9. OVERVIEW OF FLOODPLAIN MANAGEMENT

9.1 SELECTION OF THE FLOOD PLANNING LEVEL

The flood planning level (FPL), previously known as the 'designated flood' level or 'flood standard', is the flood level selected for planning purposes, and will directly determine the area of land that should be subject to flood-related building and development controls.

Selection of the FPL is one of the most critical decisions in floodplain management, and is not an easy one. It should be based on an understanding of the flood behaviour, together with the balancing of social, economic and environmental consequences of flooding, including the potential for property damage and the risk to human life. Traditionally, only one FPL has been selected for a particular area, but current thinking is to consider more than one FPL for different types of developments or locations within the floodplain.

The adoption of a singular FPL may be unduly restrictive for some types of land uses. For example, whilst it may be appropriate for some land uses, such as a hospital, to be located above a PMF flood, it could be argued that residential, industrial or recreational land uses do not require such restrictive controls.

Also, the adoption of a singular FPL causes misconceptions by the community regarding flood risk. Most importantly, residents within the floodplain (i.e. the area below the PMF) but above the FPL, often mistakenly believe they are not at risk from flooding.

To overcome the shortcomings of a singular FPL, a 'graded' set of controls which consider the variation of damage risk with flood frequency and land use, have been proposed for Cabramatta Creek. These are contained in the 'Planning Matrix' approach discussed in Section 8.4. This is also consistent with the approach adopted in other floodplain management studies that are being prepared for both Councils.

The planning matrix approach does not rely on the definition of a singular FPL. In essence, the approach makes use of a range of FPL's for various land uses within the flood prone land below the PMF, without specifically referring to this term.

Within the planning matrix, the selection of the controls and the various flood conditions at which the controls apply, has been based on:

- the procedures and philosophy espoused in the Government's *Floodplain Management Manual*;
- consideration of the social, economic and environmental impacts of flooding and the proposed controls;
- investigations carried out within the current study;
- community attitudes expressed during the current study;
- minimising Council's exposure to legal actions in relation to flooding;
- Council's existing interim flood policy and flood planning level;

- views expressed by the Floodplain Management Committee and various senior officers within Council and the Department of Infrastructure Planning and Natural Resources; and
- experience gained from the development of planning controls and flood policies for various communities across NSW in recent years.

9.2 RANGE OF FLOODPLAIN MANAGEMENT MEASURES

Floodplain management measures can be divided into three categories:

9.2.1 Options that Modify the Way a Flood Behaves

These include:

- improving the conveyance of the creek to carry floodwaters, through clearing of rubbish, debris, or other obstructions, and the development of programs to ensure the creek corridor remains free from these items;
- enlarging the channel to increase its capacity by widening or deepening;
- construction of bypass channels or floodways;
- straightening the channels or lining with rock, gabions or concrete;
- carrying out works in the Georges River to help prevent floodwaters backing up into Cabramatta Creek;
- constructing upstream dams or detention storages;
- enlarging bridges and culverts to improve the flow of water under roads; and
- the construction of levees to keep floodwaters away from property.

9.2.2 Options which Minimise Damage by Modifying the Property

These include:

- voluntary purchase of the most flood-liable houses and conversion of land to open space;
- raising of houses above the 100 year ARI flood;
- redevelopment of flood prone houses to a form more compatible with the flood hazard;
- flood-proofing of individual residential and business properties with small floodwalls and deflector banks;
- relocating flood liable houses to areas of higher ground; and
- providing consistent, equitable controls on development in flood-liable areas

9.2.3 Options Which Reduce Damages by Improving the Response of People and Organisations to Floods

These include:

- improving flood warning before and during floods;
- improving evacuation procedures and emergency assistance during floods;
- making sure all information about the potential risks of flooding is available to all residents and business owners;
- providing Section 149 certificates stating whether or not properties are flood affected;
- making sure residents and business owners have flood action plans;
- installing some flood markers to act as constant reminders of the height of previous floods; and
- promoting public education, community participation and flood awareness programs.

9.3 COMMUNITY CONCERNS AND SUGGESTIONS

Results from the community consultation process for this study have been presented in a separate document [Bewsher Consulting, 1998h]. Key findings have also been presented in Section 6 of this report, including a list of favoured floodplain management measures that the community felt 'could prevent damage', in their order of popularity across the Cabramatta Creek catchment.

It is interesting to note that there was high community support for improved flood warning and programs to increase community awareness of flood issues, including the provision of some form of certificate to every resident defining the flood status of their property.

Other options that were favoured by the community involved works to improve or restore the condition of the creek corridors, including the eradication of rubbish and exotic vegetation, and the implementation of a bush management program.

Options involving the raising of houses, voluntary purchase of flood prone houses, and the construction of levees received less support.

9.4 CRITERIA FOR EVALUATION OF OPTIONS

In evaluating potential floodplain management options within the study area, a range of assessment criteria has been used. These include:

9.4.1. Financial Feasibility

Options proposed within the floodplain management plan must be capable of being funded. There are various sources of funding that may be utilised, including funding related to the development of new release areas (Section 94 contributions), funding assistance from the RTA for construction of works necessary to compensate for loss of

floodplain storage from the proposed WSO Highway, and funding from both Liverpool and Fairfield Councils, with assistance from the Department of Infrastructure, Planning and Natural Resources, for the alleviation of existing flood problems.

9.4.2 Economic Merit

The ratio of the benefit divided by the cost (i.e. the benefit–cost ratio) is a common measure of assessing economic feasibility. Theoretically, no investment should be made on an option if the benefit/cost ratio does not exceed unity (i.e. if the benefits do not exceed the costs). However, traditionally many floodplain management options have been undertaken where this is not the case because the intangible benefits, (i.e. those not able to be quantified), are considerable.

9.4.3 Community Acceptance

Assessment of possible community attitudes towards any proposed floodplain management option is essential. If community attitudes are strongly negative, this is often enough to deter the implementation of the proposals which otherwise may have significant merit.

9.4.4 Environmental Impact

Floodplain management options involving structural works may often have significant environmental impacts. Impacts on vegetation, visual amenity and soil erosion/sedimentation, are issues which must commonly be addressed when evaluating works within watercourses.

9.4.5 Impact on Flood Behaviour

The impact on flood behaviour caused by the option needs to be considered for upstream and downstream locations. These impacts can include such things as changes in flood levels, changes in velocities or alteration of flow directions.

9.4.6 Performance during Large Floods

All options must be assessed in the knowledge that large floods, i.e. larger than the 100 year ARI flood, or larger than any known historical flood, will happen at some time in the future. It is therefore imperative that the options do not expose the community to unacceptable risks by providing a false sense of security.

9.4.7 Technical Feasibility

If the proposed options involve structural works, these works must be able to be constructed and be free from major technical constraints.

9.4.8. Political/Administrative Impact

Any recommended option will have more chance of success if it involves little if any disruption to current political and administrative structures, attitudes and responsibilities.

10. ASSESSMENT OF FLOODPLAIN MANAGEMENT MEASURES

Possible floodplain management options for Cabramatta Creek are discussed below in terms of the evaluation criteria presented in **Section 9.4**. Each option has been included in a qualitative assessment matrix (**Table 10.3**) in order to assess its relative merits, and whether or not the option should be included in the floodplain management plan for Cabramatta Creek.

The options are discussed in three general groups; those that modify flood behaviour, those that modify the property in order to minimise flood damage, and those that modify people's response to flooding.

10.1 MEASURES THAT MODIFY FLOOD BEHAVIOUR

10.1.1 Clearing the Creek of Rubbish, Debris, Exotic Vegetation and Man-Made Obstructions

Recommended for further consideration.

One of the key findings from the community questionnaire was that many people regarded litter and debris in the Creek to be a significant problem. There are also some examples where gross pollutants, such as abandoned car bodies, have been dumped in the middle of the Creek. One case was recently observed in Hinchinbrook Creek, where a dumped car body occupied much of the available space within the creek banks, leaving very little room for the conveyance of floodwaters. There are also a number of fallen trees and other snags throughout the creek system. Although these reduce the waterway area of floodwaters to some degree, they also provide aquatic habitat.

Not only do these obstructions reduce the available capacity of the creek to convey floodwaters, but many of these objects will be carried downstream during floods, resulting in increased damage to buildings and other structures that may be in their path. The obstructions are also likely to result in localised increases in velocities around these objects, leading to scouring of river banks, slumping, and subsequent siltation of the downstream creek system. This will then lead to further reductions in the conveyance capacity of the creek system, with resulting increases in flood levels.

An initial program of works to selectively clear the creeks of major obstructions is warranted. However, this should not be undertaken as a once-off activity. It is important that it is part of a co-ordinated plan to manage the creek corridors and existing vegetation.

Selective clearing and de-snagging works are recommended throughout Cabramatta Creek and Hinchinbrook Creek.

School, community and landcare groups should be encouraged to participate in a well co-ordinated program of works. Total cost for the initial activities are estimated at $300,000.

10.1.2 Developing an Urban Bushland Management Program for the Creek Corridor

Recommended for further consideration.

A vegetation survey [Mount King Ecological Surveys, 1990] has previously been undertaken for Cabramatta Creek, as well as a Bushland survey report for the Elouera Nature Reserve [Greening Australia, 1991]. Both these reports emphasised that the existing creek system represents a significant natural resource in the Cabramatta Creek catchment, and that it contained a unique stand of native bushland within the Western Sydney Region. The North-South Hinchinbrook-Cabramatta Creek system and the East-West Cabramatta Creek system are also important wildlife corridors that span the catchment. A number of management plans have also been prepared for Fairfield City Council.

The implementation of an urban bushland management program in accordance with the above management plans which have already been implemented, plus specific actions to cover additional areas, would preserve and improve the ecological and aesthetic quality of the creek corridors. It would also ensure that debris and exotic species are controlled and do not result in severe weed infestation that reduces the hydraulic conveyance of the creeks themselves.

The program will necessarily be long term and ongoing, involving monitoring and maintenance on a regular basis to gauge the success of various measures and impacts on the environmental qualities of the creek corridors. A planned and co-ordinated approach is needed to ensure that major weed infestations do not become seed sources which impact on rehabilitated areas.

An urban bushland management program would include;

- bush regeneration program;
- community education on noxious and problem species;
- consolidation of bushland through supplementary planting to link pockets of remnant communities;
- staged revegetation with native species;
- weed eradication program;
- support and encouragement of volunteer bush regenerators; and
- selected creek bank stabilisation works including reducing creek bank grades where possible.

The estimated cost to prepare an Urban Bushland Management Program is $60,000. Implementation of the program would be several hundreds of thousands of dollar, although some volunteer labour would be available to reduce costs. It is anticipated that initial works would be spread over about 5 years.

Over the last few years, Liverpool and Fairfield Councils have been developing an integrated management plan for Lower Cabramatta and Brickmakers Creek that includes weed removal, litter control and revegetation. The project recently received funding of $250,000 through DIPNR for these activities.

10.1.3 Restoring the Creek to a More Natural Condition

Recommended for consideration as part of the Urban Bush Management Program.

This was another option favoured by the community. Development and implementation of the above bushland management program will ensure that the environmental quality of the creek system is enhanced, allowing large portions of the existing creek system to be maintained in a more 'natural' condition, rather than being allowed to deteriorate.

