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Ipswich City Council

Natural Disaster Risk Management Studies Program

Stage 3

Risk Evaluation and Treatment

August 2002

Prepared for **Ipswich City Council** by
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Fisher Stewart

Ipswich City Council

Natural Disasters Risk Management Studies Program
Stage 3
Risk Evaluation and Treatment

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Executive Summary

Risk Management Process
The Natural Disaster Risk Management Report for Ipswich City Council has been undertaken in three Stages, namely:

Stage 1	Risk assessment identifying impact of potential hazards and evaluation of whether risks are acceptable to the community, and preliminary review of treatment options.
Stage 2	Hydrological and hydraulic studies for the non-urban areas of Ipswich Detailed flood vulnerability analysis for the whole City, including local tributary floods. Flood extent mapping for the whole City.
Stage 3	Further risk treatment studies as required. Development of options to reduce unacceptable risk Preparation of reports for submission to DES

Council established a risk management team comprising a Project Steering Committee and a Study Advisory Group. Council was assisted in **Stages 1** and **3** by Consultant Fisher Stewart Queensland Pty. Ltd., and in **Stage 2** by Halliburton KBR Pty. Ltd. A Community Reference Group (CRG) was formed in **Stage 1**, and 2 CRG Workshops were held.

The Study has been undertaken according to the process set out in Zamecka and Buchanan (2000), and in the *DES Guidelines for the undertaking of Disaster Risk Management Studies*. This report and the accompanying *Natural Disaster Mitigation Report* have been prepared according to these Guidelines.

The methodology in the above publications has been expanded to provide more spatial detail by the use of GIS techniques. In addition to the mapping capability of the GIS, the census data was obtained from the Australian Bureau of Statistics ABS on a census collection district (CCD) basis, thereby enabling statistics on properties flooded, for example, to be computed on a CCD basis, and also enables community vulnerability to be evaluated on a CCD basis. This approach has provided useful information to identify high priority areas.

The formal reports are supported by reports on the 3 Study Stages comprising:

Stage 1
Preliminary Natural Disaster Risk Management Report, prepared by Fisher Stewart Queensland Pty. Ltd. (Nov 2001)

Stage 2
Ipswich Rivers Flood Studies prepared by Halliburton KBR Pty. Ltd. (Jan 2002)
Local Storm Flood Mapping prepared by Halliburton KBR Pty. Ltd. (March 2002)

Stage 3
This report entitled, *Risk Evaluation and Treatment*, prepared by Fisher Stewart Queensland Pty. Ltd. (August 2002). This outlines further risk evaluation studies, and provides more information in regards to proposed treatments.

In addition to the work undertaken for this study, a great deal of useful information was available from the work of AGSO (2001) *Community Risk Analysis in Ipswich City.*

Council has also submitted a number of Status Reports as required by its agreement with DES.

Key Issues

Stage 1 of the Study considered all credible natural disasters affecting Ipswich. These are:

- Floods;
- Severe Storms;
- Bushfires;
- Earthquakes;
- Landslides;
- Extreme Temperatures.

It was determined from the risk analysis and evaluation, that risks were acceptable in relation to: earthquakes, landslides and extreme temperatures, and that the only treatment required in respect of these hazards is to raise community awareness of both the risks and procedures to minimise the risks.

In respect of the other hazards, i.e. floods, severe storms and bushfires, it was determined that the risks are currently unacceptable, and that prevention/mitigation measures are warranted as well as measures to raise the community awareness.

Of the risks posed by these hazards, the greatest risks are posed by flooding. Studies determined that of the population of **126,853** (1996 census):

- **2,300** people will be flooded in a 20 Year ARI event;
- **5,800** people will be flooded in a 50 Year ARI event;
- **9,300** people will be flooded in a 100 Year ARI event; and
- Approximately **54,000** people will be flooded in a Probable Maximum Flood.

Floods, therefore, have the potential to cause major disasters in Ipswich. The **1974 flood** was the largest recorded in the 20th century (20.7m at the Ipswich flood gauge), in which approximately **2,000 properties** were affected, with **41 properties swept away** and **600 fully submerged**. A recurrence of the 1974 flood would now result in approximately **4,700 properties** being affected due to further increase in floodplain occupation in the period since 1974.

Work on local tributary flooding, undertaken as part of this study, has been used to identify *Primary Flow Paths*, which are defined as the areas flooded as a result of a 100 Year ARI in each tributary catchment, but in the absence of backwater effects from either the Brisbane or Bremer Rivers. There are **4,300 people** living within these *primary flow paths*, in which risks are high, not only of flooding, but of houses being swept away by floodwaters. Reduction of flooding in the primary flow paths is a major objective of the Mitigation Plan.

A provisional list of road closures was developed during Stage 3 for events of 20, 50 and 100 years ARI. This showed a total of **113 roads** cut during only a **20 Year ARI** event.

Significantly this includes sections of:

- The Ipswich Motorway at the Goodna Creek, Woogaroo Creek and Six Mile Creek crossings;
- Brisbane Road at the Bundamba Creek, Deebing Creek crossings;
- The Warrego Highway at the Bremer River, Sandy Creek (North), and Ironpot Creek crossings; and
- The Cunningham Highway at the Warrill Creek, Purga Creek, Deebing Creek, and Bundamba Creek crossings.

These are all important regional routes as well as major routes through Ipswich. A closure frequency of once in 20 years (on average) is unacceptable in respect of these critical routes, and they should be raised to the National Highway standard of 50 Year ARI flood immunity.

There are also a number of other lifeline and critical facilities located within flood liable areas, and steps should be taken to reduce these.

There are about **1,380** properties (about **4,200** people) located within areas of **high bushfire risk**, and a further **5,350** properties (about **16,000** people) in areas of **moderate bushfire risk**.

Treatment Strategies

The risk treatment strategies have been divided into 3 categories, namely:

a) Actions already in hand or implemented;

b) Actions endorsed by Council for implementation; and

c) Proposed future actions subject to funding availability

Actions listed under c) require major funding and are beyond Council's ability to fund totally. This section also includes actions that are not within Council's responsibility.

Due to the scale of some of these actions, a ten-year implementation program is proposed. A summary of the costs of the actions proposed under b) and c) is given in **Table S1.** Details of the proposed treatment strategies are given in the *Natural Disaster Risk Management Report* (Fisher Stewart 2002a) and the *Natural Disaster Mitigation Plan* (Fisher Stewart 2002b).

