is seeking your views on how to best manage land within the Anzac Creek catchment that is subject to a flooding risk. This is your opportunity to participate in the study. If would you like further information, or would like to complete a questionnaire or attend the workshop planned to commence in July, please complete the attached form and return it in the enclosed envelope (no stamp required). The workshop will provide you with an opportunity to have your say as the study progress.

For more information about the Anzac Creek Floodplain Risk Management Study & Plan please contact W. Siripala at Liverpool City Council on 9821 9251.

Yours faithfully,

Steven Martin
Team Leader – Drainage & Floodplain

ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

Please complete this form and return it to Liverpool City Council in the enclosed envelope (no stamp required) by Wednesday 23 May.

All information provided will remain confidential, and only used for the purpose of this study.

Please Tick (Yes or No)

Would you like to be sent a Questionnaire?

This will provide us with information about your views on floodplain management measures and other issues that you feel are important.

☐ **Yes** ☐ **No**

Would you like to participate in a workshop?

The one off workshop is scheduled to commence in late July. It will provide more information about the study and allow you to have your say in the floodplain management plan that is prepared.

☐ **Yes** ☐ **No**

Are there any issues that you would like the study to consider?

Please provide your comments below, or provide your contact details

☐ **Yes** ☐ **No**

Other comments…….....
……
.
……
..
……
.
……
.
……
…
……
…
……

Contact Details (Please complete if you answered yes to any of the above)

Name:

……

Address:

……

.....

Telephone Business:…… **Home:**……

Thank you for your participation in this study

APPENDIX B3

COMMUNITY SURVEY
COVERING LETTER AND DETAILED QUESTIONNAIRE

Our Ref: 2007/0930
Contact: W. Siripala,
Date: 25 May 2007

«Name»
«Street»
«Address»

Dear Sir/Madam,

RE: ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Thank you for your interest in the Anzac Creek Floodplain Risk Management Study, and for taking time to complete the response form that was distributed to landowners, residents and businesses in early May. We are now pleased to enclose a copy of the Study Questionnaire which you requested.

The questionnaire will provide us with information on your flood experience and you opinion on the type of controls Council should consider for development. The questionnaire also provides a range of measures available for consideration to minimise the effect of flooding from Anzac Creek. Your opinion on these measures and any other measures you think should be considered will greatly assist our study. Please feel free to raise any other issues or concerns that you would like the study to address. A map showing the study area also is attached for your information.

We would appreciate it if you could complete the questionnaire and return it to us in the reply paid envelope by Friday 15 June 2007. Please note that no stamp is required.

Again thank you for your interest in the study. We look forward to receiving your views on the study.

Yours faithfully,

Steve Martin
Team Leader – Drainage & Floodplain

ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY

IMPORTANT COMMUNITY QUESTIONNAIRE FOR LANDOWNERS, RESIDENTS AND BUSINESSES ABOUT

Liverpool City Council is carrying out a Floodplain Risk Management study for Anzac Creek

This Questionnaire will help us to determine the flood issues that are important to you. Please take a few minutes to complete and return it in the reply paid envelope provided. This will be helpful to us in collecting people's thoughts and ideas about flooding along Anzac Creek. If you have a residential property within the study area, please complete Parts A to E. If you have a business property, please complete Parts A to F.

Please place your completed survey in the postage paid envelope provided and return it before 15 June 2007. No stamp is required.

Please complete the questionnaire for the property in which you have an interest. **All information provided will remain confidential and only used for the purpose of this study.**

House No. _____or Lot No _____Street Name_____

Name (optional) _____

Name or Business organisation (if applicable) _____

PART A –ABOUT YOUR PROPERTY

1. What is your property?

a. House ❑
b. Business ❑
c. Unit/Flat/Apartment ❑
d. Other, Please specify ❑

_____

2. If your property is a residential property, is it?

a. Owner occupied ❑
b. Rented ❑

3. If you have a business or organisation at your property, is it?

a. Owner occupied ❑
b. Tenant occupied ❑

4. How long have you owned, lived at or had your business or organisation at your property?

_____years

PART B – YOUR FLOOD EXPERIENCE

5. Have you ever experienced a flood at the property?

a. No ❑ b. Yes ❑

If yes, which floods?

a. August 1986 ❑
b. April/May 1988 ❑
c. June 1991 ❑
d. Other (please specify)

_____

6. In the biggest flood you have experienced was the property flooded above floor level?

a. No ❑ b. Yes ❑

If yes, what the depth of water over the floor (as best you can remember)?

_____inches/centimetres

What year? _____

7. In the biggest flood, what was the maximum depth of water over your grounds (as best you can remember)?

_____inches/centimetres

What year? _____

8. During the biggest flood, what was the approximate cost to you (at the time) from the damage caused by the flood?

$_____

9. Do you think your property could be flooded sometimes in the future?

a. No ❑ b. Yes ❑

Why and/or how do you think the property would/wouldn't be flooded?

_____
_____
_____
_____
_____

PART C
YOUR OPINION ON FLOODPLAIN RISK MANAGEMENT MEASURES

10. Are you aware of any works that has been carried out by either Council or the owner that you believe will reduce the flood problems at your property?

(Tick one or more boxes)

a. Not aware of any measures ❑
b. House built at specified floor level ❑
c. House raised ❑
d. Flood-compatible building materials used ❑
e. Creek capacity has been enlarged ❑
f. Bridges added or enlarged ❑
g. Other (please specify)

_____
_____
_____
_____

11. Are there any works that you think Council should consider to reduce the flood risk at your property?

a. No ❑ b. Yes ❑

If yes, please provide details.

_____
_____
_____
_____

PART D
YOUR OPINION ON COUNCIL'S CONTROLS ON DEVELOPMENT

12. What level of control do you consider Council should place on new development to minimise flood-related risks?

(Tick one or more boxes)

a. Stop all new development on land with any potential to flooding. ❑
b. Stop all new development only in the most dangerous areas of the floodplain. ❑
c. Place restrictions on development such as minimum floor levels and/or the use of flood compatible building materials. ❑
d. Advise people of flood risks, and allow individuals to choose how they would reduce flood damage. ❑
e. There should be no control on development in flood-affected areas. ❑

13. What <u>notifications</u> do you consider Council should give about the potential flood affectation of individual properties?

a. Advice every resident and property owner on a regular basis of the known potential flood threat. ❑
b. Advise only those who enquire to Council about the know potential flood threat.❑
c. Advise prospective purchasers of property of the know potential flood threat. ❑

PART E –OTHER INFORMATION

14. If you are happy for us to contact you in order to clarify any information regarding your responses, please provide your details below;

Name: _____
Address: _____
_____
Phone (home) _____

Phone (work) _____
How and when would you prefer to be called?

_____
_____
_____

For additional questionnaires or further information about the Anzac Creek Floodplain Risk Management Study, please call Wali Siripala at Council on 9821 9251.

PART F – SUPPLEMENTARY QUESTIONS FOR BUSINESSES

Please complete this part only if you operate a business from this property

15. Name of business

_____
_____
_____

16. Which of the following best describes the type of building you operate your business from?

(Tick one or more boxes)
a. Industrial unit in larger complex ❑
b. Stand alone factory ❑
c. Stand alone warehouse ❑
d. Shop ❑
e. Education ❑
f. Community building ❑
g. Other ❑
h. If other, please specify
_____
_____

17. In the biggest flood, what action did you take to protect your property against flood damage?

a. None ❑
b. Moved vehicles ❑
c. Lifted stock & equipment ❑
d. Used sandbags to try to prevent water entering the premises ❑
e. Other action ❑
If other, please specify
_____
_____

18. In the biggest flood, was the business or facility closed or disturbed in any way (including any clean up)?

a. No ❑ b. Yes ❑

If yes, for how long was your business or facility closed or disrupted?

a. less than 1 day ❑
b. 1 to 2 days ❑
c. 2 days to 1 week ❑
d. More than 1 week ❑
e. If more than 1 week, please specify,
_____weeks

19. During the biggest flood, did floodwaters damage any of the following?

(Tick one or more boxes)
a. No damage occurred ❑
b. Vehicles ❑
c. Electrical equipment, machinery, Tools ❑
d. Stock and other goods ❑
e. Carpet, furniture, fittings and/or office equipment ❑
f. Your premises (paint, structurally etc.) ❑
g. Other part of your property ❑
If other, please specify ❑
_____

20. During the biggest flood, what was the approximate cost to you (at the time) from the damage caused by the flood?

$ _____

21. As a result of the biggest flood, did any of the following happen to you or any of your staff during or after the flood?