In some areas of the catchment, such as sections of Brickmakers Creek and Maxwells Creek, the natural creek has been replaced by a grassed trapezoidal channel, resulting in a loss of most of the previous creek corridor vegetation. Whilst this presents an efficient channel for the conveyance of floodwaters, it is less satisfactory from an ecological or environmental view.

A difficulty in restoring artificial channels to a more natural form is that it is likely to be accompanied by an increase in flood levels. In fact the reason why the channels were constructed in this form in the first place was probably in an effort to lower flood levels, although this was not a very environmentally friendly solution. It may be possible to convert some of these channels back to a more natural form if other compensatory measures can also be provided. For example, there is some scope for the reach of Brickmakers Creek between Memorial Avenue and Hoxton Park Road to be converted to a more natural channel, provided an upstream detention basin is also provided in the Amalfi Park area to compensate for the likely increases in flood level. The costs of these works are high, and little or no flood benefit will be obtained. For these reasons, this option has not been recommended apart from works identified in the urban bushland management program.

In other areas, where channel amplification measures may be recommended, opportunities to incorporate a natural channel form should be incorporated in these designs wherever possible.

10.1.4 Enlarging the Creek by Widening or Deepening

Selected areas recommended for further consideration.

Extensive creek widening upstream of Jedda Road has previously been considered for Maxwells Creek, which would allow further industrial development in accordance with Council's Local Environmental Plan. This would also include reconstruction of the Jedda road crossing. A reserve width of 100m and an excavation volume of 55,000 m^3 would be necessary. Total cost is estimated at $1.4M. A revised form of this scheme that incorporates additional detention storage and limited land fill west of Ash Road has been proposed.

Further upstream on Maxwells Creek, between Kurrajong Road and Camden Valley Way, additional channel works have been proposed, in association with proposed detention basin storage, the proposed Western Sydney Orbital and other areas that have been zoned for development. A concept drainage plan for this reach of the Creek was recently prepared for the RTA, and is the subject of further detailed design. The proposed channel works is being designed around a number of constraints, including areas of significant vegetation and other areas of archaeological significance.

A significant restriction on Lower Cabramatta Creek occurs in the vicinity of the Elizabeth Drive Bridge, which restricts the full capacity of the bridge from being utilised. It is proposed that this waterway area be increased to improve the conveyance under the bridge. These works are proposed in conjunction with other works recommended in Blamfield Oval and the Tresalam Street levee.

A reach of Brickmakers Creek, between Orange Grove Road and Memorial Avenue, is significantly inadequate compared to the channel capacity both upstream and downstream. Throughout much of this reach the creek is little more than an undersized ditch that has been constructed within a relatively wide reserve. The capacity of the creek will be exceeded in very minor flood events, with significant flows escaping from the creek and travelling overland away from the creek towards the Liverpool CBD area and other residential areas. Further investigation of the flood problem of this area, and recommended measures to alleviate the flooding, was recently undertaken [Bewsher Consulting, 2003], with results provided in **Appendix C**.

10.1.5 Construction of Bypass Channels or Floodways

Selected areas recommended for further consideration.

A large high level floodway adjacent to Cabramatta Creek was built in the 1950-60s, which provides protection to property located between Elizabeth Drive and Hoxton Park Road at the Miller TAFE College. Further modifications to this floodway have been proposed in the past.

Preliminary investigations have been undertaken into the extension of the existing floodway upstream from Miller TAFE College to the confluence with Creek A, and up into Hinchinbrook Creek. Such works would prevent about 250ha of land being inundated in a 100 year ARI flood, and would prevent the occurrence of the Wilson Road breakout. Works would include 2 six lane crossings of Hoxton Park Road, about 700,000 m³ of excavation and the likely removal of riparian vegetation in the area. Total cost has been estimated at over $12M. It has not been recommended in this study due to the high cost and the environmental consequences of such works.

A floodway channel has recently been constructed in Orange Grove Golf Course, to improve overland flow to the high level culverts under Orange Grove Road. These works are estimated to marginally improve flood behaviour in this vicinity.

A smaller floodway was investigated beside Lower Cabramatta Creek, just upstream of the Main Southern Railway line. These works are estimated to cost less than $0.1M although the flood benefits are minimal. There are also likely to be environmental concerns with this proposal, and it has therefore not been considered further.

A more significant floodway was previously proposed between the Hume Highway and the Main Southern Railway [Kinhill, 1991]. This consisted of selected vegetation removal and limited earthworks to provide a clearer flowpath during times of flooding. However, the flood benefit of these works is low, and there would be considerable environmental concerns in undertaking these works. In particular, the area contains maternity colonies of the Grey-Headed Flying Fox. This is one of only two major colonies within Sydney. As such, this proposal has not been considered further.

10.1.6 Straightening the Creek or Lining with Rock, Gabions or Concrete

Not recommended for further consideration.

Concrete lining of Maxwells Creek, between Hoxton Park Road and Jedda Road, has been proposed in earlier studies to reduce the extent of flood liable land and allow further industrial development up to the creek banks. The total cost of the works has been estimated at $20M. This solution is considered to result in adverse environmental impacts, and would be aesthetically unpleasing. It would also result in a loss of natural floodplain storage, leading to an increase in downstream flood levels.

This type of solution was not regarded well by the community, with only 30% of questionnaire respondents favouring such measures. The option is not recommended for further consideration.

10.1.7 Works in the Georges River to Lower Flood Levels

Not recommended for further consideration

A preliminary investigation of major flood mitigation works on the Georges River was carried out by the DLWC and Liverpool City Council in March 1998. Potential flood mitigation works upstream of Liverpool were assessed with the objective of lowering design flood levels throughout the Lower Georges River.

The following flood mitigation options on the Georges River were investigated:

- a diversion channel, on the southern side of the East Hills railway line, to divert high flows from the Georges River to Harris Creek;
- a major flood mitigation dam across the Georges Valley; and
- the provision of flood mitigation storage areas adjacent to the banks of the river.

The above works on the Georges River could lower flood levels at Liverpool by up to 1.0m. A similar reduction would occur at the confluence of the Georges River with Cabramatta Creek. As flood levels in Lower Cabramatta Creek are heavily influenced by flood conditions in the Georges River, there is potential for significant reduction of flood levels in Cabramatta Creek, as far up as Orange Grove Road.

The magnitude of works necessary on the Georges River to achieve these flood level reductions is large, and the costs associated with these works extremely high ($100M plus). The works can not be justified by flood benefits along Cabramatta Creek alone, and may even be difficult to justify on flood savings throughout the entire Georges River Valley.

A major flood mitigation dam on the Georges River was further investigated as part of the Georges River Floodplain Risk Management Study and Plan [Bewsher Consulting, 2004]. The study found that the proposal was expensive ($60M to $100M for two different options) and difficult to justify based on the reduction in flood damages. There were also significant environmental issues associated with the proposed dam, and the proposal was not recommended.

10.1.8 Construction of Upstream Dams or Detention Basins

Recommended for further consideration.

Detention basins offer the opportunity for the temporary storage of floodwaters during and prior to the peak of the flood. The peak flood discharge can therefore be reduced downstream of the basin.

The new release area development that has occurred within the Cabramatta Creek catchment, and that will continue to occur over the coming years, will result in an increase in the impervious areas within the catchment. Without compensatory flood mitigation measures, such as the construction of detention basins, this would result in an increase in both the rate and volume of flood runoff.

10.1.8.1 Liverpool's Existing Strategy

Liverpool City Council has adopted a flood mitigation strategy to compensate for the new release area development within the catchment. The strategy, which has been discussed in Section 5.2, involves the construction of up to 16 detention basins located within the catchment to ensure that downstream peak flow rates are not increased as a result of this development. Nine of the new release area basins have already been constructed. Implementation of the new release area basin strategy is being funded through Section 94 developer contributions.

A thorough review of the basin strategy was undertaken as part of the floodplain management study, with the findings discussed in **Section 5**, and further reported in the "Review of Basin Strategy" working paper [Bewsher Consulting, 1999a]. The initial review indicated that the existing strategy was not completely achieving its objectives of maintaining pre-developed flood flows throughout the catchment. A revised basin strategy was proposed (**Figure 5.2**) which recommended a large detention basin, known as Basin 22, be constructed near the confluence of Hinchinbrook Creek and Cabramatta Creek. In addition, certain recommendations were provided for the other basins in the strategy that are yet to be built.

Basin 22 was subsequently revised as part of recent investigations undertaken for the RTA and Council. The size of Basin 22 is now considerably smaller than that which was originally proposed in the draft floodplain management study in 1999.

10.1.8.2 Initial Proposal for Basin 22

Basin 22 was initially proposed to be the largest basin in Cabramatta Creek. As it is located towards the middle of the catchment, it had the potential to have a significant impact on flood behaviour throughout Lower Cabramatta Creek. A large basin at this location could potentially satisfy the following objectives:

- make up any shortfall in the existing basin strategy throughout the lower reaches of Cabramatta Creek;
- allow some other detention basins that are included in the existing basin strategy to be omitted (Basins 4, 6, & 11C);
- compensate for any adverse impacts arising from the proposed Western Sydney Orbital (**Section 5.4**);

- reduce existing flood problems that are experienced in the lower catchment (a reduction of up to 0.3m for the 100 year ARI flood); and
- assist in alleviating problems towards the lower end of Hinchinbrook Creek, arising from the Wilson Road flood breakout.

Construction of the basin was to be staged, in accordance with available funding and the particular objectives of the basin at any particular time.

The most immediate objective of Basin 22 was to make up for any shortfall in the existing basin strategy. The total active storage volume (in addition to the natural floodplain storage volume that exists at the site) of up to 650,000m³ was proposed to cover any shortfall in the existing strategy, and to allow some other smaller basins to be omitted from the strategy.

Additionally it was estimated that 100,000 m^3 storage volume would be required to satisfy the anticipated ultimate catchment development, which is outside the new release area. It is unlikely that this storage would be required in the immediate future.

A further 100,000m³ of storage volume was estimates to be required to compensate for loss in floodplain storage should the proposed Western Sydney Orbital proceed. This storage may or may not need to be provided at some time in the future, pending the outcome of this proposal.

The proposed Basin 22 is shown on **Figure 10.1**.

10.1.8.3 Staging of Basin 22

Construction of Basin 22 was divided into 3 stages. The first stage of construction involved the partial acquisition of the site, and excavation of some 380,000m³ of earth to form the northern pond of the basin. A temporary low level embankment was proposed immediately downstream of the excavation to maintain existing 100 year ARI design flood levels. As it is not intended to increase flood levels throughout the site, it is not necessary to acquire the southern portion of the basin site at this stage.

The second stage of Basin 22 included further land acquisition and the construction of the main embankment around the basin site to raise flood levels, and thus increase flood storage within the site. An additional 270,000m³ of flood storage was to be provided by this means, giving a total active flood storage volume of 650,000m³.

The final stage of construction was tied in with the proposed Western Sydney Orbital and possible further catchment development. It included modification to the southern embankment, final land acquisition, and the excavation of up to 200,000m³ of earth to form the southern pond, giving a total active flood storage volume of 850,000m³.