Table S1 Costs of Proposed Risk Treatment Actions

Hazard	Estimated Costs Year 2002-2003	Estimated Costs Year 2003-2012	Estimated Costs Total
Floods – People and Buildings	$2.07 million	$164 million	$166.1 million
Floods – Environment, Lifelines and Critical Facilities	$0.35 million	$137 million	$137.4 million
Floods Sub-total	**$2.42 million**	**$301 million**	**$303.5 million**
Severe Storms	$0.25 million	$23.1 million	$23.4 million
Bushfires	$0.19 million	$20.6 million	$20.8 million
TOTAL	**$2.9 million**	**$345 million**	**$348 million**

1. Study Aims, Area and Scope

1.1. Study Aims

The purpose of the Study was to prepare a **Natural Disaster Risk Management Plan** and a **Natural Disaster Mitigation Plan** for Ipswich City. In turn, this may require amendments to Council's **Planning Scheme**, and its **Counter Disaster Plan.**

The Study was divided into 3 Stages as summarised in **Table 1.** These stages are as identified in the Project Plan approved by DES for the Study.

Following its completion of **Stage 1** of the Study, Fisher Stewart was engaged by Ipswich City Council to undertake Stage 3, which is the subject of the current report.

Table 1 Summary of Project Stages

Stage	Outcomes
1	Report on risk assessment identifying impact of potential hazards and evaluation of whether risks are acceptable to the community.
2	Report on hydrological and hydraulic studies for the non-urban areas of Ipswich. Report on detailed flood vulnerability analysis for the whole city.
3	Report on further risk treatment studies as required. Report on development of options to reduce unacceptable risk.

1.2. Study Area

Ipswich is located in the southeast corner of Queensland, about 40km west of Brisbane. The general location and the city boundaries are shown in the maps in **Figure 1.**

Ipswich City borders six other local government areas – Esk (to the north), Laidley (to the west), Boonah and Beaudesert (to the south), and Logan and Brisbane (to the east).

Ipswich City covers an area of 1775km^2 and lies largely in the Bremer River sub-catchment of the Brisbane River catchment. The Bremer River rises in the McPherson Range to the south and has a catchment area of 2030km^2.

The Bremer sub-catchment lies in the southern most corner of the Brisbane River catchment. The Brisbane River catchment encompasses an area of 13,750km^2. The Bremer River flows through Ipswich City prior to its confluence with the Brisbane River near Moggill. The major tributaries of the Bremer River are Warrill, Purga and Bundamba Creeks. Warrill Creek accounts for approximately 2/3 of the Bremer River catchment and joins the Bremer River 10km upstream of Ipswich.

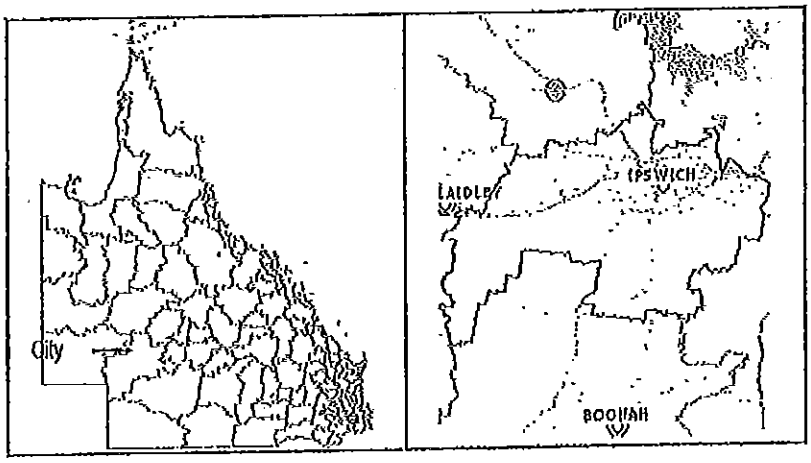


Figure 1 **Location Map**

The population of Ipswich City Local Government Area, as given by the 1996 Census, was **126, 853.** The suburbs of Carole Park, Karana Downs and Mount Crosby were transferred from Ipswich City to Brisbane City in 2000. The projected populations contained herein take account of these changes.

1.3. Scope of Work - Stage 3

This report refers to **Stage 3** of Council's *Natural Disaster Risk Management Program* and involves the consideration of risk treatment options for Ipswich City, and the preparation of reports for submission to the Department of Emergency Services.

The Scope of Work for **Stage 3** was developed at the conclusion of Stages 1 and 2, to meet the requirements of DES for the project within budgetary constraints.

The Scope of Work comprised:

- Undertaking further risk treatment studies as identified in Stage 1, in respect of **the agreed unacceptable risks** only, namely *flooding, severe storms, and bushfires;*

- Development of risk treatment options in respect of the agreed unacceptable risks only;
- Preparation of a report on risk treatment studies and options (this report);
- Preparation of the **Natural Disaster Risk Management Report** and the **Natural Disaster Mitigation Plan** for submission to the Department of Emergency Services based on the processes, findings and outcomes of this study.

The agreed Scope of Work emphasised those tasks relating to areas in which Council has power to act; with issues for which the power to act resides elsewhere, covered either by reference to the responsible agency for a response, or by a recommendation for such referral as appropriate.

These components are expanded upon in the following paragraphs:

1.4. Risk Treatment and Option Studies

With reference to the treatment option tables developed from the second CRG workshop, further risk treatment studies and consideration of options were undertaken in respect of the following:

- Flooding;
- Severe Storms; and
- Bushfires.

The scope of these components are outlined below.

1.4.1. Flooding

a) Prevention/Mitigation

- Brief investigation of the feasibility of construction of levees to reduce area flooded;
- Brief investigation other structural flood mitigation measures such as flood control storages including indicative costs and feasibility;
- Reporting on road damage costs and means of reducing in future;
- Taking account of current and proposed planning policies and procedures in respect of flood liable areas;
- Quantification of the number of flood affected houses which could practically be raised and estimate the cost thereof;

- Quantification of the number of commercial and industrial premises in the floodplain that could be flood proofed and estimate the cost thereof;

- Identification, quantification and prioritisation of properties for voluntary purchase by Council;

- Brief investigation of the scope for upgrading the flood warning hardware and of upgrading the flood forecasting procedures, including flash flooding;

- Identification of priority actions in respect of local stormwater flooding priority areas;

- Investigation of the need for and scope of river management works at key locations to prevent erosion and potential avulsion (course change);

- List the lifelines which would be flooded under various events up to PMF, and identify the priorities and costs of improving lifeline resilience (including roads);

- List the critical facilities, which would be flooded under various events up to PMF, together with a prioritised list for their relocation or flood proofing.

b) *Preparedness*

- Flood mapping for a range of flood magnitudes;

- Investigation of the sequence of closure, and subsequent availability for reopening, of roads in the flood liable areas, and identify any required improvements to ensure at least one means on access/egress to all areas;

- Structuring of an appropriate community awareness program in respect of inundation prevention, damage limitation, preparedness, response and recovery including flood management plans for communities and businesses;

- Investigation of projected future population throughout the flood liable areas, to enable the future needs for response personnel and equipment and their preferred locations to be undertaken;

- Investigation of the scope for and potential means of improving the interpretation of flood warnings;

- Investigation of the scope for and potential means of improving the dissemination of flood warnings;
- Investigation of appropriate means of improving the addressing of rural properties;
- Review of the Ipswich City Council Counter Disaster Plan – Flood Sub Plan to ensure consistency with the Study outcomes.