(Tick one or more boxes)
a. No problems experienced ❑
b. Inconvenience or disruption to normal routine ❑
c. Isolation (blocked by floodwaters) ❑
d. Employee unable to come to work ❑
e. Loss of business trade ❑
f. Experienced general ill-health ❑
g. Higher employee absenteeism ❑
h. Higher insurance premiums ❑
i. Considered selling/moving the business ❑

PLEASE USE THIS SHEET FOR MORE COMMENTS IF REQUIRED

APPENDIX B4

LIASION WITH GOVERNMENT AGENCIES AND GROUPS- COVERING LETTER

Our Ref: 2007/0930
Contact: Steve Martin,98219254
Date: 22 May 2007

«Name»
«Street»
«Address»

ANZAC CREEK FLOODPLAIN MANAGEMENT STUDY
STAKE HOLDER SURVEY

This letter is to inform you about a floodplain risk management study that is currently underway for Anzac Creek and to invite your participation in the study by completing a questionnaire. A map showing the study area and flood extents is also enclosed for your information. WBM Pty Ltd combined with Bewsher Consulting are the floodplain management specialist undertaking the study for Liverpool City Council.

Anzac Creek is a small tributary of Georges River and flows entirely within the Liverpool LGA through the suburbs of Wattle Grove and Moorebank. The study area for the project extends from Newbridge road in the north to East Hills Railway line in the south and covers parts of the suburbs of Moorebank, Wattle Grove, Hammondville and Holsworthy.

Liverpool City Council has already completed a flood study for Anzac Creek. The flood study has defined the flood behaviour and provided flood levels and flood extents along the creek for a range of flood events up to the Probable Maximum Flood.

The current study will look at various options that may be able to reduce the risks and damages caused by flooding along Anzac Creek. The assessment of these options will consider the opinion of local residents as well as environmental, social, economic and engineering factors. The recommendations of the study will be brought together in the Anzac Creek Floodplain Risk Management Plan, which will guide Council in managing flood-prone land now and into the future.

An important component of the floodplain risk management study is input from agencies, authorities and interests groups, such your organisation. We would be pleased if the appropriate person in your organisation could complete the enclosed questionnaire from your organisation's viewpoint. Please attach other information or additional comments that you feel may be useful.

We would be grateful if completed questionnaire could be returned in the reply paid envelope provided by Friday 15th June 2007. If you need to discuss any aspect of this questionnaire or the study in general, please feel free to call me on 9821 9254.

Yours faithfully,

Steve Martin
Team Leader-Drainage & Floodplain

APPENDIX B5

ISSUES RAISED THROUGH THE QUESTIONNAIRES

TABLE B1

Issues Raised from Short Questionnaire

Survey Number	Issues Raised
1.	Has lived 40 years at the address and never looked like it was going to flood the area. Why this floodplain is shown in Council charts as the problem does not exist? It affects my land value.
2.	The Creek is a public disgrace running along side of a sports field while hundred of people use it. Several years ago Council promised to clean it out. We have lived here for 40 years & we used to see birds life on the creek & fish. In fact I have seen people fishing here. Clean the creek minimise the flooding.
3.	
4.	Where Council has laid pedestrian path behind all housed where no drains up between fence and pathways.
5.	1. Regular maintenance to the stormwater management system. 2. Floodplain needs to be preserved. 3. Attempts should be made to reduce stormwater into Anzac Creek especially with new developments. 4.The use of materials that filters out tonic elements from the water. 5. The removal of trees blocking the water flow. 6. The possibility of using this water to the local playing fields. 7. Provide pollution traps
6.	Toilets not cleaning when raining – This occurred 4 times for the last 12 months & occasionally before that.(hand written not clear)
7.	What plans are in place if & when we have floods like we had 20 years ago?. Keep the creek behind our properties free of rubbish and overgrown shrugs etc.
8.	Manage the drainage run off system of rain. Why waste it?
9.	If the creek was cleaned out, so the water could run more freely. The drainage is not very good at Wattle Grove. My yard floods when we get heavy rain because the drain is too small.
10.	After checking out the affected area we feel first of all a good clean up of the area for weeds and rubbish removed.
11.	Moorebank is on a flood plain, but other place get floods and we don't. So I don't know where the Council gets its information from. I have lived here 50 years and have still got to see a flood.
12.	I have lived in the Area for 42 years and have yet to see a flood. So I don't know where the Council gets its information from. But they know how to waste rate payers money.
13.	Five years ago there were significant rains and occasionally there have been downpours which have resulted minor flooding in low line areas. It would be beneficial for the study to include aspects of stormwater planning. It would be beneficial for residents to see topographical maps and stormwater maps. What are plans for improvement of stormwater handling in the light of fully industrial and residential development in the area?
14.	Keep me informed on flooding as I have a property in Wattle Grove
15.	The development along side the creek has made a difference as it has become wider. A bank of dirt was laid for truck to come across the creek to drop more drop. Since completion, the bank of dirt has not been removed. Residents at the end of Talbot Court are deeply

	concerned. If not dirt bank is removed, the area would be flooded during heavy rain.
16.	Cleanliness of the creek (eg. Flushing via stormwater) is required.
17.	1. In particular the water runoff into the lake-where does it come from-the adequacy of the overflow- who is responsible for keeping overflow drain. Clear of rubbish. 2. what is the flood line in the worst case?
17.	When does propose to clean out Anzac Creek on Junction Road. This would be the biggest pollution hazard in the Council area.
18.	No concern at this stage.
18.	1. Stop chopping trees down in Wattle Grove. That may help minimising flood. 2. Plant trees which Council promised when trees were chopped last year. 3. Council has made a mess of what was a beautiful place to live.
19.	We would like to be kept informed as our property there has been leased out. What is the flood risk there?
20.	Hand written not clear
21.	Total clean up (removing trees, shrub etc.) will stop future flooding in the area between Junction (M5) and New Bridge Road.
22.	We rent a house and want to know more about flood risk –when was previous flood, when will be next how fast will it rise and to what point will it reside, will an action be taken by authorities to help, e.g. sandbags, volunteers etc.?
22.	Wants to potential of future improvements to existing property.
23.	Why is this concern now! And after the study what will Council would do with the result. Like to the catchment boundary for the study.
23.	Would like to understand the effect of this plan will have on my property in Collie Court.
24.	What are Council's plans to alleviate the possibility of future flooding of Anzac Creek?
25.	1.At present there is a flood problem with the pathway under Anzac Road. If there is sufficient rain this footpath is unusable due to flood.
26.	Allow Anzac Creek to flow rather than having various dam walls from Brickendon Court to Anzac Road. Due to dam walls water builds up and stormwater can not flow to the Creek. Brickendon Road end is too low for stormwater.
26.	1. Runoff from roads & house collect flow down in drain faster than if on natural land. Drainage point should clear off from weeds and rubbish before storms or flood season.
27.	How much it would cost the study? Will I be in a near future plan or it is in still process? Is it well studied plan or another cost but no action?
28.	Perhaps developing the creek and removing all trees, grasses etc that have built up would assist the flows running down. The area has been totally neglected since we moved in. Floodways along Anzac Road needs to be maintained.
29.	Return the natural creek flow with billabongs and bush land along side (hand written not clear)
30.	Would like to know what assumptions is made for future development, i.e.% of impervious land and allowance for on site detention, form of detention etc. and also the type model used (i.e steady, 2D etc.) for the study.
31.	(writing clear- to be added)
32.	(writing not clear-to be added)

33.	Is Council being upfront & open with the development plans proposed for the Defence land opposite Wattle Grove?. I am suspicious about the silent over the proposals for that land & future usage
34.	I think we will be better able to identify any potential issues in the once we have attended the workshop.
35.	Would like to know what the expected PMF level on my property is. I was not aware my property was potentially affected by flood.