10.1.8.4 Cost of Basin 22

The estimated construction cost for Basin 22 was estimated at $13.6M (excluding land acquisition costs). However, there were cost savings for not having to construct Basins 4, 6, and 11C (a saving of $3.3M plus land acquisition savings). There were also a number of sources of funding for this project due to the wide range of benefits

that it was to provide. Sources of funding include Section 94 Contributions from future development, RTA funding associated with the proposed Western Sydney Orbital, Council flood mitigation funding, and State and Commonwealth funding assistance through the DIPNR.

10.1.8.5 Revised Proposals for Basin 22

Land acquisition costs for Basin 22 increased dramatically as the proposed WSO highway became more of a certainty. The land that the basin was to be located is zoned industrial, and its close proximity to entry and exit ramps to the highway made this land valuable for freight and other transport purposes. The extent of the original basin proposed at this location became less economically viable as a result.

Other technical problems emerged as further investigations were undertaken in relation to a basin at this location. A high saline water table was found to be present close to the surface in this vicinity, which limited the excavation depth that could be practically achieved within the basin.

Subsequently, only the RTA showed any real interest in constructing a reduced size basin at this location. The most recent proposal, which is still subject to detailed design by the consortium designing the WSO highway, has a much smaller basin that is only able to achieve the objective of mitigating any adverse flood impacts from the highway. The likely footprint of the revised basin is indicated on **Figure 10.1**.

As Basin 22 is now much smaller than originally envisaged, it is most unlikely that any of the basins from Council's original strategy can be omitted. That is Basins 4, 6 and 11C should now be added back into the detention basin strategy.

10.1.8.6 *Other WSO Basins*

Two other basins, apart from Basin 22, have been proposed throughout the catchment to ensure that there are no adverse flood impacts from the proposed WSO highway.

A new basin on Hinchinbrook Creek at Government Road Drive has been proposed by the RTA. The main Basin on Maxwells Creek (Basin 18) has also been relocated further upstream and expanded to provide for compensation for the proposed highway and also for Liverpool Council's basin strategy. The basin is currently being designed and constructed as part of the WSO highway design.

10.1.8.7 *Brickmakers Creek*

Apart from the new release area detention basin strategy and the WSO highway basins, another basin has been proposed to be constructed at the top end of Amalfi Park, on Brickmakers Creek.

A proposed layout for the Amalfi Park detention basin is included as **Figure 10.2**. The objective of this basin is solely to reduce existing flood problems in Brickmakers Creek. It has been estimated that the basin will reduce the 100 year ARI flood levels throughout much of Brickmakers Creek by approximately 0.3m. This will significantly reduce flood problems associated with some 100 properties adjacent to Brickmakers Creek.

FIGURE 10.1

0 50 100 200m
Scale

N

LEGEND

- Proposed Embankment (Bewsher Consulting Concept - 1999)
- Proposed top water storage level = RL 27.6
  Total storage volume = 1,087,000m³
  (Bewsher Consulting Concept - 1999)
- Proposed permanent water areas (Bewsher Consulting Concept - 1999)
- Proposed Western Sydney Orbital Basin
  Total storage volume = 345,000m³
  (Subject to Detail Design)

Mounding to direct flood flows to culvert

New culvert to direct Wilson Road breakout flows to Basin 22

Under viaduct on northern side of Hoxton Park Road, raise ground levels up to 0.5m to block flows

Under viaduct on southern side of Hoxton Park Road, lower ground levels to direct excess Hinchinbrook Creek flows into Basin 22

(Bund Crest RL 28.0)

(Bund Crest RL 27.0)

(Flood Storage Pond)

Flood Storage Pond

(Spillway)

E287000 E287500 E288000

N1244500 N1244000

WILSON RD Bridge HOXTON PARK ROAD WHITFORD ROAD BANKS ROAD ILLAROO RD PROPOSED WESTERN SYDNEY ORBITAL Bridge FIRST AVENUE JOADJA ROAD JEDDA ROAD Potential Link Road

Hoxton Park Reserve

Miller Tafe College

Catholic Club

Liverpool West Substation

Liverpool Substation

Hinchinbrook Creek

Cabramatta Creek

Boundary

Proposed

Pylon

Pylons

Bush Area Retained

FLOODPLAIN MANAGEMENT CONSULTANTS

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Plot file : J1150-fig10.3(new)
Plot scale : 4 (= 1:4000 @a3)
Date : May 2004

BASIN 22
1999 CONCEPT LAYOUT AND PROPOSED W.S.O. LAYOUT

CABRAMATTA CREEK
FLOODPLAIN MANAGEMENT STUDY

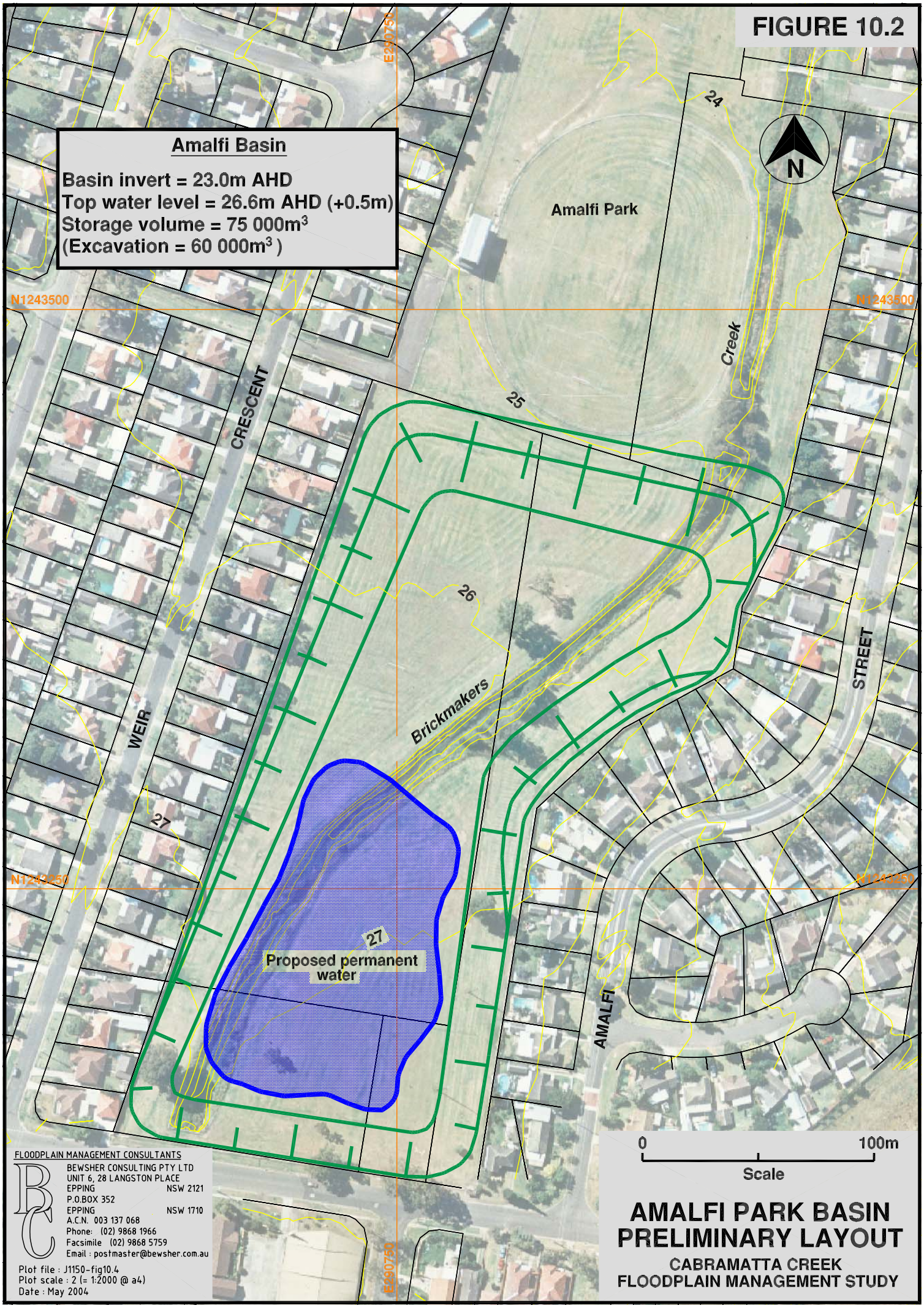
FIGURE 10.2
Amalfi Basin
Basin invert = 23.0m AHD
Top water level = 26.6m AHD (+0.5m)
Storage volume = 75 000m3
(Excavation = 60 000m3)
N
Amalfi Park
24
25
26
27
Creek
CRESCENT
WEIR
Brickmakers
STREET
AMALFI
Proposed permanent water
N1243500
N1243250
E290750
0
100m
Scale
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Plot file : J1150-fig10.4
Plot scale : 2 (= 1:2000 @ a4)
Date : May 2004
AMALFI PARK BASIN
PRELIMINARY LAYOUT
CABRAMATTA CREEK
FLOODPLAIN MANAGEMENT STUDY

10.1.8.8 Summary of Basins to be Constructed

A list of detention basins that are proposed to be constructed in the Cabramatta Creek catchment, and not yet constructed, is provided in **Table 10.1**. Each of these basins is subject to further evaluation and detailed design. Wherever possible, opportunities for off-line detention basins should be pursued, in consultation with DIPNR, to enhance aquatic and riparian environments.

Further basin details are provided in the "Review of Basin Strategy" working paper [Bewsher Consulting, 1999a].

TABLE 10.1
Detention Basins Proposed to be Constructed in the Catchment
(Does not include detention basins already constructed)

Detention Basin	Type of Basin	Storage (m3)	Cost* ($)
Basin 22[2]	WSO basin (RTA)	336,000	Included in WSO Cost
Government Dr[2]	WSO basin (RTA)	205,000	Included in WSO Cost
Basin 18[2]	WSO basin (RTA) New Release Area	405,000	Included in WSO Cost
Basin 3B	New Release Area	184,000	600,000
Basin 4	New Release Area	183,000	1,800,000
Basin 6[3]	New Release Area	170,000	1,100,000
Basin 11C	New Release Area	35,700	400,000
Basin 12[4]	New Release Area	89,000	2,100,000
Basin 14[4]	New Release Area	45,000	300,000
Amalfi Park	Existing Flood benefit	75,000	1,400,000

[1] Costs exclude land acquisition costs and additional excavation to form permanent wet storage areas
[2] Subject to detailed design by the consortium designing the WSO highway
[3] Subject to Hoxton Park Aerodrome Master Plan
[4] Subject to Edmondson Park Master Plan

10.1.9 Enlarging Bridges and Culverts to Improve their Flood Capacity

Recommended for consideration for the purpose of improving flood access.

Enlargement of the Main Southern Railway Line crossing of Cabramatta Creek has been investigated in the past. However, minimal flood benefits are obtained by increasing the waterway area at this location, as flood waters are largely controlled by flooding in the Georges River. This option has a very low benefit/cost ratio, and is not recommended for further consideration.

There are several bridges and culverts throughout the catchment that are overtopped during flood events. Amplification of these structures, to improve flood access, is recommended for various locations throughout the catchment. These measures are discussed below.