1.4.2. Severe Storms

a) Prevention/Mitigation

- Brief review of the history of storm damage to overhead powerlines and telephone cables – review for patterns eg repeated failures in certain locations, repeated type of failure – and refer to relevant service providers in respect of review engineering design with a view to improvement and cost of relocation underground at key locations;
- Brief review of the history of storm damage to substantiate or otherwise the perception of "storm tracks" and increased storm risk in certain high exposure areas, with a view to better informing the community if they are in a high risk zone;
- Identification of major road lifelines and consideration of the scope to reduce their storm hazard exposure;
- Investigation as to whether critical facilities are reliant on single lifelines and consider duplication where they are.

b) Preparedness

- Structuring of an appropriate community awareness program in respect of storm damage prevention, preparedness, response and recovery. This should include advise to owners of pre – 1980 buildings of current code requirements and encouragement of compliance with current best practice;
- Investigation of projected future population throughout the study area, to enable the future needs for response personnel and equipment and their preferred locations to be undertaken;
- Investigation of appropriate means of improving the addressing of rural properties;
- Review the Ipswich City Council Counter Disaster Plan – Cyclone and Storm Sub Plans to ensure consistency with Study outcomes.

1.4.3. Bushfire

a) Prevention/Mitigation

- Take account of Council planning and design requirements for rural residential subdivisions;
- Refer the maintenance of overhead powerlines and telephone cables in rural areas, with a view to reducing incidence of ignition by lightning strikes to the relevant agencies for their response;
- List the lifelines passing through bushfire risk areas, and identify the priorities and costs of improving their resilience (including roads);
- List the critical facilities passing through bushfire risk areas, together with a prioritised list for their relocation or fireproofing.

b) Preparedness

- Structuring of an appropriate community awareness program in respect of fire prevention, damage limitation, preparedness, response and recovery including fire management plans for communities and businesses.
- Investigation of projected future population throughout the bushfire risk areas, to enable the future needs for response personnel and equipment and their preferred locations to be undertaken;
- Investigation appropriate means of improving the addressing of rural properties;
- Review the Ipswich City Council Counter Disaster Plan – Bushfire Sub Plan to ensure consistency with Study outcomes.

1.4.4. Consultation

Consultation in **Stage 3** comprised:

- Meetings of the SAG to discuss treatment options and draft recommendations; and
- Identification of interface issues with adjacent local authorities, and if warranted meet with representatives of those authorities to discuss impacts and matters of mutual interest and benefit.

1.4.5. Stage 3 Report

The **Stage 3** report:

- Provides a concise report on the investigations undertaken in **Stage 3,**
- Outlines the treatment options considered,
- Makes recommendations for inclusion in the *Natural Disaster Mitigation Plan.*

1.4.6. Reports to Department of Emergency Services

The following reports were prepared for submission to the *Department of Emergency Services:*

- **The Natural Disaster Risk Management Report;** and
- **The Natural Disaster Mitigation Plan.**

The first of these reports consolidated information provided in the individual reports on **Stages 1, 2** and **3** into a single document, whilst the second summarised the proposed strategies for mitigation of damage from future events, including an action plan for implementation.

2. Further Risk Studies

2.1. Risk Evaluation

Stage 1 of this project concluded that risks to parts of the Ipswich community are unacceptable in respect of the following hazards:

- Flooding;
- Severe Storms; and
- Bushfires.

Stage 1 also concluded that additional risk evaluation was required in respect of these hazards. These additional risk evaluation studies were undertaken in **Stages 2** and **3**.

Stage 2 comprised the hydraulic modelling components and the preparation of flood mapping in respect of the following:

- The rural parts of the City not covered by the previous hydraulic modelling studies, on the basis of a *regional* flood – that is flooding in the Brisbane River as well as the Bremer River and its tributaries, in which flood levels are increased in the Bremer River by way of backwater from the Brisbane River; and
- Local flooding in the Bremer River and its tributaries in the absence of a Brisbane River flood.

Halliburton KBR undertook **Stage 2** and reference to its reports (Halliburton KBR 2002a, 2002b) should be made for details of this component.

The remaining components were undertaken as part of **Stage 3** and are reported upon herein.

The additional risk evaluation studies in respect of flooding, severe storms and bushfires are addressed in **Chapters 3** to **5** hereof respectively.

2.2. Risk Treatment

Stage 3 focused on the identification and evaluation of a range of options to treat or mitigate these risks.

Risk treatment comprises four main elements (Zamecka and Buchanan 2000), namely:

- Prevention/mitigation;

- Preparedness;
- Response; and
- Recovery.

Each of these seeks to reduce the impact of future events on the community. In the terms of the risk equation:

RISK = HAZARD x ELEMENTS AT RISK x VULNERABILITY

Treatment measures reduce the risk by reducing one or more of the elements in the right hand side of the equation.

In respect of **prevention** or **mitigation**, treatments aim to either eliminate or reduce the adverse impact of the event, that is, they reduce the hazard or exposure to it. For example, in the context of flood risk, treatments in this category include both structural or works measures, such as construction of flood levees or flood proofing of buildings, and non-structural measures such as planning controls to limit development of the floodplain and hence reduce the exposure to the risk.

Preparedness measures accept that the hazard will occur at some future time, and seek to reduce the extent of harm, and damage resulting from the hazard, by reducing the community vulnerability. Measures in this category include; raising community awareness; improving the accuracy of warnings and the means of disseminating them to the community; and contingency planning.

Response measures seek to reduce the harm and damage to the community both during the event in the short term afterwards, by ensuring that well trained resources are available to act in response to a hazard situation, in order to assist community response, provide emergency accommodation and provisioning and response coordination.