TABLE B2

Comments/issues from Detailed Questionnaire

Survey Number	Locality	(Q.9) Why property would/wouldn't be flooded?, (Q.11) Works that Council should consider to reduce flood risk) & other comments
1.	Ellesmere Ct, Wattle Grove	Q.11-Enlarge creek capacity.
2.	Burdekin Ct Wattle Grove	Q.9 Yes. The creek opposite the house is very dirty, full of reeds, other wastes and water does not get away as quick as it should. Q.10- Clear the creek of overgrown reeds & debris
4.	Glenelg Ct, Wattle Grove	Q9- No. My Property is higher than road and far from the creek.
5.	Colo Ct, Wattle Grove	Q9- Yes. Property is too high above creek level. Q.11- Enlarge creek capacity.
6.	Wellwood Ave, Moorebank	Q.9-yes. Locate on 100year floodplain. Q11- Clean the creek from M5 to Newbridge Rd of trees, shrubs & rubbish. Last cleaned 12-13yrs ago.
7.	Gal Cres. Wattle Grove	Q.9-Yes. No drainage provided under the footpath. Q.11- The creek is heavily polluted. Council has made no attempt to clean it up. EPA should be informed.
8.	Wellwood Ave, Moorebank	Q.9-Yes. Property is too close to the creek and built up of rubbish in the creek. Q.11 – Clean out the creek.
9.	Gal Cres. Wattle Grove	Q.9- Yes. Council constructed a pathway without consulting and no drainage provided.Q.11- Rectify pathway & drainage.
11.	Renton Ave, Moorebank	Q.11-Clean the creek & area of ERN Smith Field between Junction Rd & Newbridge Rd.
12.	Corryton Ct	Q.9-Yes. Stormwater outlet to Corryton Ct detention pond poorly maintained. Could block, choke and cause future flood from heavy rain. Q.11- Regular maintenance of detention pond. Installation of lockable booms or bollards to detention pond access point.
13.	Torrens Ct, Wattle Grove	Q.9- Yes. Behind my property is space provided for stormwater drain which I fear might get flooded. Q.11-Council should fill the area between our property and Anzac Road. Don't let the stormwater threaten our property.
14.	Talbot Ct, Wattle Grove	Q.9- Yes. Trees were planted over main drain. Drain is becoming blocked on a regular basis.
15.	Moorebank Ave, Moorebank	Q.9- Yes. The property is identified as affected by 100year flood.
16.	Peri Ct, Wattle Grove	Q.9-Yes.Not aware that we were in a flood prone area. Not much information can remember when I purchased land from Delfin.Q.11-Adequate stormwater drain is required. Attention to Anzac Ck required not block the flow.
17.	Sandover Ct, Wattle Grove	Q.9- Yes. Creek on side of house fills up very quickly on heavy rain. Q.11-Enlarge Creek Capacity and keep the creek form trees, shrubs & overgrowth.
18.	Bridges Ave, Wattle Grove	Q.9- Yes. There is a dike across us & it might cause us flooding. Q.11- Clean the dike from leaves and debris.
19	Collie Ct, Wattle Grove	Q.9- Don't know whether property would be flooded.Q.11- Provide better warning & forecasting. And provide better structural measures and develop planning.
20.	Corrin Ct, Wattle Grove	Q.9- Yes. The house is build below the street level.
21.	Gal Cres. Wattle Grove	Q.9-No. The house is half way of a hill. Q11- The creek has been rerouted and since then no flood seen for 30years.
22.	Paroo Ct, Wattle Grove	Q.9-Yes.Due to development to Anzac Creek.
23.	Eldon Ct, Wattle Grove	Q.9- Continuous heavy rain causing Anzac Ck to flood and backing up into the lake causing it to flood. Q.11- Make rainwater tanks compulsory and subsidise installation, thus reducing the flood risk. Increase the capacity of Wattle Grove detention pond.
24.	Newbridge Rd,	Q.9-Yes. Because of blocked drain.

	Moorebank	
25.	Heathcote Rd, Moorebank	Q.9- Yes. Flat area and water slow to pass. Q.11-Provide better drainage. Other: During heavy rain water board mains & subsidiary line cause back up to private pipes. Toilet does not work & we have had to have it cleared.
26.	Ellesmere Ct, Wattle Grove	Q.9- yes. The land west of Anzac Ck is currently not developed. Our property could be flooded if that land development included landfill. Q.11- Allocate space in development which is allowed to flood, ie parking lots, grass area etc.
27.	Brickendon Ct, Wattle Grove	Q.11- Regular cleaning of drains in W/Grove as with heavy rain street are flooded and we have to drive through water or walk through water to get to car.
28.	Barrow Ct, Wattle Grove	Q.9- No. Because of lack of rain in last few years and low water level in dams and creeks. Q.11- Provision of better stormwater drainage, high grounds in many areas as a shelter in flood. Supply flood escape plans to each house.
29.	Banyule Ct, Wattle Grove	Q.9- Yes. In heavy rain the western bank has been over flown. Q.11- By keeping the western bank lower than the eastern, effectively creating a floodway on the non residential side of the creek.
30.	Regent Cres.	Q.9-Yes, Street drains not cleaned or maintained. Creek is overgrown with mud, sludge & rubbish. Over 30 yrs I have never seen gutter drains cleaned. Q.11 Refer Q.9.
31.	Blamoy Road, Wattle Grove	Q.9-Maybe. Not sure what effect substantial rain will have on the ability of detention basin to our rear releasing through the drain. Q.11- Clean detention basin, increase size of drains under M5, ensure the opening of drains are kept clean. Other Comments; The Drain at M5 culvert does not cope large influx as front of drain poorly maintained & seems to be no trash screens. I believe no enough pipes/drains installed under M5. Blamoy Rd has overflowed in heavy rain and Grates blow off.
32.	Deadman Rd, Moorebank	Q.9- yes. Shown as flood liable. Q.11- Guarantee area free of flooding if possible by levee banks surrounding. Other comments: 1. Lack of awareness of occupants in Moorebank industrial area that flood problem may arise any time. 2.Emergency access routes and measures for protection of stores etc. need to be made known.3.Capital work project that would ease the likelihood of flooding need to be proposed & funded.
33.	Wellwood Ave, Moorebank	Q.9- No history of flooding and not close to waterways. Haven't seen any water issues after rain.
35.	Anzac Mews, Wattle Grove	Q.9- yes, I have sandy soil carried to my place from flooding. Q11- Reduce stormwater from new developments. Stormwater system should receive regular maintenance. Floodplain need to be preserved. Other comments: Use of water from Anzac Creek for playing field to be looked at. Waterways require scheduled maintenance for activities such as sediment, trash removal etc. Maintenance must be addressed during planning & design
37.	Exford Ct, Wattle Grove	Q.9-Yes. End of Exford Ct next to stormwater drains which blocks up with rubbish and sticks from rain. End of drain is overgrown with weeds. Q.11- Clear drains off weed growth.
38.	Larra Ct, Wattle Grove	Q.9-Yes , Not enough drain. Q.11-should look at drainage problems an do some work on the creek. Other comments: The park opposite us always floods- drainage in the area is not very good. My backyard gets flood with heavy rain.
39.	Corryton Ct, Wattle Grove	Q.11-Yes, if Anzac Creek behind property is blocked, my property could be flooded. Q.11-Dredge the creek and if possible build levy banks.
40.	Anzac Mews, Wattle Grove	Q.9-Yes, if the creek parallel to Anzac Rd blocked or exceeded capacity property could be flooded. Q.11- On-site and detention ponds could be utilised if military area to be developed. Other: 1. one third of upper catchment is in military reserve. Proposed industrial & residential development on this land should not increase downstream flooding; appropriate measures should be adopted and paid by the developers.2. Water quality of Anzac Creek should be maintained or enhanced as the creek is inhabited by a lot of birds and some fish (mostly crab).

41.	Brownlow Ct, Wattle Grove	Q.9-Yes, if the creek next to my house will break its banks. Q.11-To reduce flood risk open up & enlarge the creek and remove obstacles e.g.: trees, bush & reeds.
42.	Talbot Ct Wattle Grove	Q.9- Yes. The land is flat and the neighbour 3 houses down has been flooded. Q.11- Widening of creek.
43.	Woolmers Ct, Wattle Grove	Q.9-yes. New development could add additional runoff into the system.
44.	Burdekin Ct, Wattle Grove	Q.9-Yes. Increased development both domestic & industrial shedding and no development to flood water control.
45.	Bradshaw Ave, Moorebank	Q.9-No. Because of proper drainage facilities from over the years from recent development.
46.	Tweed Ct, Wattle Grove	Q.11- Mainly the rubbish and sewerage.
49	Wattle Grove	Q.9-Don't know. Q.11- Check drainage regularly.