10.1.10 Improving Flood Access of Roads

Recommended for further consideration.

There are a number of arterial roads throughout the catchment that are subject to flooding, even during relatively minor flood events. Previously identified problem areas [Kinhill, 1993] are indicated in **Table 10.2**.

TABLE 10.2
Main Problem Areas for Inundation of Roads at Creek Crossings

LOCATION	FREQUENCY OF OVERTOPPING (ARI)	DEPTH OF OVERTOPPING IN 100 YEAR (ARI) FLOOD	PROPOSED FOR UPGRADING
Cabramatta Creek			
▸ Elizabeth Drive	20 years	0.5m	No
▸ Hoxton Park Road	1 year	2.2m	Recently upgraded
Hinchinbrook Creek			
▸ Hoxton Park Road	1 year	0.8m	Recently upgraded
▸ Cowpasture Road	1 year	1.2m	Yes
Maxwells Creek			
▸ Hoxton Park Road	20 year	0.5m	Recently upgraded
▸ Jedda Road	1 year	0.7m	Yes
Brickmakers Creek			
▸ Homepride Ave	20 year	0.4m	No
▸ Orange Grove Rd	50 year	0.2m	Yes
▸ Elizabeth Drive	50 year	0.2m	Yes
▸ Moore Street	1 year	0.5m	Yes
▸ Memorial Avenue	10 year	0.3m	No

Hoxton Park Road has very limited capacity along Cabramatta Creek, Hinchinbrook Creek and Maxwells Creek. Raising this road to provide a high level of service (20 years plus) is unlikely to be feasible without adversely impacting on flood behaviour through various parts of the study area. This issue was investigated by the RTA and

some upgrading of the road has recently been undertaken. It is understood that there has been some amplification of culverts at Cabramatta Creek and Maxwells Creek, and also minor adjustments to the road crest to reduce the frequency of road closure. Whilst these measures may reduce the frequency of road closure, it is still likely to occur at relatively frequent intervals.

The potential upgrading of Cowpasture Road to prevent overtopping and road closure has recently been investigated by the RTA. It is understood that measures are proposed by the RTA, in conjunction with the proposed WSO highway, to reduce the frequency of overtopping of this road.

Most of the bridge crossings on Brickmakers Creek will benefit from the proposed detention basin at Amalfi Park, if subsequent investigations into the feasibility of this basin site prove satisfactory. However, it is still likely that the Orange Grove Road culvert will need to be amplified, as other proposed channel improvement works upstream of this culvert will result in additional flows being carried in the creek and additional flows that have to pass under the culvert (refer to **Appendix C** for further details). It is also recommended that consideration be given to updating the Elizabeth Drive culvert, although the actual size could vary pending the review of the Amalfi Park basin. Amplification of the Moore Street culvert should also be considered.

The current system for signposting road closures should also be reviewed. The SES consider that much of the road congestion which occurs during flood periods could be reduced by signposting road closures well before the actual closure point. For example, road closures on Hoxton Park Road should be notified at the Hume Highway. The additional signposting would allow motorists to select alternative routes well before reaching the closure point.

10.1.11 Construction of Levees to Protect Property

Minimal regrading to existing Tresalam Street levee recommended.

Levees are often used to prevent flooding of populated areas on the floodplain. However, in some circumstances they can make flooding worse for people outside or upstream of the levee, and can also give a false sense of security as overtopping or breaching of the levee can occur in large floods.

An existing levee has been built to provide protection to existing houses in the Tresalam Street area. There have been problems associated with this levee, including:

- inadequate allowance for drainage of the local area behind the levee;
- flood flows crossing Elizabeth Drive and entering the area “protected” by the levee; and
- whether the levee provides a sufficient level of protection.

Separate investigations have been undertaken for this area. Recommendations include, the construction of a small deflector levee in Blamfield Park to eliminate floodwaters spilling into the “protected” area, improvements to the capacity of the Elizabeth Drive bridge, and possible minor regrading of the height of the levee. An earlier investigation also recommended consideration of local flood pumps behind the levee to minimise internal drainage problems during large floods.

One of the benefits of the original proposal for Basin 22 was a reduction in downstream flows and therefore an increase in the level of protection afforded by the Tresalam Street levee. However, as only a reduced size basin is now likely to be constructed, the level of protection provided by the levee will remain unchanged. A comparison of a recent longitudinal survey of the levee crest with the most up-to-date design flood levels for this area [Water Research laboratory, 1998b] indicates that the levee provides protection to about the 100 year flood (without freeboard). Increasing the height of the levee is unlikely to provide further protection, as the deflector levee in Blamfield Park has been limited to the 100 year flood to avoid increases in upstream flood levels. Therefore, floodwaters are likely to inundate the area behind the Tresalam Street levee at about the 100 year flood from floodwater overtopping Elizabeth Drive, regardless of whether the Tresalam Street levee is raised or not. Some benefit would be obtained from installing an early warning system, in the form of an automated siren, to warn residents should potential overtopping of the levee become likely.

A levee has also previously been proposed further downstream at Garden Street. Again, Basin 22 was to significantly reduce flood problems experienced in this vicinity, and a levee was thought to be no longer required. With the smaller Basin 22 now proposed, further consideration of the Garden Street levee, or other measures such as house raising, may now need to be reconsidered.

10.2 MEASURES THAT MODIFY THE PROPERTY

10.2.1 Voluntary Purchase of the Most Flood-Liable Houses

Not generally recommended.

Under a voluntary purchase scheme, Council would offer to purchase flood liable properties if and when they became available for purchase, subject to the availability of funds at the time. Voluntary purchase is not compulsory acquisition and affected property owners can expect to receive market values, or higher than market values, for their properties (i.e. values assume no voluntary acquisition scheme is in place and disregards development constraints that may apply on that land due to its flood prone nature.

Voluntary purchase schemes, by their very nature, cannot be implemented immediately. To be successful, the majority of owners in the area need to take up the offer and a suitable allocation of funds must be available to purchase the properties. There needs to be an ongoing commitment from Council to continue to purchase properties into the future as they become available, in spite of changes to Council's elected officers and senior staff.

Only those houses that are subject to extreme flood hazard are usually considered for inclusion in voluntary purchase schemes. Such houses would typically be well below the 20 year ARI flood, or may be inundated by over 1m of floodwaters in a 100 year ARI flood. It is not anticipated that any houses in the catchment would experience flooding of this magnitude.

As well as residential properties, there are a number of commercial premises affected by flooding. State Government funding is not available for voluntary purchase of commercial properties, so Council would have to meet the full cost of these purchases if a voluntary purchase scheme involving commercial property was considered.

The cost of this option is high and does not address flooding problems elsewhere in the catchment. The nature of flooding is such that expenditure of this nature would be difficult to justify. In addition the option was not favoured by respondents to the community questionnaire.

10.2.2 Voluntary House Raising

Recommended for further consideration.

The raising of timber and fibro houses has proved to be an effective floodplain management option for various locations throughout NSW. Fairfield City Council has been implementing a successful house raising program in Prospect Creek for many years now, with over 100 house being successfully raised. House raising has also been carried out in the Lake Macquarie City Council area, and in other parts of northern New South Wales. It has also been proposed in several recently completed floodplain management plans, such as the Woronora River, Manly Lagoon and Wyong River floodplain management plans.

There are various forms of house raising schemes that can be considered. Obviously, the easiest form of house raising will be where houses are of either timber or fibro construction. Experience by Fairfield Council in Prospect Creek has shown that most houses can be raised by 1-2m for a cost typically in the range of $40,000 to $80,000.

Where houses are of a brick veneer, or full brick construction, the physical raising of these houses will be more costly, and in most cases impractical. Under these circumstances, variations to the traditional house raising concept may need to be considered. One solution is to build a first floor extension on top of the existing building, and convert the lower floor to a non-habitable form. A disadvantage of this option is that there will be a temptation by the owner to occupy both floors, and the objective of minimising flood damage may be lost. A second solution is to completely rebuild the house at higher level, which may or may not be accompanied by a change in home ownership. With a change in home ownership, Council would acquire the property (if offered for sale), demolish the existing house, and sell the vacant building lot with appropriate floor level controls. Typical net costs for these options are likely to range from $60,000 to $80,000 per house.

The State Government has provided two forms of financial subsidy for house raising schemes in the past. The usual form of the scheme involves a subsidy based on the full cost of house raising, where this is shown to be economically justified. This is generally the case for timber or fibro houses that are located below or close to the 20 year ARI flood level. In some other cases, a partial subsidy limited to $10,000 has been offered, with the homeowner expected to pay the difference in cost. The alternative scheme can be useful for houses where there is marginal economic flood benefit from house raising, either because the house is flooded infrequently or because it is expensive to raise.

There are various disadvantages associated with house raising, for example:

- steps to gain access to the house may not be suitable for older people or those with disabilities;
- other property damage within the property, e.g. damage to parked cars and equipment, may still occur;
- after raising, residents may 'close in' any downstairs area to create further habitable areas (without Council approval) and thus increase future damage potential;
- there may be aesthetic and town planning restrictions associated with raising some houses. For example, isolated raising of some properties in a street may not be appropriate, and it may be necessary to raise a group of properties in a street.

The above problems aside, a number of houses in Cabramatta Creek would benefit from house raising. Whilst final lists are still to be determined, they are likely to include residential homes that are below the 100 year flood in Lower Cabramatta Creek, on both the Fairfield and Liverpool Council areas.

A preliminary list of property that could be considered by Fairfield Council is provided in Appendix D. A property list for Liverpool Council is still to be formulated.

10.2.3 Flood-Proofing of Individual Residential and Business Properties

Recommended for further consideration.

Individual properties can be modified to reduce the impacts of flooding by the construction of flood retaining walls outside the house (similar to levees in function), waterproofing walls of houses and by placing shutters across doors and other openings. This option would be most effective for short duration floods as extended periods of inundation would increase the likelihood and extent of leaks through the waterproofing measures.

Properties which may be suited to flood proofing are largely limited to commercial properties. Flood-proofing options may be appropriate for Liverpool Catholic Club where the floor level is only just above the 100 year flood level. This could be in the form of landscaping mounds and/or speed humps about 0.3-0.5m high around the perimeter of the building, supplemented by readily available sandbagging equipment. Other properties that could benefit include a number of unit blocks in Brickmakers Creek which have ground floor levels or entry foyers just below the 100 year ARI flood level.

For such measures to be effective when the premises are unattended, it would be necessary for flood gates and similar structures to be erected. It is recognised that this may be a labour intensive process and therefore owners may only erect these structures when wet weather is imminent. As many flood events may occur in the night or on weekends, such measures could not be relied upon to provide total protection for commercial properties.

The works could be at no cost to Council, or with some Council contribution.

10.2.4 Relocation of Flood Liable Houses to Areas of Higher Ground

Not recommended for further consideration.

This can be considered as a special form of house raising, except it also involves a relocation of the house to higher ground. It may sometimes be possible to move the house to higher ground within the property boundaries, although in most cases there will not be sufficient area of high ground for this purpose. More usually it involves the relocation of the house to a new vacant property, which could be in the same street, or possibly a nearby street.