Recovery measures seek to reduce the medium to long-term harm and damage by such activities as housing and financial assistance, counselling, and restoring lifelines and essential services.

Whilst the boundaries between these categories are not fixed, they do provide a useful means of classification of treatment options.

The risk treatment studies in respect of flooding, severe storms and bushfires are addressed in **Chapters 3** to **5** hereof respectively.

As future populations need to be quantified in relation to all hazards, population projections are dealt with in the following paragraph in this section.

2.3. Population Projections

The population of Ipswich (local government area in 1996, from the census of that year, was **126,853.** This is concentrated in the urban areas. Historic and projected populations for Ipswich are given in **Figure 2,** which is based on figures in AGSO (2001a) and DLGP (2001).

Figure 2 shows an increasing growth rate from about 1970, which is projected to continue. The projections in DLGP (2001) for Ipswich are based on 1.55% pa for 2001 – 2011 and 1.8% pa for 2011 – 2021.

The **Stage 1** Report (Fisher Stewart 2001) also showed population distribution by CCD. This shows a marked variation across the area, with the most densely populated area, the Diamond Street area of Riverview, having a population density of 2840 km^{-2}. Six other CCDs have a density of more than 2500 persons km^{-2}, these being in the suburbs of Collingwood Park, Eastern Heights, Leichhardt, Raceview, Redbank Plains and Silkstone. Conversely, the lowest population densities are in the rural areas, where densities of less than 50 km^{-2} occur. The lowest population density in Ipswich of less than 1 km^{-2} is in Opossum Creek.

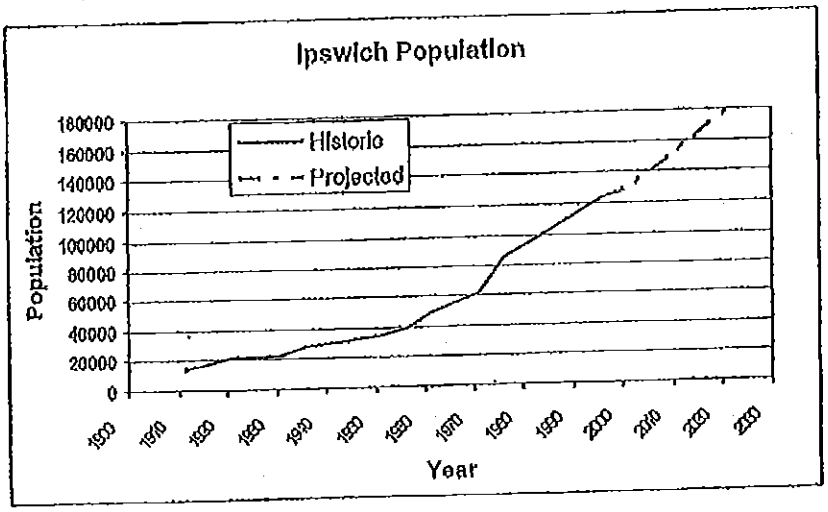


Figure 2 **Historic and Projected Population in Ipswich**

For the purpose of **Stage 3**, Council provided population projections on a CCD and suburb basis, with projected populations of:

- **142,800** for 2001
- **173,100** for 2011 and
- **221,300** for 2021.

The 2011 and 2021 estimates represent increases over the 2001 figures of **21%** and **55%** respectively.

The spatial distribution of these projections, on a percentage increase basis, is shown in **Figures 3** and **4** for years 2011 and 2021 respectively. It can be seen from these figures, that the greatest increases are in the more outlying suburbs.

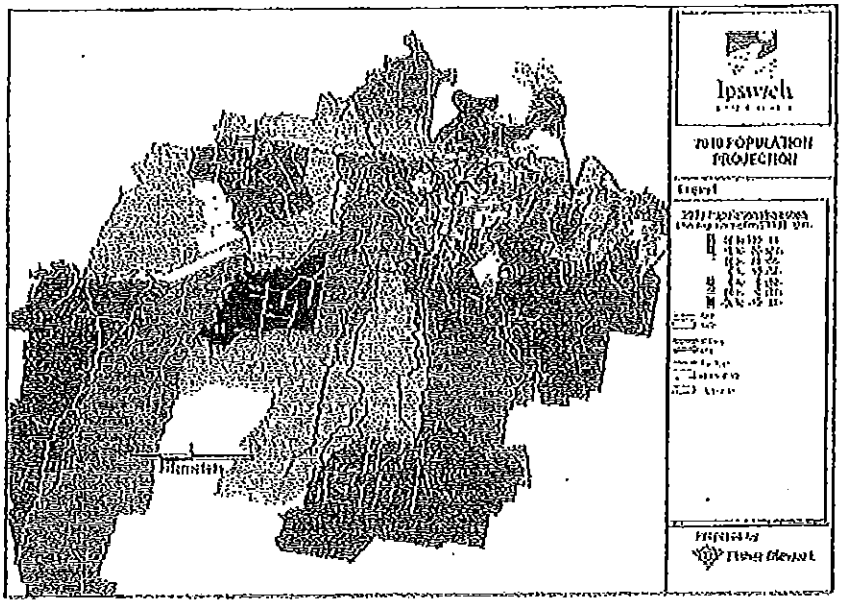


Figure 3 **Spatial Distribution - Population Projection 2011**

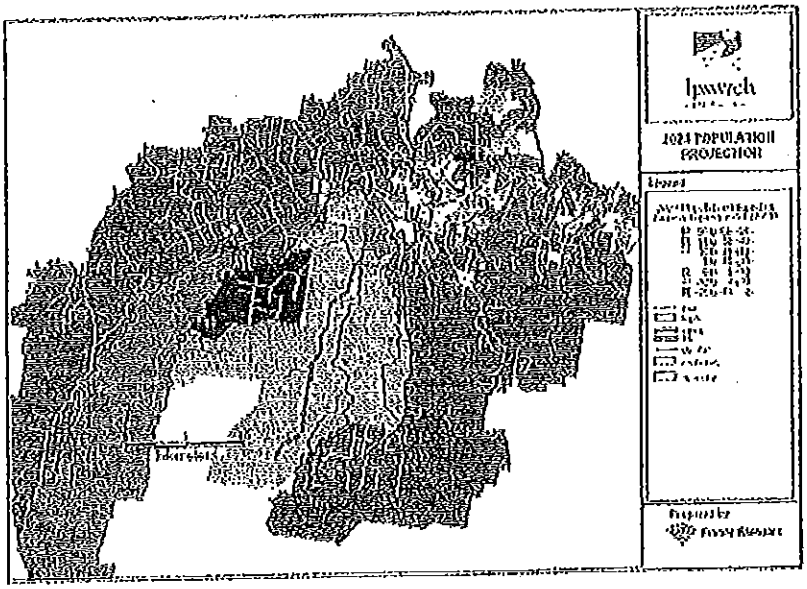


Figure 4 Spatial Distribution - Population Projection 2021

3. Flooding

3.1. Risk Evaluation Studies

3.1.1. Flood Mapping

Flood mapping for the urban areas of Ipswich was produced by Sinclair Knight Merz (SKM 2000).