APPENDIX B6

SUMMARY OF RESPONSES TO DETAILED QUESTIONNAIRE

SUMMARY OF RESPONSES TO DETAILED SURVEY QUESTIONNAIRE

Location	Survey No.	PART A - YOUR PROPERTY									PART B- YOUR FLOOD EXPERIENCE														PART C - OPINION ON FLOODPLAIN MEASURES									PART D- OPINION ON COUNCILS CONTOLS TO DEVELOPM								PART E- Other information
		Question 1				Question2		Question 3		Question 4	Question 5						Question 6				Question 7		Question 8	Question 9			Question 10							Question 11			Question 12					Question 13			Question 14
		Type of property				Residential ownership		Business, ownership		Length of period owned, lived or had a business, Years	Flood experience at the property						Flooded above floor in biggest flood				Depth over ground-biggest flood		Damage by flood	think of future flooding of the property			Awareness ofworks by Council or the owner to reduce flood risks							Other works to consider			Level of control Council should place on new development to reduce flood risks					ion Council should giv			Contact details for any calrification
		a.	b.	c.	d.	a	b	a	b		a	b	a	b	c	d	a	b			a	b		a	b	c	a	b	c	d	e	f	g	a	b	c	a	b	c	d	e	a	b	c	
		House	Business	Unit/Flat/ Apartment	Other	Owner Occupied	Rented	owner occupied	Tenant Occupied		No	Yes	Aug-86	April/May 1988	Jun-91	Other	No	Yes	depth	year	depth	year		No	Yes	Why/How	Not aware any	specified floor level	house raised	flood-compatible material	creek capacity enlarged	bridges added	other	No	Yes	Other	Stop all in all floodplain	Stop all in most dangerous	Minimum floor level/flood compatible	Advise only	No control on development	Regulare advice to all on flood risk	Advise only those who enquire	Advise purchasers of property	
Ellesmere Ct, Wattle Grove	1	✓				✓		✓				✓						✓							✓					✓						✓						✓			
Burdekin Ct, Wattle Grove	2	✓				✓				12.2	✓						✓								✓	✓	✓								✓	✓						✓			✓
Paroo Ct, Wattle Grove	3	✓								1		✓														✓								✓				✓	✓						
Gleneg Ct, Wattle Grove	4	✓				✓				1.5	✓													✓		✓	✓								✓				✓				✓		✓
Colo Ct, Wattle Grove	5	✓				✓				7	✓						✓							✓		✓	✓							✓			✓		✓					✓	✓
Wellwood Ave, Moorebank	6	✓				✓		✓		13.5	✓														✓	✓								✓			✓			✓			✓		
Gal Cr, Moorebank	7	✓				✓				23			✓	✓				✓			10cm	1986	Nil		✓	✓	✓						✓		✓								✓			✓
Wellwood Ave, Moorebank	8				✓	✓				8	✓														✓	✓														✓				✓		✓
Gal Cr, Moorebank	9	✓				✓				24								✓					Nil		✓	✓								✓			✓						✓		✓
Seton Rd, Moorebank	10		✓						✓	2	✓																✓												✓		✓	✓			
Renton Ave, Moorebank	11	✓				✓						✓	✓	✓	✓	✓	✓							✓				✓				✓						✓					✓	✓	✓	✓
Corryton Ct, Wattle Grove	12	✓				✓				10	✓														✓		✓														✓				✓
Torrence Ct, Wattle Grove	13	✓				✓				5	✓														✓	✓	✓														✓				✓
Talbot Ct, Wattle Grove	14	✓				✓				8							✓				27inches	2005	Nil		✓	✓					✓			✓	✓							✓			✓
Moorebank	15		✓			✓	✓			15	✓														✓	✓	✓								✓	✓						✓			✓
Peri Ct, Wattle Grove	16	✓				✓				9	✓														✓	✓														✓				✓
Sandover Ct, Wattle Grove	17	✓				✓				6	✓														✓									✓						✓			✓		✓
Bridges Ave, Moorebank	18	✓					✓			2	✓														✓	✓								✓						✓				✓
Collie Ct, Wattle Grove	19	✓					✓			5	✓															✓								✓						✓				✓
Corrin Ct, Wattle Grove	20	✓					✓				✓														✓	✓								✓				✓						✓	✓
Gal Cr, Moorebank	21	✓				✓				40	✓													✓		✓					✓	✓	✓	✓	✓				✓						
Paroo Ct, Wattle Grove	22	✓				✓				7	✓													✓		✓	✓								✓						✓			✓	✓
Eldon Ct, Wattle Grove	23	✓				✓				3	✓														✓	✓	✓								✓	✓	✓					✓	✓	✓
Newbridge Rd, Moorebank	24	✓	✓			✓	✓	✓		18		✓			✓		✓								✓	✓													✓						✓
Heathcote Rd, Moorebank	25		✓					✓		16		✓			✓		✓				12inches	1991	$200		✓	✓	✓								✓	✓						✓			✓
Ellesmere Ct, Wattle Grove	26	✓				✓				6	✓						✓				0	2002			✓	✓		✓							✓	✓						✓			✓
Brickendon Ct, Wattle Grove	27	✓				✓				3	✓																			✓				✓	✓					✓			✓	
Barrow Ct, Wattle Grove	28	✓				✓				12	✓													✓		✓		✓							✓	✓						✓	✓	✓	
Banvule Ct, Wattle Grove	29	✓				✓				14	✓														✓	✓	✓								✓	✓						✓			✓
Regent Cr, Moorebank	30		✓					✓		25		✓	✓	✓	✓			✓	4inches	86/88	4inches	86/88			✓	✓	✓								✓	✓						✓			✓
Blamoy Rd, Wattle Grove	31	✓	✓			✓		✓		5	✓														✓	✓	✓								✓	✓				✓					✓
Deadman Rd, Moorebank	32		✓						✓	17	✓														✓	✓							✓			✓						✓	✓	✓	✓
Wellwood Ave,Moorebank	33			✓			✓			7	✓													✓		✓	✓								✓					✓				✓	✓
Jennolan Ct, Moorebank	34	✓				✓					✓														✓									✓					✓				✓		✓
Anzac Mews,Wattle Grove	35	✓				✓					✓														✓									✓			✓						✓		✓
Chaovel Ave, Wattle Grove	36	✓				✓				11	✓																																✓		✓	✓
Exford Ct, Wattle Grove	37	✓				✓				1	✓														✓	✓		✓							✓	✓				✓	✓	✓			
Larra Ct, Wattle Grove	38	✓				✓				6	✓														✓	✓								✓	✓				✓			✓		✓
Corryton Ct, Wattle Grove	39	✓					✓			0.5	✓														✓	✓								✓	✓					✓				✓
Anzac Mews,Wattel Grove	40	✓				✓				10	✓										200cm				✓	✓					✓			✓	✓					✓			✓	✓
Brownlow Ct, Wattle Grove	41	✓				✓				12		✓				1995	✓				6cm				✓	✓								✓	✓				✓	✓	✓		✓	✓	✓
Talbot Ct, Wattle Grove	42	✓				✓				10	✓														✓	✓								✓	✓					✓				✓
Woolmers Ct, Wattle Grove	43	✓				✓					✓						✓								✓	✓								✓					✓				✓	✓
Burdekin Ct, Wattle Grove	44	✓				✓				6		✓				2001	✓				12cm				✓	✓								✓						✓				✓	
Bradshaw Ave, Moorebank	45	✓				✓				49	✓						✓							✓		✓			✓					✓					✓	✓			✓	✓
Tweed Ct, Wattle Grove	46	✓				✓				7	✓						✓							✓										✓	✓	✓					✓			✓
Ellesmere Ct, Wattle Grove	47	✓				✓				5	✓													✓										✓				✓					✓		
Bundarra Ct, Wattle Gove	48	✓				✓				5	✓													✓										✓					✓					✓	
Not Given	49	✓					✓			34	✓																										✓				✓		✓	
Como Ct, Wattle Grove	50	✓				✓				6																								✓	✓				✓			✓		
Market St, Moorebank	51	✓				✓				59	✓						✓							✓		✓								✓	✓				✓	✓	✓		✓		

PART F- SUPPLEMENTARY QUESTIONS FOR BUSINESSES

Location	Survey No.	Question15	Question 16							Question 17					Question 18						Question 19							Question 20	Question 21								
			Type of business							Action taken in the biggest flood					In the biggest flood, business closed/disturbed?						Flood damage in the biggest flood							Cost of flood damage	Inconvenience, loss of business etc. occurred in the biggest flood								
		Name of business	a	b	c	d	e	f	g	a	b	c	d	e	a	b	a	b	c	d	a	b	c	d	e	f	g		a	b	c	d	e	f	g	h	i
			Industrial unit	Stand alone factory	Warehouse	Shop	Education	Communinity Building	Other	None	Moved vehicles	Lifted stocs & equipments	used sandbags etc.	Other	No	Yes	Less than 1 day	1 to 2 days	2 days to 1 week	More than 1 Week	No damage	Vehicles	Electrical equipment, tools etc.	Stock and other goods	Carpet, furniture, office equipment etc	Premises (paint, structuire etc)	other		No problem	disruption to normal routine	isolation (blocked by flood)	Employee unable to come	Loss of business	Health problems	employee absenteeism	Higher insurance premiums	Considered selling the business
Ellesmere Ct, Wattle Grove	1																																			
Burdekin Ct, Wattle Grove	2																																			
Paroo Ct, Wattle Grove	3																																			
Gleneg Ct, Wattle Grove	4																																			
Colo Ct, Wattle Grove	5																																			
Wellwood Ave, Moorebank	6																																			
Gal Cr, Moorebank	7																																			
Wellwood Ave, Moorebank	8																																			
Gal Cr, Moorebank	9																																			
Seton Rd, Moorebank	10																																			
Renton Ave, Moorebank	11																																			
Corryton Ct, Wattle Grove	12																																			
Torrence Ct, Wattle Grove	13																																			
Talbot Ct, Wattle Grove	14																																			
Moorebank	15	✓		✓							✓					✓		✓									✓		Nil	✓							
Peri Ct, Wattle Grove	16																																			
Sandover Ct, Wattle Grove	17																																			
Bridges Ave, Moorebank	18																																			
Collie Ct, Wattle Grove	19																																			
Corrin Ct, Wattle Grove	20																																			
Gal Cr, Moorebank	21																																			
Paroo Ct, Wattle Grove	22																																			
Eldon Ct, Wattle Grove	23																																			
Newbridge Rd, Moorebank	24										✓					✓					✓								✓								
Heathcote Rd, Moorebank	25	✓							✓		✓					✓		✓												✓							
Ellesmere Ct, Wattle Grove	26																																			
Brickendon Ct, Wattle Grove	27																																			
Barrow Ct, Wattle Grove	28																																			
Banvule Ct, Wattle Grove	29																																			
Regent Cr, Moorebank	30	✓	✓								✓			✓		✓		✓									✓			✓	✓	✓	✓				
Blamoy Rd, Wattle Grove	31	✓								Office																										
Deadman Rd, Moorebank	32		✓																																	
Wellwood Ave,Moorebank	33																																			
Jennolan Ct, Moorebank	34																																			
Anzac Mews,Wattle Grove	35																																			
Chaovel Ave, Wattle Grove	36																																			
Exford Ct, Wattle Grove	37																																			
Larra Ct, Wattle Grove	38																																			
Corryton Ct, Wattle Grove	39																																			
Anzac Mews,Wattel Grove	40																																			
Brownlow Ct, Wattle Grove	41																																			
Talbot Ct, Wattle Grove	42																																			
Woolmers Ct, Wattle Grove	43																																			
Burdekin Ct, Wattle Grove	44																																			
Bradshaw Ave, Moorebank	45																																			
Tweed Ct, Wattle Grove	46																																			
Ellesmere Ct, Wattle Grove	47																																			
Bundarra Ct, Wattle Gove	48																																			
Not Given	49																																			
Como Ct, Wattle Grove	50																																			
Market St, Moorebank	51																																			