Such a scheme was successfully implemented by Lake Macquarie City Council in the early 1980's. It involved Council acquiring vacant flood free lots in several streets where there were flooding problems, and arranging a “land swap” with owners of flood liable houses in the same street. This allowed the flood liable houses to be relocated further up the street, away from the river. The flood liable lots then passed into Council’s ownership.

It is unlikely that a similar scheme will be successful in Cabramatta Creek, as only a few of the existing houses would be suitable for relocation, there are limited vacant lots within the existing developed area, and the cost of acquiring flood free vacant lots in the study area would be high.

10.2.5 Building and Development Controls

Recommended for further consideration.

Land use planning and development controls are key mechanisms by which Council can manage flood affected areas within the Cabramatta 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.

A review of flood related planning controls in Cabramatta Creek has been presented in **Section 8**. Specific amendments to existing planning controls have been proposed, and a revised floodplain management policy for both Councils has been recommended.

A ‘planning matrix’ approach forms the main basis of the proposed floodplain management policy, which is proposed to be adopted as a development control plan for each Council. The planning matrix provides guidance as to the location and appropriate land uses within the floodplain. These planning matrices should be monitored and reviewed and updated as future floodplain management plans are prepared, or existing ones reviewed.

A brief summary of the principal findings and recommended planning measures is provided below:

- a graded set of planning controls to be applied to the study area (as proposed in the planning matrix in **Figure 10.5**) which are tailored to the proposed land use and flood level, and which recognise flood risks up to and including the PMF;

- amendments to Local Environmental Plans (in particular major consolidating planning instruments) applicable to the study area to contain objectives to restrict development in high hazard areas, and control the form of development in the floodplain to ensure it is compatible with flood risk;

- a proposed flood prone land policy to be adopted by both Councils for the catchment, as a Development Control Plan in accordance with the EP&A Act.

Figure 10.3
Proposed Planning Matrix for Cabramatta Creek

Planning & Development Controls

Templat V4.0

Planning Consideration	Flood Risk Precincts (FRP's)																			
	Low Flood Risk								Medium Flood Risk								High Flood Risk							
	Critical Uses & Facilities	Sensitive Uses & Facilities	Subdivision	Residential	Commercial & Industrial	Tourist Related Development	Recreation & Non-Urban	Concessional Development	Critical Uses & Facilities	Sensitive Uses & Facilities	Subdivision	Residential	Commercial & Industrial	Tourist Related Development	Recreation & Non-Urban	Concessional Development	Critical Uses & Facilities	Sensitive Uses & Facilities	Subdivision	Residential	Commercial & Industrial	Tourist Related Development	Recreation & Non-Urban	Concessional Development
Floor Level		3		2,6,7	5,6,7	2,6,7	1,6	4,7				2,6,7	5,6,7	2,6,7	1,6	4,7							1,6	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 & 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 & 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 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 "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 erection 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. 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 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,* or a *PMF* if required to satisfy evacuation criteria (see below).
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,* or a *PMF* if required to satisfy evacuation criteria (see below). 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 engineers 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.

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	Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest *habitable floor* level to an area of refuge above the *PMF level*, or a minimum of 20% of 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*.
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.

10.3 MEASURES THAT MODIFY THE RESPONSE TO FLOODING

10.3.1 Improved Flood Warning

Recommended for further consideration.

Actual flood damages can be reduced if there is sufficient warning time for the community to take appropriate damage reduction measures.

10.3.1.1 Role of Bureau of Meteorology

The Bureau of Meteorology is the government agency responsible for issuing flood warnings throughout Australia. Dissemination of flood warning and action to evacuate or otherwise assist people in the event of flooding is the responsibility of the State Emergency Services (SES).

As the Bureau's resources are limited, they are only able to provide a complete flood warning service in those catchments that would benefit most from these warnings. As a general guide, the Bureau will only provide a formal flood warning service in catchments where there is likely to be at least 6 hours warning of impending flooding. Whilst this is the case for the Georges River, the response time to flooding in Cabramatta Creek is likely to be much more rapid due to its smaller catchment size.

The Bureau of Meteorology provides a formal flood warning service for the Georges River, with the main reference point being the Liverpool weir. Whilst these flood warnings will be a benefit to residents in Lower Cabramatta Creek, who can be affected by backwater flooding from the Georges River, there is no other site specific flood warning advice issued within the Cabramatta Creek catchment.

The Bureau also provides a range of meteorologically-based warning services, including:

I. ***Flood Watches*** – typically provide 24 to 48 hour notice. These are issued by the NSW Flood Warning Centre and are a "heads up" that flooding is possible based upon current catchment conditions and future rainfall that is predicted by computer models of the atmosphere.

II. ***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 an analysis of the synoptic situation.

III. ***Severe Weather Warnings***. For synoptic scale events that can 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, including Cabramatta and Prospect Creeks.

10.3.1.2 Issues for Cabramatta Creek

Whilst the response time to flooding in Cabramatta Creek is low, and typically of the order of 2-3 hours, it would nevertheless benefit from a flood warning system for the lower to middle part of the catchment, where most of the existing flood problems are

encountered. The existing procedures could be augmented with a separate flood warning system specially designed for Cabramatta Creek. This is particularly important if a large detention basin, such as Basin 22, is built towards the middle of the catchment. The system could monitor water levels within the basin, in addition to catchment rainfall, and provide flood warnings for residents in the lower catchment. A key feature of the warning system would be a prediction on the likelihood of overtopping of the basin spillway, which is likely to occur in floods greater than a 100 year ARI event.

Given the short time between rainfall and flooding, an improved flood warning system for Cabramatta Creek should strategically incorporate the meteorologically-based warning services provided by the Bureau of Meteorology. Installation of an "Alert" system that incorporates a number of rain and river height recorders with telemetry equipment to transfer the data in real time to a base station could also be considered. A personal computer at the base station would record the data, and with the aid of several algorithms provide a prediction of future flood conditions. The base station could warn of impending flooding through the sounding of one or more sirens, or through automated telephoning of advice to SES Officers or other key individuals.

Whilst the Bureau will provide assistance in installing and maintaining the necessary rain gauges, Council would be responsible for the river gauges and base station. Existing river gauges on Cabramatta Creek at the Hume Highway (Manly Hydraulics Laboratory), and at Orange Grove Road (Department of Land and Water Conservation) could be incorporated in the system at little cost to Council. The SES would have the main responsibility for receiving and disseminating flood warnings, as well as organising evacuations and other emergency response management activities.

As a minimum, it is recommended that an automated flood siren be installed in the Tresalam Street levee area, to warn residents prior to potential overtopping of the levee.

10.3.1.3 Composition of Proposed Warning Scheme

Components of the flood warning scheme are likely to include:

- two new rain gauges located in Upper Cabramatta Creek and Hinchinbrook Creek ($10,000);
- one rain/river station inside Basin 22 ($20,000);
- conversion of existing river stations at Orange Grove Road and Hume Highway ($5,000);
- base station with computer ($10,000); and
- software development ($5,000).

The total cost of the above system is estimated to be $50,000, with maintenance costs estimated as $5,000 per annum.

Further discussions between both Councils, the Bureau of Meteorology, SES, and the DIPNR are recommended to establish a preferred flood warning system for Cabramatta Creek, and to establish sources of funding and responsibilities for the system.

10.3.2 Improved Evacuation Procedures and Emergency Assistance

Recommended for further consideration.

The SES is the State's 'combat' agency for flooding and fulfils a vital role in emergency planning and management.

As part of the current study, the SES has been made aware of the existing flood problems in the study area and has participated in the floodplain management committee meetings held to discuss potential floodplain management options. Further details of the frequency and depth of inundation of arterial roads throughout the catchment will shortly be provided to the SES, together with details of the most severely affected properties.

These measures will assist the SES develop an improved Local Flood Plan for Cabramatta Creek, comprising preparedness measures, the conduct of response operations, and the coordination of immediate recovery measures.

The SES will also fulfil an important role in the development and operation of the flood warning system proposed for Cabramatta Creek. Continued and increased cooperation with the SES, such as that initiated during the current study, will have significant benefits to Cabramatta Creek.

10.3.3 Flood Awareness Programs

Recommended for further consideration

Actual flood damages can be reduced if community awareness of flood issues is raised.

The last significant floods that occurred in Cabramatta Creek were the 1986 and 1988 flood events. Whilst community awareness of flooding would have been high immediately following these floods, much of this awareness will have faded over the subsequent years. There will also be a significant number of new residents that have since moved into the catchment, who have probably never experienced a flood, at least not in Cabramatta Creek. Thus the community awareness of the risks of flooding in Cabramatta Creek is now likely to be limited. This conclusion is also supported by results from the community questionnaire, which indicated that 58% of residents that live close to the creek have received no information about flooding.

The development and implementation of an effective flood awareness and education program in the study area has the opportunity to improve the knowledge and experience of residents to mitigate flood hazards. A flood awareness and education program is proposed that incorporates the following components:

- **Updating Section 149 Certificates**. The questionnaire responses indicate that only 5% of residents have obtained information about flooding at their property from Council. Council should continue to advise prospective property purchasers that a property is flood liable by notification on Section 149(2) certificates. These certificates should be updated from information from the current flood study modelling. In addition, a proposed flood certificate (discussed below) could be appended to the Section 149(2) certificate;

- **Issuing Flood Certificates**. A flood certificate issued to individual property owners would inform them of the flood situation at their particular property. This certificate would contain vital information such as the expected flood levels in a range of storm events. When combined with ground levels and floor levels, depths of flooding over the property could be determined. It could be issued with Council rates notices on either a yearly or biennial basis. The community questionnaire indicated that most people in the catchment (71%) were in favour of flood certificates being issued. In fact, this measure was the third most popular flood mitigation measure supported by the community.

- **Community Education Programs**. Contact with local schools and community groups is an excellent means of improving community education of flooding issues. A prime example is the "flood icon" project undertaken by Fairfield City Council for Prospect Creek. This program involved schools and other groups in a competition to design an appropriate reminder of past floods, to be constructed in one of the local parks. The project received an Institution of Municipal Engineers Australia award. Other programs could include talks given by Council staff and handouts containing general flood information. Public displays on flooding could be set up in public buildings such as the Council chambers, library or shopping centre. Such displays could contain information about the Floodplain Management Plan as well as information from the SES;

- **Construction of Flood Markers**. Flood markers act as reminders of the height of previous floods. The marking of past flood levels on telephone poles (or on specially constructed flood totem poles) will also provide constant reminders of flooding risks. Appropriate locations for flood markers include parks or reserves which are readily accessible by the general public. They should be clearly visible both prior to flooding and during flood events.

For the flood awareness program to be successful and cost-effective, it should be implemented by both Councils over the whole catchment. To ensure the program is on-going, responsibilities need to be identified and allocated to key individuals within each Council.

Such a program could cost approximately $100,000 to develop and implement, and about $10,000 per annum to maintain.

10.3.4 Encouraging Flood Action Plans for Residents and Business Owners

Recommended for further consideration.

Flood action plans comprise instructions for people at individual properties telling them what they should do before, during and after a flood, where they should go and who they should contact if there is a flood. They may be formulated for single residential properties or may apply to blocks of units or town houses. They could also be developed for commercial properties located within the catchment.