Hydraulic model studies to enable flood maps for the rural areas to be produced were undertaken as part of **Stage 2** of the current study by Halliburton KBR (2002a). The flood mapping was undertaken subsequently by ICC for average recurrence intervals (ARI) of 20, 50 and 100 Years.

Halliburton KBR (2002) also studied local river and creek flooding, that is, flooding in the absence of backwater from the Brisbane River, or, in the case of Bremer River tributaries, from the Bremer River. ICC also mapped the flood extents in respect of this local flooding.

These are reproduced as **Figures 5** to **7** hereof respectively, with **Figure 8** being the PMF Flood Map reproduced from the Stage 1 Report.

3.1.2. Definition of Primary Flow Path

Analysis was carried out, in Stage 2, to investigate the area of floodplain subject to higher damage from fast flowing water, as would occur in the tributary waterways in the absence of backwater from the Brisbane and Bremer Rivers. These conditions can occur during a local flood event, or during the early stages of a regional event before backwater becomes established.

Whilst these local floods have lower flood levels than the regional floods (ie those with backwater) of the corresponding ARI, the absence of backwater results in higher velocities. The higher velocities are both hazardous, and can also cause bank and bed erosion in the waterway.

The extent of flooding under these conditions is referred to herein as the *100 Year ARI Primary Flow Path.*

In the case of Ipswich, where significant development has historically occurred even below the 20 Year ARI flood extent (with backwater), this is a reasonable scenario to consider.

The primary flow paths, determined as outlined above, are shown in **Figure 9.**

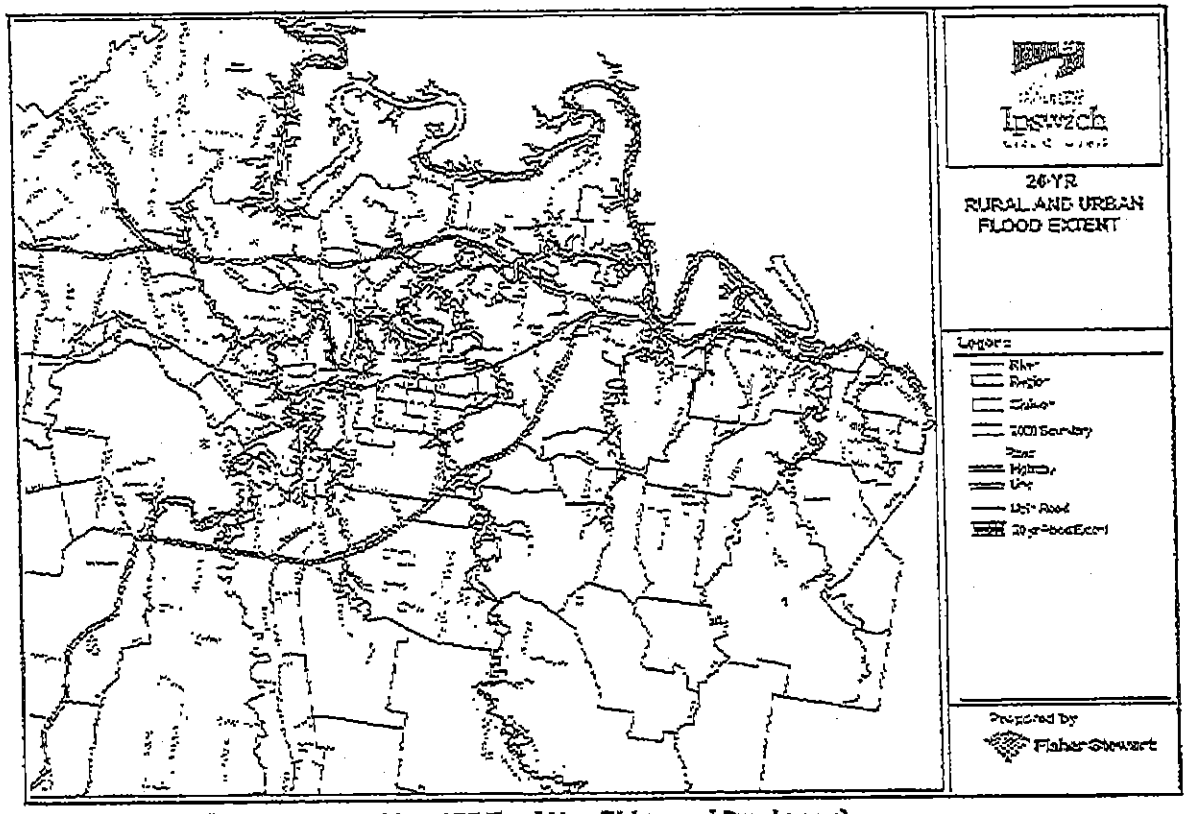


Figure 5 20 Year ARI Flood Map (Urban and Rural areas)