APPENDIX B7

COMMUNITY WORKSHOPS MATERIAL

COMMUNITY WORKSHOPS

Two community workshops were held at Liverpool City Council Administrative building in the evening of Wednesday,01 August (within Eastern Neighbourhood Forum) and Thursday, 02 August 2007 (within Central Neighbourhood Forum) to:

- Provide the community with an overview of the study and results of computer modelling including flood risk maps for Anzac Creek,
- Provide the local community with the preliminary results and recommendations of the study;
- Provide the study team with a means to obtain feedback from the local community before the recommend draft Floodplain Risk Management Plan was presented to the Liverpool Floodplain Management Committee.

To advertise the workshops, a newspaper article was published in the local newspaper and invitations were sent to all the respondents (47 nos.) who expressed their willingness to participate in the workshops during the community survey. Council also placed an advertisement on Council website.

The workshop was supported with approximately 15 attendees each day. Other than Council staff & study team, a SES representative was also present.
The majority of the issues raised were dealt with successfully at the workshops. The main issues raised included:

- Stormwater flooding problems in the study area,
- Funding and sources of funding for proposed works,
- Concern over future development in the catchment,
- Whether '1933 flood' was considered in this study,
- Whether the damages other than physical damages were considered in the study,
- Timing for finalising the study, commencing of recommended works and prioritisation of work
- Available recorded information on'1933 flood', 1956 flood and 1873 flood,
- Incorporation of scientific levels and known level marking in the study,
- Possibility of diversion of Anzac Creek to Harris Creek to minimise the flooding risk on lower part of Anzac Creek,
- Emphasised urgency to implement the management study.

A brochure on 'Frequently Asked Question on Floodplain Risk Management Studies', a feedback form and flood brochures from SES were available to take from the community workshops.

(Newspaper Article and invitation letter attached)

Our Ref: 2007/0930
Contact: Wali Siripala, 9821

9251

Date: 18 July 2007

Name
Street
Suburb

Dear Sir/Madam,

RE: COMMUNITY WORKSHOPS ON ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY

I refer to your request to participate in the workshop for Anzac Creek Floodplain Risk Management Study which is currently underway.

Council will be running two workshops with the local community and other stake holders to present the outcomes of the study to date, discuss the proposed floodplain management options and development controls for the study area, and further identify community expectations in regard to the study.

The workshops will be held at **Liverpool City Council's Administrative building, commencing at 7:30pm on Wednesday, 01st August** (within Eastern Neighbourhood Forum) **and on Thursday, 02nd August 2007** (within Central Neighbourhood Forum)**.**

Liverpool City Council would like to invite you to attend the workshops to find out more about the study and to have your say in the Floodplain Risk Management Study and Plan. Please advice your intention to attend to the Forum Coordinator, Cassandra Bugden on 9821 8859.

Please do not hesitate to contact Wali Siripala on 9821 9251 if you need further information regarding the workshops.

Yours faithfully,

Eddie Kobeissi
Acting Team Leader- Drainage & Floodplain

COMMUNITY WORKSHOPS ABOUT ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY

A Floodplain Risk Management Study for Anzac Creek is currently underway.

Under the NSW State Government's Flood Policy, the management of flood-prone land is the responsibility of local Councils. As such, Liverpool City Council is responsible for local planning, development controls and land management within the Anzac Creek floodplain which is located entirely within the Liverpool Local Government Area.

The study will look at various options that may be able to reduce the risks and damages caused by floods along Anzac Creek. The assessment of these options will consider the input of local residents as well as environmental, social, economic and engineering factors.

Council is holding two community workshops with the local community and other stakeholders to present the outcomes of the study to date, discuss the proposed floodplain management options and development controls for the study area, and further identify the community's expectations in regard to the study.

The workshops will be held at **Liverpool City Council's Administrative building, commencing at 7:30pm on Wednesday, 01st August** (within Eastern Neighbourhood Forum) **and on Thursday, 02nd August 2007** (within Central Neighbourhood Forum)**.**

For more information on the workshops please contact Wali Siripala at Council on 9821 9251.

APPENDIX B8

PUBLIC EXHIBITION RESPONSES

RailCorp

RailCorp Property
GPO Box 47
Sydney NSW 2001
DX 390 SYDNEY
Tel: (02) 9224 3930 Fax: (02) 9224 3962
Email: andrew.gillies@railcorp.nsw.gov.au

26 March 2008

The General Manager
Liverpool City Council
Locked Bag 7064
LIVERPOOL BC NSW 1871

ATTENTION: Mr W Siripala

Dear Sir,

RE: Draft Anzac Creek Floodplain Risk Management Study and Plan
Ref: 2007/0930

I refer to the Council's letter dated 13 March 2008 regarding the public exhibition of the Draft Anzac Creek Floodplain Risk Management Study and Plan.

Rail Corporation New South Wales (RailCorp) has reviewed the Draft Study and Plan and wishes to advise that it has no further comments to make.

RailCorp has already provided comments as detailed in section 3.4.3 of the Draft Study and Plan, and has nothing further to add to this.

Also, please note that the State Rail Authority and Rail Infrastructure Corporation were merged into what is now RailCorp, so any further consultation need only be made with RailCorp.

Thank you for providing RailCorp the opportunity to comment and please contact me if you have any further enquires.

Yours faithfully,

Andrew Gillies
Assistant Town Planner
RailCorp Property

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Our ref: LP8-5-3698
Your ref: 2007/1930

25 March 2008

The General Manger
Liverpool City Council
(Attn: E. Kefalianos)
Locked Bag 7064
Liverpool BC NSW 1871

Dear Sir/ Madam

Re: Draft Anzac Creek Floodplain Risk Management Study and Plan

Thankyou for giving NSW Department of Primary Industries the opportunity to comment on the above mentioned draft plan.

Officers of the Department have reviewed this document and consider its content to be adequate in light of the policies and provisions under the *Fisheries Management Act 1994*. Please note that a dredging and reclamation permit may be required from this Department for the proposed installation of bollards nears the M5 culvert and the removal of aquatic vegetation from the waterway.

For any further information please telephone me on 9527-8552.

Yours sincerely,

Carla Ganassin
Conservation Manager (Central)
Aquatic Habitat Protection Unit

Cronulla Fisheries Centre
PO Box 21 CRONULLA NSW 2230
202 Nicholson Parade
Tel: (02) 9527 8411 Fax: (02) 9527 8576
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ABN 51 734 124 190

SES
STATE EMERGENCY SERVICE

SES State Headquarters
Level 4, 6-8 Regent St
Wollongong NSW 2500
PO Box MC 6126
Wollongong NSW 2521
Phone: (02)4251 6666
Fax: (02)4251 6620
angela.toniato@ses.nsw.gov.au

16 April 2008

General Manager
Liverpool City Council
Locked Bag 7064
LIVERPOOL NSW 1871

Attention: Wali Siripala

Dear Wali,

DRAFT ANZAC CREEK FLOODPLAIN RISK MANAGEMENT STUDY & PLAN

Thankyou for your letter dated 13 March 2008 seeking comments from the NSW State Emergency Service (SES) on the Draft Anzac Creek Floodplain Risk Management Study & Plan.

As the combat agency for floods and storms the NSW SES seeks to ensure that sustainable emergency management principles relating to floodplain risk management (FRM) are considered in the outcomes of FRM Studies & Plans. This requires the partnership of the SES and Local Government to achieve mutually agreed outcomes for the community.