The plans would be simple instructions, similar to those for fire emergencies or first aid, and would be posted at noticeable locations within buildings.

TABLE 10.3 SUMMARY OF FLOODPLAIN MANAGEMENT OPTIONS — QUALITATIVE ASSESSMENT MATRIX (1999 Draft Report)

OPTION NO.	DESCRIPTION OF OPTION	AIM OR CRITERIA OF OPTION	COMMENTS AND RELATIVE SCORE FOR EACH CRITERIA									RECOMMENDED FOR INCLUSION IN PLAN
			Financial feasibility	Economic merit	Community acceptance	Environmental Impacts	Impacts on flood behaviour	Consequences in extreme flood	Reduction in number of buildings flooded in 100 yr ARI flood	Technical feasibility / difficulty	Administrative / political / legal impacts	
1	**OPTIONS WHICH MODIFY FLOOD BEHAVIOUR**											
1.1	Clearing the creek of rubish, debris, Exotic vegetation and man made obstructions	Improve creek conveyance and to avoid the exacerbation of flooding over time	$0.3M + +	O	+ +	+ +	+	+	+	+ +	+	yes
1.2	Developing an urban bushland management program for the creek corridor	To preserve and improve the ecological and aesthetic quality of the creek corridors, and maintain the conveyance capacity of the creeks	$0.1M + +	O	+ +	+ +	O	O	O	+ +	+	yes
1.3	Restoring the creek to a more natural looking condition	Improve aesthetic quality of the creek system	n.a – –	– –	+	+ +	– –	–	–	–	O	no
1.4	Enlarging the creek by widening or deepening -											
	Maxwells Ck between Jedda Rd and Kurrajong Rd	Improve creek conveyance to lower flood levels	$1.4M –	O	– –	– –	–	–	+	O	O	no
	Maxwells Ck between Kurrajong Rd and Camden Valley Way	Improve creek conveyance and tie in with other proposals	$2.0M O	O	O	O	+	O	O	+	O	yes
	Elizabeth Drive bridge	Improve flow of water under Elizabeth Drive Bridge	$0.1M + +	+	+	O	+	+	+	+	O	yes
1.5	Construction of bypass channels or floodways											
	Extend existing floodway from Miller TAFE college to Creek A, including into Lower Hinchinbrook Ck	Lower flood levels and prevent the Wilson Road flood breakout	$12M – –	– –	–	– –	+ +	+	+ +	–	O	no
	Floodway channel across Orange Grove Golf Course	Improve conveyance of floodwaters to high level culverts under Orange Grove Rd	$0.4M +	+	O	–	+	+	+	+	O	yes
	Floodway channel upstream of Main Southern Railway	Lower flood levels upstream of Main Southern Railway	$0.1M +	O	O	–	O	O	O	+	O	no
1.6	Straightening sections of Maxwells Ck or lining with rock, gabions or concrete	Reduce extent of flooding between Hoxton Park Road and Jedda Road	$20M – –	– –	– –	– –	+	O	+	–	O	no
1.7	Investigate major flood mitigation works for the Georges River (investigation only at this stage)	Major works could lower flood levels in Lower Cabramatta Creek by up to 1.0m	$0.2M +	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	O	yes
1.8	Construction of upstream dams or detention basins											
	Basin 3B	Mitigates impact of upstream development	$0.6M O	+	O	+	+	O	+	+	O	yes
	Basin 12	Mitigates impact of upstream development	$2M O	+	O	+	+	O	+	+	O	yes
	Basin 14	Mitigates impact of upstream development	$0.4M O	+	O	O	+	O	+	+	O	yes
	Basin 18	Mitigates impact of upstream development and Western Sydney Orbital	$4.1M O	+	O	+	+	O	+	+	O	yes
	Basin 22	Mitigates impacts of upstream development, Western Sydney Orbital, and existing flood problems in Lower Cabramatta Ck	$14M +	+	O	+	+ +	O	+	–	O	yes
	Amalfi Park Basin	Reduces existing flood problems in Brickmakers Creek	$1.4M +	+	O	O	+	O	+	+	O	yes
1.9	Enlarging Bridges and culverts to improve their flood conveyance	Enlarge Main Southern Railway to reduce upstream flood levels	$6.5M – –	– –	O	–	O	O	O	O	O	no

TABLE 10.3 SUMMARY OF FLOODPLAIN MANAGEMENT OPTIONS — QUALITATIVE ASSESSMENT MATRIX (1999 Draft Report)

OPTION NO.	DESCRIPTION OF OPTION	AIM OR CRITERIA OF OPTION	COMMENTS AND RELATIVE SCORE FOR EACH CRITERIA									RECOMMENDED FOR INCLUSION IN PLAN
			Financial feasibility	Economic merit	Community acceptance	Environmental Impacts	Impacts on flood behaviour	Consequences in extreme flood	Reduction in number of buildings flooded in 100 yr ARI flood	Technical feasibility / difficulty	Administrative / political / legal impacts	
1.10	Improving flood access of roads by culvert amplification and/or road raising											
	Cabramatta Ck - Hoxton Park Rd	Improve trafficability up to 100 year ARI flood	$1.0M +	O	+	O	O	O	O	+	O	yes
	Hinchinbrook Ck - Hoxton Park Rd	Improve trafficability up to 100 year ARI flood	$0.5M +	O	+	O	O	O	O	+	O	yes
	Maxwells Ck - Hoxton Park Rd	Improve trafficability up to 100 year ARI flood	$0.5M +	O	+	O	O	O	O	+	O	yes
	Maxwells Ck - Jedda Rd	Improve trafficability up to 100 year ARI flood	$0.5M +	O	+	O	O	O	O	+	O	yes
	Brickmakers Ck - Moore St	Improve trafficability up to 100 year ARI flood	$0.3M +	O	+	O	O	O	O	+	O	yes
1.11	Construction of levees to protect property	Minor regrading of top of Tresalam Street levee to provide consistent freeboard	$0.2M +	+	O	O	O	O	+	+	O	yes
2	OPTIONS WHICH MINIMISE THE DAMAGE BY MODIFYING THE PROPERTY											
2.1	Voluntary purchase of severely flood affected properties	Purchase & demolition of residential properties which are severely flood affected (up to 20 houses)	$4.0M – –	– –	–	+	O	+ +	+	O	O	no
2.2	Voluntary House Raising	Modify existing houses so that floor levels are raised to above the 100 year flood level (up to 50 houses)	$2M –	–	O	O	O	+	+	O	O	yes
2.3	Flood proofing of individual properties	Reducing the impacts of flooding on individual properties by waterproofing walls, putting shutters across doors and using materials that are relatively unaffected by submersion etc.	No cost to Council n.a.	n.a.	–	O	O	+	n.a.	O	O	yes
2.4	Relocation of flood liable houses to areas of higher ground	Similar to house raising, but also involving relocation to a higher site	Not available –	– –	O	+	O	+ +	+	O	–	no
2.5	Building and development controls	Controlling future impacts, for example by setting minimum floor levels for future development and extensions to existing dwellings	No capital cost n.a.	n.a.	+ +	O	+	+ +	n.a.	+ +	–	yes
3	OPTIONS WHICH MODIFY PEOPLE'S RESPONSE TO FLOODING											
3.1	Improved flood warning systems	To provide an indication to the SES, Council or the Police of conditions likely to cause flooding.	$0.05M +	n.a.	+ +	O	O	+	O	+	–	yes
3.2	Improved evacuation procedures and emergency assistance	SES to upgrade current emergency assistance plans	No capital cost n.a.	n.a.	+ +	O	O	+	O	+	O	yes
3.3	Flood awareness Programs	To make the public more aware of flooding issues	$0.15M +	n.a.	+ +	O	O	+	O	+	–	yes
3.4	Preparation of flood action plans for individual properties	To tell residents WHAT they should do, WHERE they should go and WHO they should contact if there is a flood	No capital cost n.a.	n.a.	+ +	O	O	+	O	+	O	yes

Notes: For description for relative scores for each criteria refer to Table 13b.
n.a. = not assessed, not available or not applicable.

TABLE 10.4 EXPLANATION OF ASSESSMENT SCORES FOR QUALITATIVE ASSESSMENT MATRIX

CRITERIA	– –	–	O	+	+ +
FINANCIAL FEASIBILITY	Very unlikely to receive funding	May not receive funding	Neutral	Would possibly receive funding	Very likely to receive funding
ECONOMIC MERIT	B/C less than 0.1	B/C = 0.1–0.3	B/C = 0.3–0.7	B/C = 0.7–1.0	B/C greater than 1.0
COMMUNITY ACCEPTANCE	Strongly against	Generally against	Neutral	Some support	Strongly supported
ENVIRONMENTAL IMPACT	Significant negative impact	Some negative impact	No impact	Some positive impact	Significant positive impact
IMPACT ON FLOOD BEHAVIOUR	Significantly increase flood levels and/or velocities	Some increase in flood levels and/or velocities	No change	Some reduction in flood levels and/or velocities	Significantly reduces flood levels and/or velocities
PERFORMANCE DURING LARGE FLOODS	Significantly increases risk	Some increase in risk	No change in risk	Some reduction in risk	Significant reduction in risk
TECHNICAL FEASIBILITY	Very difficult	Difficult	Neutral	Easy	Very easy and straight forward
POLITICAL/ ADMINISTRATIVE / LEGAL IMPACT	Significant changes required which are very unlikely to be supported	Some changes required which may not be supported	No changes or impact	Some changes required are likely to be supported	Significant changes required which are likely to be strongly supported

B/C = Benefit Cost Ratio

11. RECOMMENDED FLOODPLAIN MANAGEMENT PLAN

A draft floodplain management plan showing preferred floodplain management measures for Cabramatta Creek is presented in this Chapter. The preferred measures have been determined from the range of available measures that were discussed in **Sections 9** and **10**, after an assessment of the impacts on flooding, as well as environmental, social, and economic considerations.

Measures that were originally assessed in the draft floodplain management study [Bewsher Consulting, 1999] have been re-evaluated in light of more recent evaluations and other changes within the catchment, including the reduced size of Basin 22 and other changes associated with the proposed WSO highway.

The draft Floodplain Management Plan is presented in **Table 11.1**, and is also represented on **Figure 11.1**. The principal components of the Plan are discussed below.

Timing of the proposed works will depend on each Council's overall budgetary commitments, and the availability of funds from other sources. Funding will be available through a number of sources, as identified in **Table 11.1**. Components of the Plan will be able to be carried out directly by either Liverpool Council or Fairfield Council, whilst other components that affect both Council areas will need to be carried out jointly.

11.1 OPTIONS WHICH MODIFY FLOOD BEHAVIOUR

The major structural option that is recommended for the Cabramatta Creek catchment is a revised new release area detention basin strategy for Liverpool City Council. This basin strategy is principally aimed at ensuring that new release area development does not increase flooding elsewhere in the catchment. This includes the construction of Detention Basins 3B, 4, 6, 11C, 12, 14, and a major component of the dual purpose Council/WSO Basin 18.

The WSO component of Basin 18, in addition to a reduced size Basin 22 and Government Road Basin will provide compensatory storage for the proposed WSO highway. Design and funding for the three basins have been included as part of the WSO project.