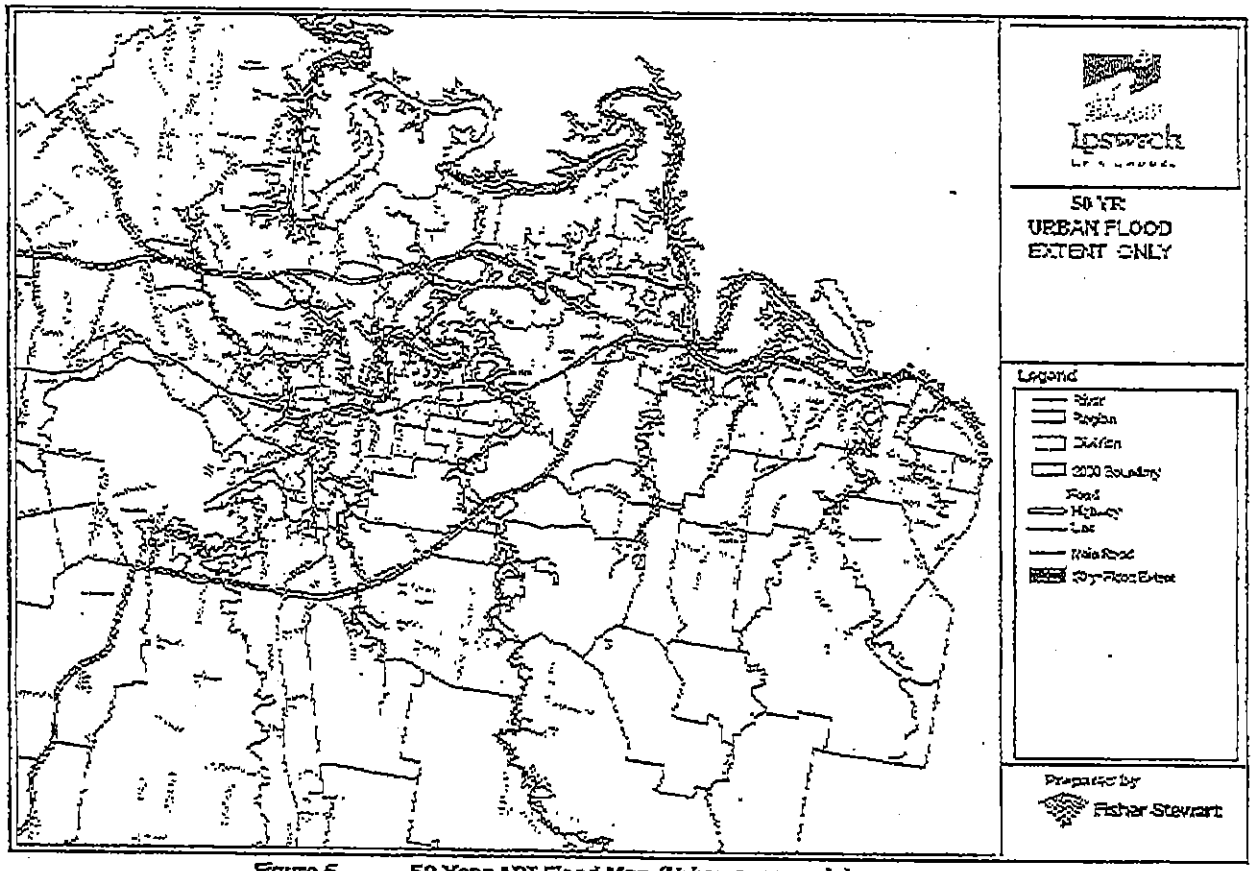


Figure 6 50 Year ARI Flood Map (Urban areas only)

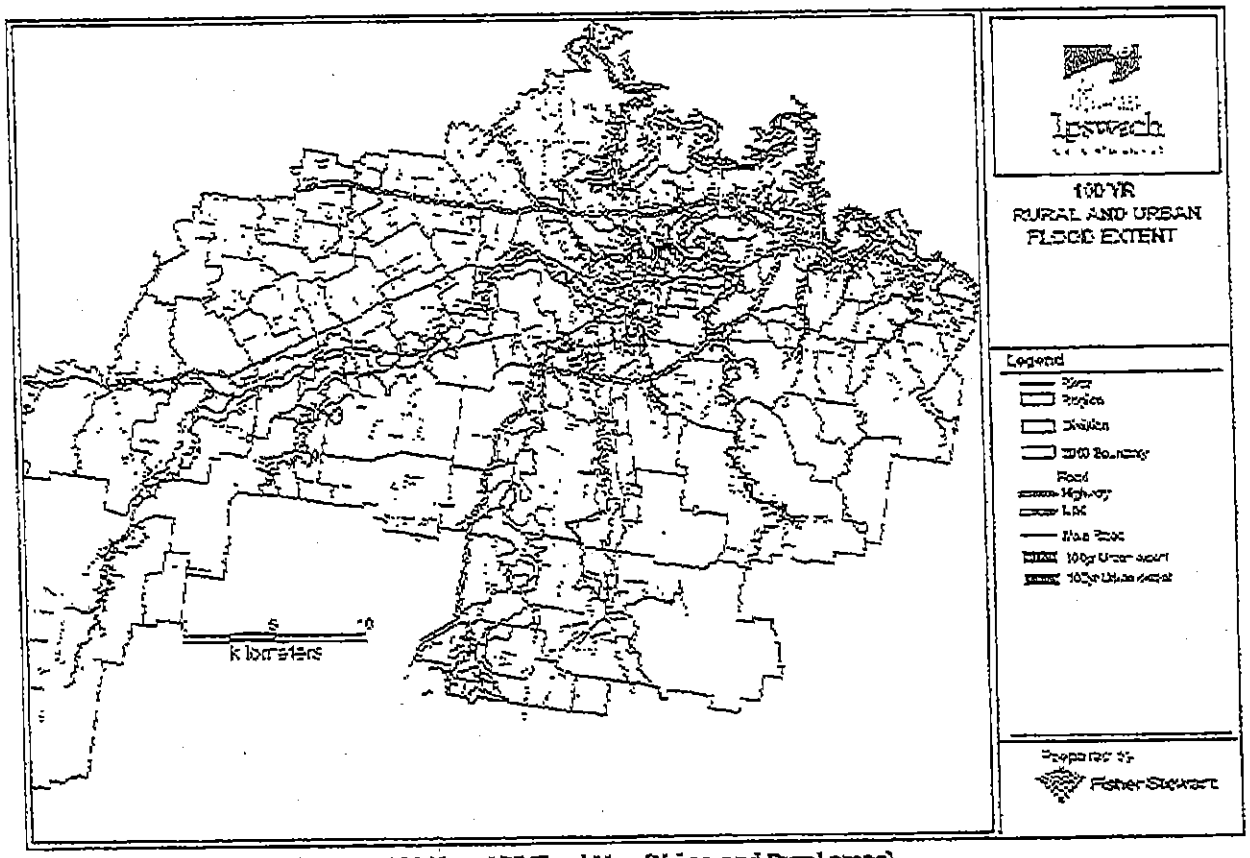


Figure 7 100 Year ARI Flood Map (Urban and Rural areas)