With specific reference to the draft document the following comments are provided:

- The recommended options that modify the flood response see pg viii, Executive Summary:
    - further detailed discussion needs to take place between the affected parties with regard to the enhancement of the Georges River Flood warning tool before this is made a recommendation in the plan. Specifically the benefits to be gained from the update need to be discussed before determining whether the project will be pursued as well as the potential funding sources
    - reference to 'improved flood warning and targeted emergency response utilising developed property databases' is directly linked to the previous point. Therefore this recommendation will depend on the resolution of that point.
- It is noted that community consultation and education material has been noted in the body of the document s7.4 but not explicitly included in the final recommendations in

Table 9.1, pg 72. The proposed methodology of the community consultation needs to be discussed further between Council and the SES to determine a workable, partnered community education strategy into the future.

- Floor level survey is usually a responsibility of council which is conducted in the FRMS&P phase. It is not necessarily the responsibility of the SES as noted in Table 9.1, pg 72. The SES does not generally have funding available to conduct this task. It is recommended that the floor level information is obtained during the FRM process and preferably before completion of the FRMS&P.

- Suggest change of wording in Table 9.1, pg 72 from 'improve emergency evacuation procedures' to *'update emergency evacuation procedures in Local Flood Plan based on revised flooding information'.*

It should be noted that the Department of Environment & Climate Change in conjunction with the SES has produced a guideline which outlines the recommended inclusions in a FRM Study titled SES Information Requirements from the FRM Process. Specifically, where a study has considered the requirements of the Guideline, the study should:

- identify deficiencies in information contained in the current Local Flood Plan (LFP) and provide recommended draft input for the subsequent review of the LFP.
- utilise existing flood intelligence cards as sources of information (relative to the warning gauges for which the Bureau of Meteorology provides warnings as noted in the State Flood Plan & other relevant gauges) and recommend additional flood intelligence where there is a deficiency.

Whilst working through the FRM process, it is recommended that Council consider the requirements of the Guideline and where possible incorporate the recommendations in the Guideline which will have significant benefit for the community in terms of flood planing, flood warning and response.

The SES appreciates the effort involved in a study of this magnitude and look forward to working together with Council on this project in the future. We thank you for the opportunity to comment and trust this information is of assistance.

If you have any further questions please do not hesitate to contact the undersigned.

Yours sincerely

Angela Toniato

Angela Toniato
Senior Planning & Research Officer

APPENDIX C: FLOOD DAMAGES ASSESSMENT

- **Adopted Residential Damage Inputs**
- **Adopted Residential Stage-Damage Tables**
- **Adopted Commercial/Industrial Stage-Damage Tables**

SITE SPECIFIC INFORMATION FOR RESIDENTIAL DAMAGE CURVE DEVELOPMENT

Version 1.00 — Queries to duncan.mcluckie@dipnr.nsw.gov.au

PROJECT	DETAILS	DATE	JOB No.

BUILDINGS

Regional Cost Variation Factor	1.00	*From Rawlinsons*
Post late 2001 adjustments	1.27	*Changes in Avge Weekly Earnings - www.abs.gov.au*
Post Flood Inflation Factor	1.40	*1.0 to 1.5*
Multiply overall structural costs by this factor		*Judgement to be used. Some suggestions below*

	Regional City Houses Affected		Factor	Regional Town Houses Affected		Factor
Small scale impact	<	*50*	*1.00*	<	*10*	*1.00*
Medium scale impacts in Regional City		*100*	*1.20*		*30*	*1.30*
Large scale impacts in Regional City	>	*150*	*1.40*	>	*50*	*1.50*

Typical Duration of Immersion	6	hours
Building Damage Repair Limitation Factor	0.75	*due to no insurance / short duration flood / long duration flood*
		Suggested range 0.75 to 0.85
Average House Size	240	m^2 *240 m^2 is Base*
Building Size Adjustment	1.0	
Total Building Adjustment Factor	**1.33**	

CONTENTS

Average Contents Relevant to Site	$ 60,000	*Base for 240 m^2 house $ 60,000*
Post late 2001 adjustments	1.27	*From above*
Contents Damage Repair Limitation Factor	0.75	*due to no insurance / short duration flood / long duration flood*
Sub-Total Adjustment Factor	0.85	*Suggested range 0.75 to 0.85*
Level of Flood Awareness	low	*low or high only. Low default unless otherwise justifiable.*
Effective Warning Time	2	hour
Interpolated DRF adjustment (Awareness/Time)	0.93	
Typical Table/Bench Height (TTBH)	0.90	*0.9m is typical height. If typical is 2 storey house use 2.6m.*
Total Contents Adjustment Factor AFD <= TTBH	**0.79**	
Total Contents Adjustment Factor AFD > TTBH	**0.85**	

Most recent advice from Victorian Rapid Assessment Method

Low level of awareness is expected norm (long term average) any deviation needs to be justified.

Basic contents damages are based upon a DRF of	*0.9*				
Effective Warning time (hours)	*0*	*3*	*6*	*12*	*24*
RAM AIDF Inexperienced (Low awareness)	*0.90*	*0.80*	*0.80*	*0.80*	*0.70*
DRF (ARF/0.9)	*1.00*	*0.89*	*0.89*	*0.89*	*0.78*
RAM AIDF Experienced (High awareness)	*0.80*	*0.80*	*0.60*	*0.40*	*0.40*
DRF (ARF/0.9)	*0.89*	*0.89*	*0.67*	*0.44*	*0.44*
Site Specific DRF (SRF/0.9) for Awareness level for iteration	*1.00*	*0.89*	*0.89*	*0.89*	*0.78*
Effective Warning time (hours)	*0*	*3*	*2*		
Site Specific iterations	*1.00*	*0.89*	*0.93*		

ADDITIONAL FACTORS

Post late 2001 adjustments	1.27	*From above*
External Damage	$ 6,700	*$6,700 recommended without justification*
Clean Up Costs	$ 4,000	*$4,000 recommended without justification*
Likely Time in Alternate Accommodation	2	weeks
Additional accommodation costs /Loss of Rent	$ 220	*$220 per week recommended without justification*

TWO STOREY HOUSE BUILDING & CONTENTS FACTORS

Up to Second Floor Level, less than	2.6	m	70% Single Storey Slab on Ground
From Second Storey up, greater than	2.6	m	110% Single Storey Slab on Ground

Base Curves

AFD = Above Floor Depths

Single Storey Slab on Ground/Low Set	13164	+	4871	x	AFD	in metres
Structure with GST	AFD	greater than	0.0	m		
Validity Limits	AFD	less than or equal to		6	m	
Single Storey High Set	16586	+	7454	x	AFD	
Structure with GST	AFD	greater than	-1.50	m		
Validity Limits	AFD	less than or equal to		6	m	
Contents	20000	+	20000	x	AFD	
Contents with GST	AFD	greater than		0		
Validity Limits	AFD	less than or equal to		2		