In addition, a new basin has been proposed in Brickmakers Creek at Amalfi Park. The objective of this basin is to reduce existing flood problems in Brickmakers Creek below the basin site, in conjunction with other channel improvement measures. Further detailed modelling of Brickmakers Creek, between Amalfi Park and Memorial Avenue, is recommended to fully evaluate these measures.

Channel works are included in the Plan on Maxwells Creek, upstream of Kurrajong Road. These works are to replace a small artificial channel that currently exists by a more "natural" watercourse, incorporating part of the detention storage requirements for Basin 18. A concept design report for these works was recently undertaken, and further detailed design is anticipated to be included in the WSO project.

There are a number of arterial roads throughout the catchment which are affected by flooding, and which result in traffic disruption and other access difficulties during relatively minor floods. The RTA has recently commenced upgrading Hoxton Park Road in the vicinity of the Cabramatta Creek and Maxwells Creek crossing. Whilst these works will reduce the frequency of overtopping of this road, it can not be expected to eliminate flooding problems along the road. To do so would require significant raising of the road, which would then likely result in an adverse impact on nearby properties. Raising of Cowpasture Road is also currently being considered by the RTA in conjunction with the WSO project.

Culvert amplification on Brickmakers Creek at Orange Grove Road, Elizabeth Drive and Moore Avenue have been recommended as part of subsequent investigations (**Appendix C**).

A package of flood mitigation works has been developed in the Elizabeth Drive area to reduce flooding problems experienced in the Tresalam Street area. The works include the construction of a low embankment upstream of Elizabeth Drive to prevent floodwaters overtopping this road and entering the area "protected" by the Tresalam Street levee. Compensatory measures for this embankment include improvements to the waterway area under Elizabeth Drive and the removal of debris and selected exotic vegetation from the creek corridor. The installation of pumps behind the Tresalam Street levee has also been recommended in other studies to reduce local drainage problems. There is little benefit in raising the Tresalam Street levee, which provides a level of protection close to the 100 year flood (with no freeboard), as overtopping from Elizabeth Drive is expected to occur at the 100 year flood level. However, an automated flood warning siren is recommended to provide residents with added warning prior to potential overtopping of the levee.

A number of individual bushland management reports have been prepared for particular areas of Cabramatta Creek. Development of an overall bushland management program covering Cabramatta Creek, Hinchinbrook Creek, Upper Cabramatta Creek, Maxwells Creek and Brickmakers Creek is recommended in the floodplain management plan. An initial program to clear the creek corridors of existing debris and other man-made obstructions is also included in the Plan.

The potential to lower flood levels in the Georges River, and consequently the lower reaches of Cabramatta Creek, is the subject of concurrent investigations. This Plan encourages further consideration of such flood mitigation works on the Georges River.

11.2 PROPERTY MODIFICATION OPTIONS

The options described above improve flooding in the Cabramatta Creek catchment, however, 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, a number of property modification options are proposed to provide the extra level of protection required within the catchment.

Voluntary house raising is proposed as part of the Cabramatta Creek Floodplain Management Plan for those residential property that are below the 100 year ARI flood

after other flood mitigation measures are implemented. Further review of the properties to be included in both schemes should be undertaken prior to establishing final lists.

Floodproofing 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.

Controls on new development and redevelopment at residential/commercial properties will ensure that the flooding problem is not made worse and that the development itself is not affected by flooding. A review of flood related planning controls has been undertaken for Cabramatta Creek. Specific amendments to existing planning controls are recommended as part of the floodplain management plan, and a revised floodplain management policy is proposed.

A "planning matrix" approach forms the main basis of the proposed floodplain management policy, which is proposed to be adopted as a development control for both Councils (**Figure 10.5**). The planning matrix provides guidance as to the location and appropriate land uses within the floodplain.

11.3 OPTIONS WHICH MODIFY PEOPLE'S RESPONSE TO FLOODING

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

Key features of the proposed flood awareness program include:

- Updating Section 149 Certificates;
- issuing flood certificates to property owners on a regular basis;
- establishing a community education program; and
- installing flood markers to act as reminders of the height of previous floods.

An improved flood warning system for Lower Cabramatta Creek is included in the floodplain management plan. This could provide additional warning time typically of 2-3 hours, allowing the community to undertake some damage reduction measures, thereby reducing actual flood damages. It is likely that the warning system would be developed in conjunction with the construction of Basin 22.

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.

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.

Table 11.1 Recommended Floodplain Management Measures

Item	Description	Responsibility	Capital Cost ($Mill)*	Maintenance Cost($000)	Source of Funds	Priority
	Measures that Modify the Flood					
1	Liverpool Council Detention Basin Strategy					
	• Basin 3B	LCC	0.6	5	S94	high
	• Basin 4	LCC	1.8	10	S94	medium
	• Basin 6	LCC	1.1	5	S94	medium
	• Basin 11C	LCC	0.4	5	S94	high
	• Basin 12	LCC	2.1	10	S94	high
	• Basin 14	LCC	0.3	5	S94	high
	• Basin 18 (included as dual purpose WSO basin)	RTA	N/A	N/A	RTA	high
2	WSO Compensatory Flood Storage Basins					
	• Basin 18	RTA	N/A	N/A	RTA	high
	• Basin 22	RTA	N/A	N/A	RTA	high
	• Government Road Basin	RTA	N/A	N/A	RTA	high
3	Amalfi Park Detention Basin (Brickmakers Ck) and/or channel improvement measures	LCC	1.4	5	LCC/DIPNR	medium
4	Additional 2D computer modeling of Brickmakers Creek, including review of flood mitigation options (Memorial Ave to Amalfi Park)	LCC	0.1	Nil	LCC/DIPNR	high
5	Brickmakers Creek FM Works (Homepride Ave to Memorial Ave)					
	• Creek rehabilitation	LCC	1.9	5	LCC/DIPNR	medium
	• Upgrade Orange Grove Road Culvert	LCC	0.4	Nil	LCC/DIPNR	high
	• Upgrade Elizabeth Road Culvert	LCC	0.6	Nil	LCC/DIPNR	high
	• Channel improvements (Orange Grove Rd to Elizabeth Dr)	LCC	2.0	5	LCC/DIPNR	high
	• Floodwall to prevent overflows to CBD area	LCC	0.1	Nil	LCC/DIPNR	medium
6	Maxwells Ck channel works (Kurrajong Rd to Camden Valley Way)	RTA	N/A	N/A	RTA	high
7	Culvert amplification/road raising to improve access					
	• Hoxton Park Road (Cabramatta Creek)	RTA	1.0	Nil	RTA	Completed
	• Hoxton Park Road (Hinchinbrook Ck)	RTA	0.5	Nil	RTA	Completed
	• Hoxton Park Road (Maxwells Ck)	RTA	0.5	Nil	RTA	Completed
	• Jedda Road (Maxwells Ck)	LCC	0.5	Nil	LCC/DIPNR	medium
	• Moore Street (Brickmakers Ck)	LCC	0.3	Nil	LCC/DIPNR	medium

Item	Description	Responsibility	Capital Cost ($Mill)*	Maintenance Cost($000)	Source of Funds	Priority
8	Works at Elizabeth Drive • Construction of low embankment upstream of Elizabeth Dr, improve effective waterway area under bridge, removal of rubbish and selective clearance of exotic vegetation • Install pumps for local drainage behind levee (subject to evaluation) • Install automated flood warning siren (subject to evaluation)	FCC/LCC FCC FCC	0.7 0.4 0.1	2 4 Nil	FCC/DIPNR FCC/DIPNR FCC/DIPNR	Completed medium medium
9	Develop an urban bushland management plan for existing creek corridors (Cabramatta Ck, Hinchinbrook Ck, Brickmakers Ck)	LCC/FCC	0.1	Nil	LCC/FCC/DIPNR	high
10	Clear Creek of existing debris and other man-made obstructions	LCC/FCC	0.3	3	LCC/FCC/DIPNR	high
11	Further investigation of flood mitigation works on the Georges R.	LCC/FCC	N/A	Nil	N/A	Completed
	Measures that Modify the Property					
12	Voluntary House Raising • Liverpool City Council • Fairfield City Council	 LCC FCC	 TBA TBA	 Nil Nil	 LCC/DLWC FCC/DLWC	 low high
13	Flood proofing individual commercial properties • Liverpool City Council • Fairfield City Council	 Individual owners	 N/A N/A	 Nil Nil	 N/A N/A	 medium medium
14	Improve existing building and development controls	LCC/FCC	Nil	Nil	N/A	high
	Measures that Modify People's Response to flooding					
15	Flood Awareness Program • Updating Section 149 Certificates • Issue flood certificates to property owners on regular basis • Establish a community education program • Install flood markers to remind of previous floods	 LCC/FCC LCC/FCC LCC/FCC LCC/FCC	 Nil Nil 0.1 0.05	 Nil Nil 10 1	 N/A N/A LCC/FCC/DIPNR LCC/FCC/DIPNR	 high high medium medium
16	Improve flood warning before and during floods	LCC/FCC	0.05	5	BoM/LCC/FCC	medium
17	Improve evacuation procedures and emergency assistance	LCC/FCC	Nil	Nil	N/A	medium
18	Prepare flood action plans for individual properties	LCC/FCC	Nil	Nil	N/A	Medium
	TOTAL		**17.4**	**80**		

* Costs exclude land acquisition, and voluntary house raising costs (to be advised)

FIGURE 11.1

Develop Urban Bushland Management Plans.
Clear Creeks of Rubbish

Culvert amplification/Road raising works
to improve flood access at various locations

Elizabeth Drive works including
upstream wall and waterway improvements
(COMPLETED)

Install Flood Warning Siren
for Residents of Tresalam St

Construct Detention
Basin No.3b

Construct Detention
Basin No.4

Construct Detention
Basin No.6

Construct Government
Road Basin
(Included in W.S.O.)

Construct reduced size
Detention Basin No.22
(Included in W.S.O.)

Construct Detention
Basin No.11c

Construct Detention
Basin No.12

Construct Detention
Basin No.14

Creek Rehabilitation
Orange Grove Rd - Homepride Ave

Upgrade Orange Grove Rd Culvert

Channel Improvement Works and Floodwall
Orange Grove Rd - Elizabeth Drive

Upgrade Elizabeth Drive Culvert

Establish revised 2D Model
and review potential options
(Memorial Ave to Amalfi Park)

Construct Amalfi Park
Detention Basin

Maxwells Creek Channel
Improvement Works
(Included in W.S.O.)

Construct Detention Basin No.18
Dual Purpose W.S.O./Council Basin
(Included in W.S.O.)