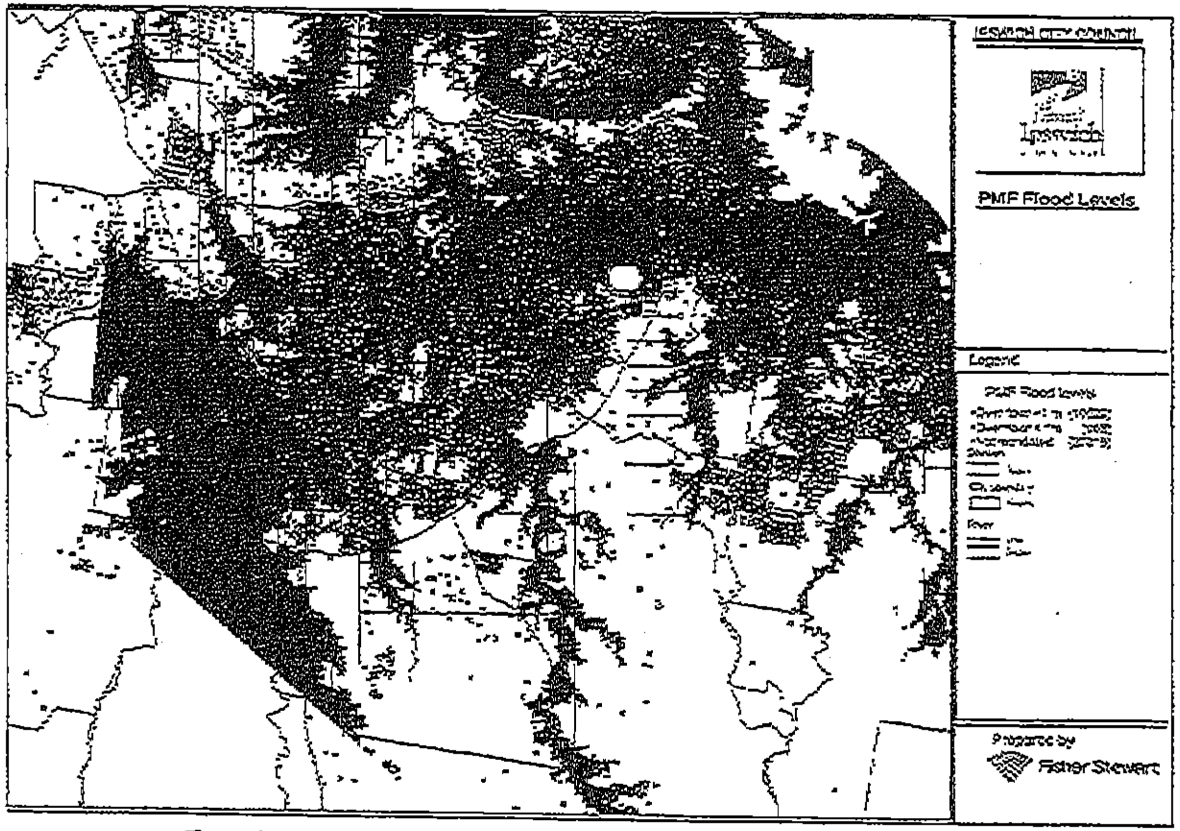


Figure 8 Probable Maximum Flood Map (Urban areas only)

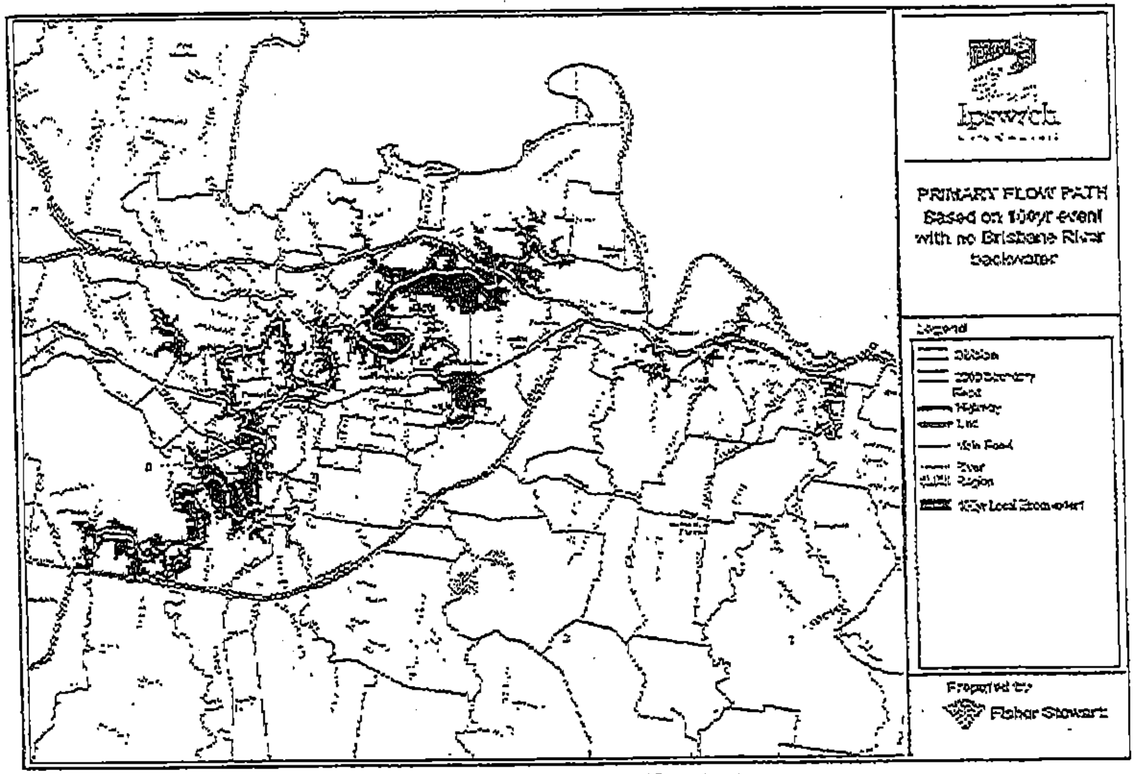


Figure 9 Primary Flow Path Extents

3.1.3. Properties Flooded

The properties flooded for 20, 50, 100 Year ARI and for PMF were identified from the flood maps, together with the number of properties within the *Primary Flow Paths*. These numbers are given in **Table 2.**

Table 2 Summary of Flood Affected Properties

Flood Scenario	No. of Buildings (population) with over floor flooding	Additional No. of Buildings (population) with water on property but not over floor	Additional Buildings (population) Isolated or Inundated
Primary Flow Path (100 Year ARI)	**1,408** (4,310)	N/A	N/A
Regional Flood 5% AEP (20 year ARI)	**764** (2,340)	130 (400)	15 (45)
2% AEP (50 year ARI)	**1,093** (5,790)	130 (400)	10 (30)
1% AEP (100 year ARI)	**3,054** (9,345)	240 (735)	35 (107)
0.5% AEP (200 year ARI)	3,760 (11,500)	270 (825)	20 (60)
0.2% AEP (500 year ARI)	5,040 (15,420)	370 (1,130)	60 (185)
PMF	17,795 (54,450)	220 (675)	1,565 (4,800)

NOTE: Updated numbers used where available (shown in bold), AGSO (2001a) numbers used elsewhere
Population affected estimated at average occupancy rate for Ipswich of 3.06 from the 1996 census.