Floodplain Specific Damage/Aftermath Curves

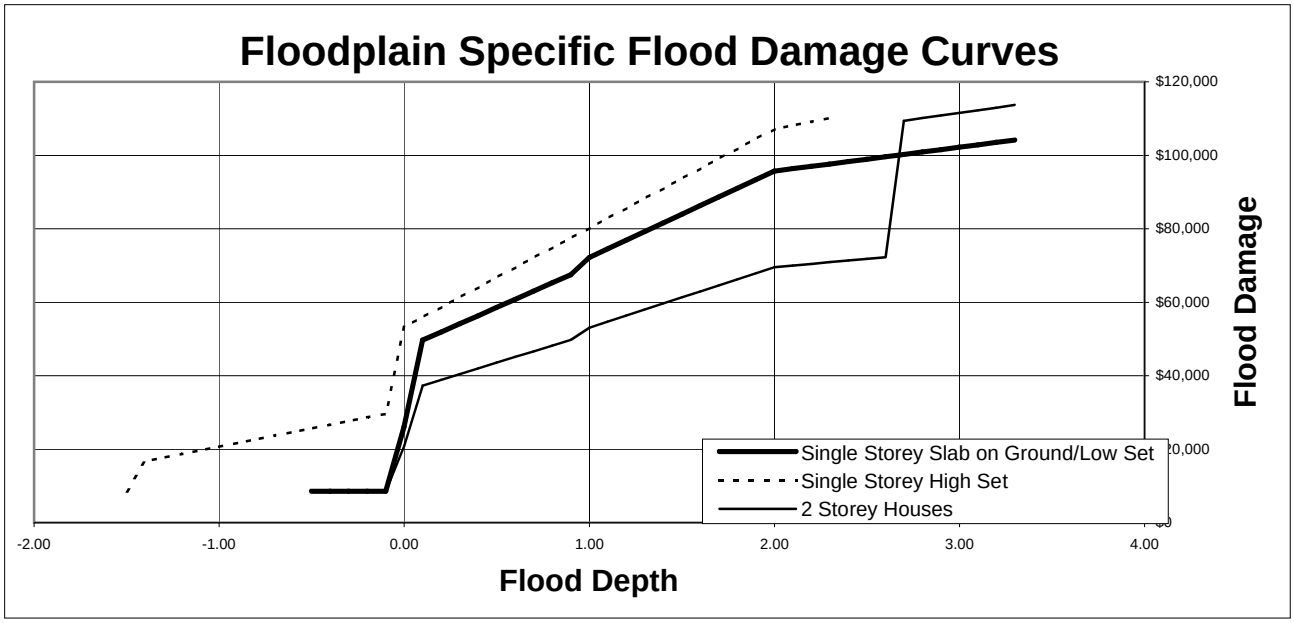
Allowance for Waves *0* m

Steps in Curve 0.1 m

Single Storey Slab on Ground/Low Set		
Static AFD	**AFD + Wave Action**	**Damage**
-0.50	-0.50	$ 8,509
-0.40	-0.40	$ 8,509
-0.30	-0.30	$ 8,509
-0.20	-0.20	$ 8,509
-0.10	-0.10	$ 8,509
0.00	0.00	$ 26,063
0.10	0.10	$ 49,666
0.20	0.20	$ 51,890
0.30	0.30	$ 54,113
0.40	0.40	$ 56,337
0.50	0.50	$ 58,560
0.60	0.60	$ 60,784
0.70	0.70	$ 63,008
0.80	0.80	$ 65,231
0.90	0.90	$ 67,455
1.00	1.00	$ 72,197
1.10	1.10	$ 74,546
1.20	1.20	$ 76,896
1.30	1.30	$ 79,245
1.40	1.40	$ 81,595
1.50	1.50	$ 83,944
1.60	1.60	$ 86,294
1.70	1.70	$ 88,643
1.80	1.80	$ 90,993
1.90	1.90	$ 93,342
2.00	2.00	$ 95,692
2.10	2.10	$ 96,342
2.20	2.20	$ 96,991
2.30	2.30	$ 97,641
2.40	2.40	$ 98,290
2.50	2.50	$ 98,940
2.60	2.60	$ 99,589
2.70	2.70	$ 100,239
2.80	2.80	$ 100,888
2.90	2.90	$ 101,538
3.00	3.00	$ 102,187
3.10	3.10	$ 102,837
3.20	3.20	$ 103,486
3.30	3.30	$ 104,136

Single Storey High Set		
Static AFD	**AFD + Wave Action**	**Damage**
-1.50	-1.50	$ 8,509
-1.40	-1.40	$ 16,711
-1.30	-1.30	$ 17,705
-1.20	-1.20	$ 18,699
-1.10	-1.10	$ 19,693
-1.00	-1.00	$ 20,687
-0.90	-0.90	$ 21,681
-0.80	-0.80	$ 22,675
-0.70	-0.70	$ 23,669
-0.60	-0.60	$ 24,663
-0.50	-0.50	$ 25,656
-0.40	-0.40	$ 26,650
-0.30	-0.30	$ 27,644
-0.20	-0.20	$ 28,638
-0.10	-0.10	$ 29,632
0.00	0.00	$ 53,265
0.10	0.10	$ 55,959
0.20	0.20	$ 58,653
0.30	0.30	$ 61,347
0.40	0.40	$ 64,041
0.50	0.50	$ 66,735
0.60	0.60	$ 69,429
0.70	0.70	$ 72,123
0.80	0.80	$ 74,816
0.90	0.90	$ 77,510
1.00	1.00	$ 80,204
1.10	1.10	$ 82,898
1.20	1.20	$ 85,592
1.30	1.30	$ 88,286
1.40	1.40	$ 90,980
1.50	1.50	$ 93,674
1.60	1.60	$ 96,368
1.70	1.70	$ 99,062
1.80	1.80	$ 101,756
1.90	1.90	$ 104,450
2.00	2.00	$ 107,144
2.10	2.10	$ 108,138
2.20	2.20	$ 109,132
2.30	2.30	$ 110,126

2 Storey Houses		
Static AFD	**AFD + Wave Action**	**Damage**
-0.50	-0.50	$ 8,509
-0.40	-0.40	$ 8,509
-0.30	-0.30	$ 8,509
-0.20	-0.20	$ 8,509
-0.10	-0.10	$ 8,509
0.00	0.00	$ 20,797
0.10	0.10	$ 37,319
0.20	0.20	$ 38,875
0.30	0.30	$ 40,432
0.40	0.40	$ 41,988
0.50	0.50	$ 43,545
0.60	0.60	$ 45,101
0.70	0.70	$ 46,658
0.80	0.80	$ 48,214
0.90	0.90	$ 49,771
1.00	1.00	$ 53,090
1.10	1.10	$ 54,735
1.20	1.20	$ 56,380
1.30	1.30	$ 58,024
1.40	1.40	$ 59,669
1.50	1.50	$ 61,314
1.60	1.60	$ 62,958
1.70	1.70	$ 64,603
1.80	1.80	$ 66,248
1.90	1.90	$ 67,892
2.00	2.00	$ 69,537
2.10	2.10	$ 69,992
2.20	2.20	$ 70,446
2.30	2.30	$ 70,901
2.40	2.40	$ 71,356
2.50	2.50	$ 71,810
2.60	2.60	$ 72,265
2.70	2.70	$ 109,412
2.80	2.80	$ 110,126
2.90	2.90	$ 110,841
3.00	3.00	$ 111,555
3.10	3.10	$ 112,270
3.20	3.20	$ 112,984
3.30	3.30	$ 113,698



Post 2004 Adjustment 1.1 (base data for 2004 - see Table right)

Depth above work area (m)	Shops and small retailers up to approx. 200m square			Industrial properties Between approx. 200m and 600m square			Large Commercial & Industrial	
	CODE	CODE	CODE	CODE	CODE	CODE	CODE	CODE
	CL	CM	CH	IL	IM	IH	L1	L2
	offset =	offset =	offset =	offset =	offset =	offset =	offset =	offset =
	1	2	3	4	5	6	7	8
-999999	$0	$0	$0	$0	$0	$0	$0	$0
0	$0	$0	$0	$0	$0	$0	$0	$0
0.01	$440	$2,640	$5,060	$3,740	$7,700	$15,400	$22,000	$308,000
0.05	$2,640	$6,600	$11,440	$10,120	$19,140	$38,280	$154,000	$462,000
0.1	$5,060	$11,440	$22,880	$19,140	$38,280	$76,560	$154,000	$462,000
0.2	$11,000	$22,000	$46,200	$37,400	$77,000	$154,000	$462,000	$462,000
0.25	$15,400	$28,600	$57,200	$46,200	$90,200	$178,200	$506,000	$462,000
0.3	$17,600	$33,000	$63,800	$50,600	$101,200	$204,600	$594,000	$462,000
0.4	$22,000	$41,800	$82,940	$63,800	$127,600	$255,200	$638,000	$484,000
0.5	$24,200	$50,600	$101,200	$77,000	$154,000	$305,800	$660,000	$506,000
0.6	$28,600	$59,400	$114,400	$90,200	$178,200	$356,400	$770,000	$506,000
0.7	$31,900	$67,540	$132,660	$107,140	$204,160	$408,320	$858,000	$550,000
0.75	$37,400	$77,000	$140,800	$114,400	$217,800	$433,400	$902,000	$572,000
0.8	$38,500	$79,200	$148,060	$119,900	$229,680	$459,360	$1,034,000	$572,000
0.9	$39,600	$81,400	$165,000	$127,600	$255,200	$510,400	$1,276,000	$638,000
1	$44,000	$90,200	$178,200	$140,800	$281,600	$547,800	$1,540,000	$770,000
1.1	$47,300	$95,700	$191,400	$148,060	$301,180	$594,660	$3,080,000	$638,000
1.2	$50,600	$101,200	$204,600	$154,000	$319,000	$638,000	$4,488,000	$770,000
1.25	$52,800	$107,800	$217,800	$165,000	$332,200	$664,400	$5,126,000	$1,166,000
1.3	$53,460	$110,000	$219,560	$168,520	$336,820	$671,000	$5,390,000	$1,232,000
1.4	$54,120	$112,200	$224,400	$173,580	$347,160	$686,400	$6,160,000	$1,386,000
1.5	$55,000	$114,400	$228,800	$178,200	$356,400	$701,800	$6,424,000	$1,540,000
1.75	$59,400	$121,000	$242,000	$191,400	$369,600	$739,200	$6,424,000	$4,488,000
2	$63,800	$127,600	$255,200	$204,600	$382,800	$765,600	$6,424,000	$6,424,000
3	$66,000	$132,000	$264,000	$209,000	$385,000	$770,000	$6,424,000	$6,424,000
9999999	$66,000	$132,000	$264,000	$209,000	$385,000	$770,000	$6,424,000	$6,424,000

APPENDIX D: PRELIMINARY COST ESTIMATES

M5 Motorway Culvert Blockage Protection

Installation of Bollards

Item	Description	Quantity	Rate	Amount
1	Investigation and Design			$ 15,000
2	Site Establishment/Preliminaries			$ 5,000
3	Erosion Control			$ 2,000
4	Establish Working/Maintenance Platform	$150m^3$	$ 150	$ 22,500
5	Dewatering	$100m^2$	$ 50	$ 5,000
6	Concrete Footings	$20m^3$	$ 250	$ 5,000
7	Bollards	4no.	$ 2,500	$ 10,000
	Sub Total			**$ 64,500**
	Contingency (30%)			$ 19,500
	Total			**$ 84,000**

APPENDIX E: FREQUENTLY ASKED QUESTIONS

Why do flood levels change over time?