Further investigate flood mitigation
works on the Georges River
(COMPLETED)

Measures that Modify Property

- Voluntary House Raising
- Flood Proofing Commercial Buildings/Units
- Improved Building and Development Controls

Measures that Modify People's Response

- Comprehensive Flood Awareness Program
- Improved Flood Warning System
- Improved Evacuation Procedures
- Preparation of Flood Action Plans

LEGEND

- Catchment Boundary
- Local Government Boundary
- Existing Detention Basin
- Proposed Detention Basin

0 1 2km
Scale

RECOMMENDED FLOODPLAIN MANAGEMENT PLAN

CABRAMATTA CREEK FLOODPLAIN MANAGEMENT STUDY

FLOODPLAIN MANAGEMENT CONSULTANTS

BEWSHER CONSULTING PTY LTD
UNIT 6, 28 LANGSTON PLACE
EPPING NSW 2121
P.O.BOX 352
EPPING NSW 1710
A.C.N. 003 137 068
Phone: (02) 9868 1966
Facsimile (02) 9868 5759
Email : postmaster@bewsher.com.au

Plot file name: J1150-fig11.1
Plot scale 50 (=1:50000 @ a3)
Date : May 2004

11.4 FUNDING AND IMPLEMENTATION

Liverpool City Council is currently collecting Section 94 Contributions from development within the new release areas, which is required for drainage and other compensatory flood mitigation measures necessary as a result of this development. Components of the Cabramatta Creek Floodplain Management Plan required for this purpose include the construction of Basins 3B, 4, 6, 11C, 12, 14 and part of Basin 18. Whilst a number of detention basins have already been constructed through this source of funding, it is now appropriate to revise the amount of Section 94 Contributions that are being collected in view of the revised detention basin strategy presented in this Plan.

The Roads and Traffic Authority (RTA) or the consortium selected to design/construct/manage the WSO project, are another source of funding towards implementation of part of the floodplain management plan associated with these works. The RTA would be required to contribute to all or part of the costs for the Government Road Basin and Basins 18 and 22, which will be required to compensate for loss in floodplain storage along Maxwells Creek, Cabramatta Creek and Hinchinbrook Creek.

Both Councils could also expect assistance with implementing parts of the Plan that contribute to reducing existing flood problems, from the State Government. Funding assistance is normally on a 2:1 basis (State:Council). Special grant money may also be available in some cases.

Although much of the Plan may be eligible for Government assistance, funding can not be guaranteed. Government funds are allocated on an annual basis to competing projects 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:

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

11.5 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, changes to the area's planning strategies, or the outcome of any further review of Liverpool Council's detention basins strategy. In any event, a thorough review every five years is warranted to ensure the ongoing relevance of the Plan.

Implementation of the Plan should also be monitored by each Council's Floodplain Management Committee.

It is also imperative that flood risk maps and other maps showing flood extents and flood levels are updated as further development occurs within the catchment, particularly for Liverpool Council where the majority of development will occur. Much of this information will be contained in Liverpool Council's GIS computer system. This will require continual updating as further studies and other assessments are undertaken in connection with ongoing development within the catchment.

12. REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZECC) (1992), *Australian Water Quality Guidelines for Fresh and Marine Waters.*

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13. GLOSSARY

Note that terms shown in bold are described elsewhere in this 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 of flood flows. A road culvert, a pipe or a narrowing of the stream channel could cause the constriction.
annual exceedance probability (AEP)	AEP (measured as a percentage) is a term used to describe **flood** size. AEP is the long-term probability between floods of a certain magnitude. For example, a 1% AEP flood is a **flood** that occurs or is exceeded on average once every 100 years. It is also referred to as the '100 year flood' or 1 in 100 year flood'. The terms **100 year flood**, **50 year flood**, **20 year flood** etc, have been used in this study. See also **average recurrence interval (ARI)**.
Australian Height Datum (AHD)	A common national plane of level approximately equivalent to the height above sea level. All **flood levels**, floor levels and ground levels in this study have been provided in metres AHD.
average annual damage (AAD)	Average annual damage is the average flood damage per year that would occur in a nominated development situation over a long period of time.
average recurrence interval (ARI)	ARI (measured in years) is a term used to describe **flood** size. It is a means of describing how likely a flood is to occur in a given year. For example, a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years. The terms **100 year flood**, **50 year flood**, **20 year flood** etc, have been used in this study. See also **annual exceedance probability (AEP)**.
catchment	The land draining through the main stream, as well as tributary streams.
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 level	A flood with a nominated probability or average recurrence interval, for example the 100 year flood.
DIPNR	Department of Infrastructure, Planning and Natural Resources. Now incorporates the floodplain management responsibilities of the former Department of Land and Water Conservation.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, **cubic metres per second (m^3/s)**. Discharge is different from the speed or **velocity** of flow, which is a measure of how fast the water is moving.

DLWC	Department of Land and Water Conservation. This was the name given to the Department of Water Resources (DWR), the Department of Conservation and Land Management (CALM) and flood sections of the Public Works Department (PWD) from May 1995. DLWC was incorporated into the Department of Infrastructure, Planning and Natural Resources (DIPNR) from 1 July 2003. DLWC has been used in this report, except for work and/or studies carried out by the departments prior to May 1995.
DUAP	The former Department of Urban Affairs and Planning (NSW). Previously the Department of Planning (NSW). Superseded by **Planning NSW**, which was incorporated into the Department of Infrastructure, Planning and Natural Resources from 1 July 2003.
DWR	The former Department of Water Resources. This department became a major component of the Department of Land and Water Conservation (DLWC) in May 1995.
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the *Local Government Act 1993*.
effective warning time	The time available after receiving advice of an impending **flood** and before the floodwaters prevent appropriate flood response actions being undertaken. The **effective warning time** is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
EP&A Act	*Environmental Planning and Assessment Act, 1979*.
extreme flood	An estimate of the **probable maximum flood (PMF)**, which is the largest flood likely to occur.
flood	A relatively high stream flow that overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	An appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood hazard	The potential for damage to property or risk to persons during a **flood**. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.
flood level	The height of the **flood** described either as a depth of water above a particular location (eg. 1m above a floor, yard or road) or as a depth of water related to a standard level such as **Australian Height Datum** (eg the flood level was 7.8m AHD). Terms also used include **flood stage** and **water level**.

flood liable land	Land susceptible to flooding up to the **probable maximum flood (PMF)**. Also called **flood prone land**. Note that the term flood liable land now covers the whole of the **floodplain**, not just that part below the **flood planning level**, as indicated in the superseded Floodplain Development Manual (NSW Government, 1986).
flood planning levels (FPLs)	The combination of flood levels and **freeboards** selected for planning purposes, as determined in **floodplain management studies** and incorporated in **floodplain management plans**. The concept of flood planning levels supersedes the designated flood or the flood standard used in earlier studies.
flood prone land	Land susceptible to flooding up to the **probable maximum flood (PMF**). Also called **flood liable land**.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate damages during a **flood**.
flood stage	see **flood level**.
Flood Study	A study that investigates flood behaviour, including identification of flood extents, **flood levels** and flood velocities for a range of flood sizes.
floodplain	The area of land that is subject to inundation by floods up to and including the probable maximum flood event, that is, **flood prone land** or **flood liable land**.
Floodplain Risk Management Plan	The outcome of a **Floodplain Management Risk Study**.
Floodplain Risk Management Study	The current study. These studies are carried out in accordance with the *Floodplain Management Manual* (NSW Government, 2001) and assess options for minimising the danger to life and property during **floods**. These measures, referred to as 'floodplain management measures/options', aim to achieve an equitable balance between environmental, social, economic, financial and engineering considerations. The outcome of a Floodplain Risk Management Study is a **Floodplain Risk Management Plan**.
floodway	Those areas of the **floodplain** where a significant discharge of water occurs during **floods**. Floodways are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in **flood levels**.
flow	see **discharge**
freeboard	A factor of safety expressed as the height above the **design flood level**. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the **floodplain**, such as wave action, localised **hydraulic** behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change.
high flood hazard	For a particular size **flood**, there would be a possible danger to personal safety, able-bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be a potential for significant structural damage to buildings.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and **velocity**.

hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of **peak discharges**, flow volumes and the derivation of hydrographs (graphs that show how the discharge or stage/flood level at any particular location varies with time during a flood).
km	kilometres. 1km = 1,000m = 0.62 miles.
km^2	square kilometres. $1km^2 = 1,000,000m^2 = 100ha \approx 250$ acres.
LGA	Local Government Area, or Council boundary.
local catchments	Local catchments are river sub-catchments that feed river tributaries, creeks, watercourses and channelised or piped drainage systems.
Local Environmental Plan (LEP)	A Local Environmental Plan is a plan prepared in accordance with the *Environmental Planning and Assessment Act*, 1979, that defines zones, permissible uses within those zones and specifies development standards and other special matters for consideration with regard to the use or development of land.
local overland flooding	Local overland flooding is inundation by local runoff within the local catchment.
local runoff	local runoff from the local catchment is categorised as either major drainage or local drainage in the NSW Floodplain Management Manual, 2001.
low flood hazard	For a particular size flood, able-bodied adults would generally have little difficulty wading and trucks could be used to evacuate people and their possessions should it be necessary.
m	metres. All units used in this report are metric.
m AHD	metres **Australian Height Datum (AHD)**.
m/s	metres per second. Unit used to describe the **velocity** of floodwaters. 10km/h ≈ 2.8m/s.
m^2	square metres. $1m^2 \approx 10.8$ square feet.
m^3/s	Cubic metres per second or 'cumecs'. A unit of measurement for creek flows or **discharges**. It is the rate of flow of water measured in terms of volume per unit time.
MHL	Manly Hydraulics Laboratory, formerly a branch of the NSW Public Works Department.
ML	Megalitre. 1ML = 1,000 m^3.
merit approach	The principles of the merit approach are embodied in the *Floodplain Management Manual* (NSW Government, 2001) and weigh up social, economic, ecological and cultural impacts of land use options for different **flood prone** areas together with flood damage, **hazard** and behaviour implications, and environmental protection and well being of the State's rivers and **floodplains**.
MIKE-11	The software program used to develop a computer model that analyses the **hydraulics** of the waterways within a **catchment** and calculates water levels (flood levels) and flow **velocities**. Known as a hydraulic model.
mm	millimetres. 1m = 1,000mm

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 water course.
peak discharge	The maximum **flow** or **discharge** during a flood.
Planning NSW	Formerly the **Department of Urban Affairs and Planning (NSW)** and the Department of Planning (NSW), at present DIPNR (since March 2003)
present value	In relation to flood damage, is the sum of all future flood damages that can be expected over a fixed period (usually 20 years) expressed as a cost in today's value.
probable maximum flood (PMF)	The largest flood likely to ever occur. The PMF defines the extent of **flood prone land** or **flood liable land**, that is, the **floodplain**. The extent, nature and potential consequences of flooding associated with the PMF event are addressed in the current study.
PWD	Public Works Department. Formerly the State Government Department responsible for floodplain management matters in tidal waterways.
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.
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, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
RAFTS	The software program used to develop a computer model that analyses the **hydrology** (rainfall–**runoff** processes) of the **catchment** and calculates hydrographs and **peak discharges**. Known as a hydrological model.
RMA-2V	A two dimensional hydraulic model used to calculate flood levels and extents in creeks and floodplains.
runoff	The amount of rainfall that ends up as flow in a stream, also known as rainfall excess.
SES	State Emergency Service of New South Wales.
stage–damage curve	A relationship between different water depths and the predicted flood damage at that depth.
velocity	the term used to describe the speed of floodwaters, usually in **m/s** (metres per second). 10km/h = 2.7m/s.
water level	see **flood level**.
water surface profile	A graph showing the height of the **flood** (**flood stage**, **water level** or **flood level**) at any given location along a watercourse at a particular time.