There is a chance that floods of various magnitudes will occur in the future. As the size of a flood increases, the chance that it will occur becomes rarer. Because some of these rare floods have never been experienced since European settlement, the height of future floodwaters is normally predicted using computer models. These computer models simulate flood levels and velocities for a range of flood sizes and flood probabilities. Given the importance of estimating flood levels accurately, councils and the NSW Department of Environment and Climate Change (DECC) engage experts to establish and operate the computer models.

From time to time the computer models are revised and predicted flood levels can change. The resultant change in flood levels however is normally very small. The reasons why the computer models are revised can include:

- new rainfall or ground topography information becomes available;
- new floods occur which provide additional data from which to fine-tune the models;
- better computer models become available as the science of flood modelling
- improves and computer capabilities increase; or
- flood mitigation works may have been carried out, or development within the catchment may have occurred, that was not previously simulated in the models.

How are these studies funded?

These types of studies are normally carried out under State Government guidelines and are funded on a 2:1 basis between the State Government and councils. This funding arrangement is also available for the construction of flood mitigation works.

My property is in a Low Flood Risk Precinct. What does this mean?

The classification of a 'Low Flood Risk Precinct' can differ slightly between councils. Generally it means that your property would not be inundated in a 100 year flood but still has a very slight risk of inundation from larger (i.e. rarer) floods.

If you are a residential property owner, there will be virtually no change to how you may develop your property. However, there may be controls on the location of essential services such as hospitals, evacuation centres, nursing homes and emergency services.

My property is in a Medium Flood Risk Precinct. What does this mean?

The classification of a 'Medium Flood Risk Precinct' can differ slightly between councils. Generally it means that your property is inundated in a 100 year flood, however conditions are not likely to be hazardous. If you are a residential property owner development controls will probably be similar to those that currently exist.

My property is in a High Flood Risk Precinct. What does this mean?

The classification of a 'High Flood Risk Precinct' can differ slightly between councils. Generally it means that your property will be inundated in a 100 year flood and that hazardous conditions may occur. This could mean that there would be a possible danger to personal safety, able bodied adults may have difficulty wading to safety, evacuation by trucks may be difficult, or there may be a potential for significant structural damage to buildings. This is an area of higher hazard where stricter controls may be applied.

Will my property value be altered if I am in a Flood Risk Precinct?

Any change in a council's classification of properties can have some impact on property values. Nevertheless, councils normally give due consideration to such impacts before introducing a system of flood risk classifications or any other classification system (e.g. bushfire risks, acid sulphate soil risk, etc). If your property is now classified as being in a Flood Risk Precinct, the real flood risks on your property have not changed, only its classification has altered. A prospective purchaser of your property could have previously discovered this risk if they had made enquiries themselves.

If you are in a Low Flood Risk Precinct, generally there will be no controls on normal residential type development. Previous valuation studies have shown that under these circumstances, your property values will not alter significantly over the long term. Certainly, when a new system of classifying flood risks is introduced, there may be some short-term effect, particularly if the development implications of the precinct classification are not understood properly. This should only be a short-term effect however until the property market understands that over the long-term, the Low Flood Risk Precinct classification will not change the way you use or develop your property.

Ultimately, however, the market determines the value of any residential property. Individual owners should seek their own valuation advice if they are concerned that the flood risk precinct categorisation may influence their property value.

My property was never classified as 'flood prone' or 'flood liable' before. Now it is in a Low Flood Risk Precinct. Why?

The State Government changed the meaning of the terms 'flood prone', 'flood liable' and 'floodplain' in 2001. Prior to this time, these terms generally related to land below the 100 year flood level. Now it is different. These terms now relate to all land that could possibly be inundated, up to an extreme flood known as the probable maximum flood (PMF). This is a very rare flood.

The reason the Government changed the definition of these terms was because there was always some land above the 100 year flood level that was at risk of being inundated in rarer and more extreme flood events. History has shown that these rarer flood events can and do happen (e.g. the 1990 flood in Nyngan, the November 1996 flood in Coffs Harbour, the August 1998 flood in Wollongong, the 1998 flood in Katherine, the 2002 floods in Europe, etc).

Will I be able to get house and contents insurance if my house is in a Flood Risk Precinct?

In contrast to the USA and many European countries, flood insurance is generally not available for residential property in Australia. Following the disastrous floods in Coffs Harbour in November 1996 and in Wollongong in August 1998, some insurance companies are now offering very limited flood cover. The most likely situation is that your insurer does not offer you flood cover. If limited flood cover is offered, the classification of your property within a Flood Risk Precinct is unlikely to alter the availability of cover. Obviously insurance policies and conditions may change over time or between insurance companies, and you should confirm the specific details of your situation with your insurer.

Will I be able to get a home loan if my land is in a Flood Risk Precinct?

Most banks and lending institutions do not account for flood risks when assessing home loan applications unless there is a very significant risk of flooding at your property. The system of Flood Risk Precinct classification will make it clear to all concerned, the nature of the flood risks. Under the previous system, if a prospective lending authority made appropriate enquiries, they would have identified the nature of the flood risk and considered it during assessment of home loan applications. As a result, it is not likely that the classification of your property within a Flood Risk Precinct will alter your ability to obtain a home loan. Nevertheless, property owners who are concerned about their ability to obtain a loan should clarify the situation with their own lending authority.

How have the flood risk maps been prepared?

Because some large and rare floods have often not been experienced since European settlement commenced, computer models are used to simulate the depths and velocities of major floods. These computer models are normally established and operated by flooding experts employed by local and state government authorities. Because of the critical importance of the flood level estimates produced by the models, such modelling is subjected to very close scrutiny before flood information is formally adopted by a council. Maps of flood risks (e.g. 'low', 'medium' and 'high') are prepared after consideration of such issues as:

- flood levels and velocities for a range of possible floods;
- ground levels;
- flood warning time and duration of flooding;
- suitability of evacuation and access routes; and
- emergency management during major floods.

What is the probable maximum flood (PMF)?

The PMF is the largest flood that could possibly occur. It is a very rare and improbable flood. Despite this, a number of historical floods in Australia have approached the magnitude of a PMF. Every property potentially inundated by a PMF will have some flood risk, even if it is very small. Under the State Government changes implemented during 2001, councils must now consider all flood risks, even these potentially small ones, when managing floodplains. As part of the State Government changes, the definitions of the terms 'flood liable', flood prone' and 'floodplain' have been changed to refer to land inundated by the PMF.

What is the 100 year flood?

A 100 year flood is the flood that will occur or be exceeded on average once every 100 years. It has a probability of 1% of occurring in any given year. If your area has had a 100 year flood, it is a fallacy to think you will need to wait another 99 years before the next flood arrives. Floods do not happen like that. Some parts of Australia have received a couple of 100 year floods in one decade. On average, if you live to be 70 years old, you have a better than even chance of experiencing a 100 year flood.

Why do councils prepare floodplain management studies and plans?

Under NSW legislation, councils have the primary responsibility for management of development within floodplains. To appropriately manage development, councils need a strategic plan which considers the potential flood risks and balances these against the beneficial use of the floodplain by development. To do this, councils have to consider a range of environmental, social, economic, financial and engineering issues. This is what happens in a floodplain management study. The outcome of the study is the floodplain management plan, which details how best to manage flood risks in the floodplain for the foreseeable future.

Floodplain management plans normally comprise a range of works and measures such as:

- improvements to flood warning and emergency management;
- works (e.g. levees or detention basins) to protect existing development;
- voluntary purchase or house raising of severely flood-affected houses;
- planning and building controls to ensure future development is compatible with the flood risks; and
- measures to raise the community's awareness of flooding so that they are better able to deal with the flood risks they face.

Will the Flood Risk Precinct maps be changed?

Yes. All mapping undertaken by council is subjected to ongoing review. As these reviews take place, it is conceivable that changes to the mapping will occur, particularly if new flood level information or ground topography information becomes available. However, this is not expected to occur very often and the intervals between revisions to the maps would normally be many years. Many councils have a policy of reviewing and updating floodplain management studies and plans about every five years. This is the likely frequency at which the maps may be amended.

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