Given the current total building stock of **45,414** (see Stage 1 Report - section 4.3.1), these are significant numbers, even for the more frequent floods, increasing to 40% with over floor flooding in a probable maximum flood (PMF).

Table 3 shows the breakdown of properties flooded in 20, 50 and 100 Year ARI regional flood events, and the 100 Year ARI local storm event (i.e. Primary Flow Path) by suburb. In **Table 3**, the suburbs are listed in ranked

order according to the number of properties flooded in a 100 Year ARI regional event.

Table 3 Number of Properties Flooded by Suburb

Suburb	Number of Buildings Flooded			
	20 Year Flood	50 Year Flood	100 Year Flood	100 Year Primary Flow Path
Goodna	182	317	401	67
North Booval	40	140	293	9
Bundamba	98	219	271	212
One Mile	37	95	213	103
Brassall	38	110	178	42
East Ipswich	28	85	177	86
Churchill	66	114	166	77
Karalee	26	119	164	45
Ipswich	45	86	119	61
West Ipswich	40	73	111	106
North Ipswich	20	46	104	61
Moores Pocket	7	40	96	39
Basin Pocket	12	47	94	66
Leichhardt	11	60	92	89
Barellan Point	17	52	77	0
Coalfalls	4	29	68	64
Gailes	16	45	67	4
Tivoli	16	35	60	35
Woodend	2	22	53	50
Sadliers Crossing	6	20	50	45
Yamanto	8	44	49	15
Riverview	3	19	45	0
Redbank	8	13	27	4
Booval	15	19	23	22
Camira	12	16	21	21
Collingwood Park	4	6	19	4
Raceview	6	8	15	0
Bellbird Park	5	7	9	0
Blackstone	4	6	6	6
Flinders View	0	0	2	2
North Tivoli	1	2	2	1
Silkstone	0	0	2	2
TOTAL BUILDINGS	764	1893	3054	1408
Population affected (@3.06)	2338	5793	9345	4308

Note: Primary Flow path based on flood extent for 100yr events with no Brisbane River backwater

Figures 10 to **13** show the distribution of flooded properties by suburb for 20, 50 and 100 Year ARI regional flood event and for the 100 Year ARI local flood event respectively.

There are 11 suburbs in which 100 or more buildings will be flooded in a 100 Year ARI regional event, with 4 suburbs containing 200 or more of these properties. These suburbs are Goodna (401 properties), North Booval (293), Bundamba (271) and One Mile (213). These **4 suburbs** account for **39%** of the total of **3,054** properties flooded in a 100 year ARI regional flood event, and the **11 suburbs with 100 or more flooded buildings** account for **71%** of the total.

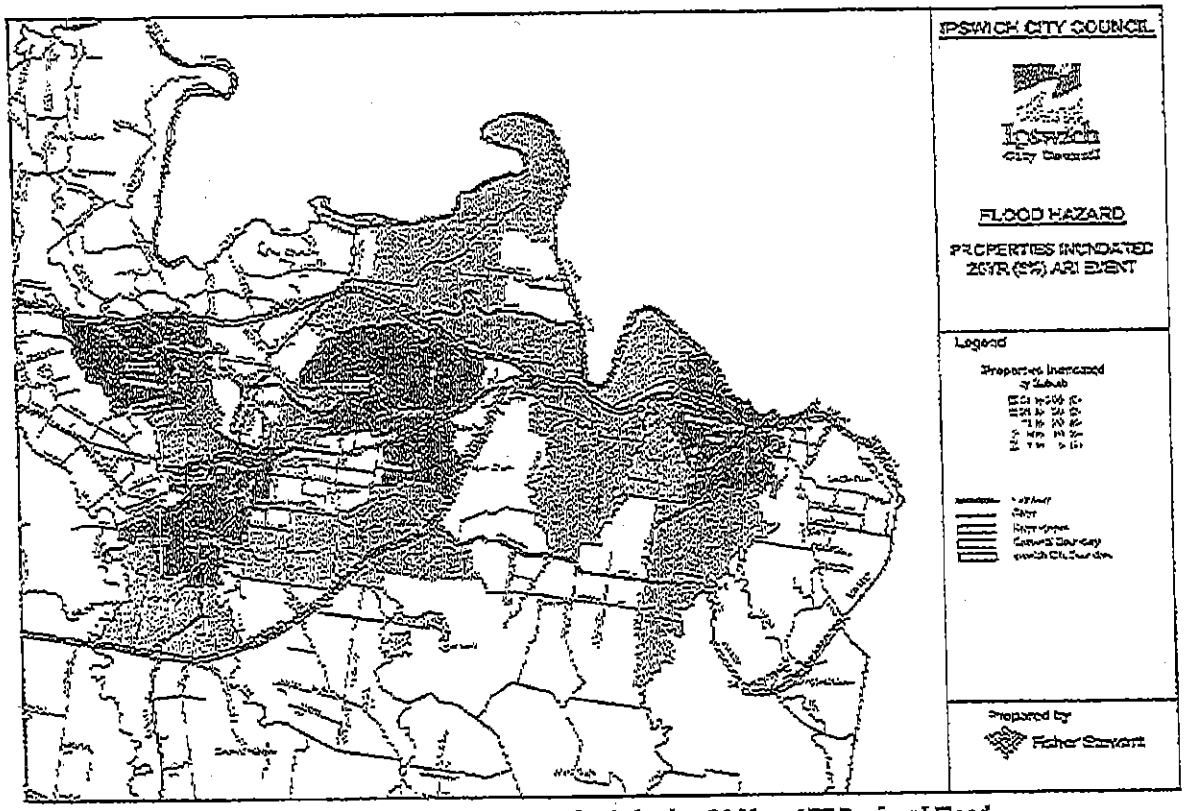


Figure 10 Properties Flooded by Suburb – 20 Year ARI Regional Flood

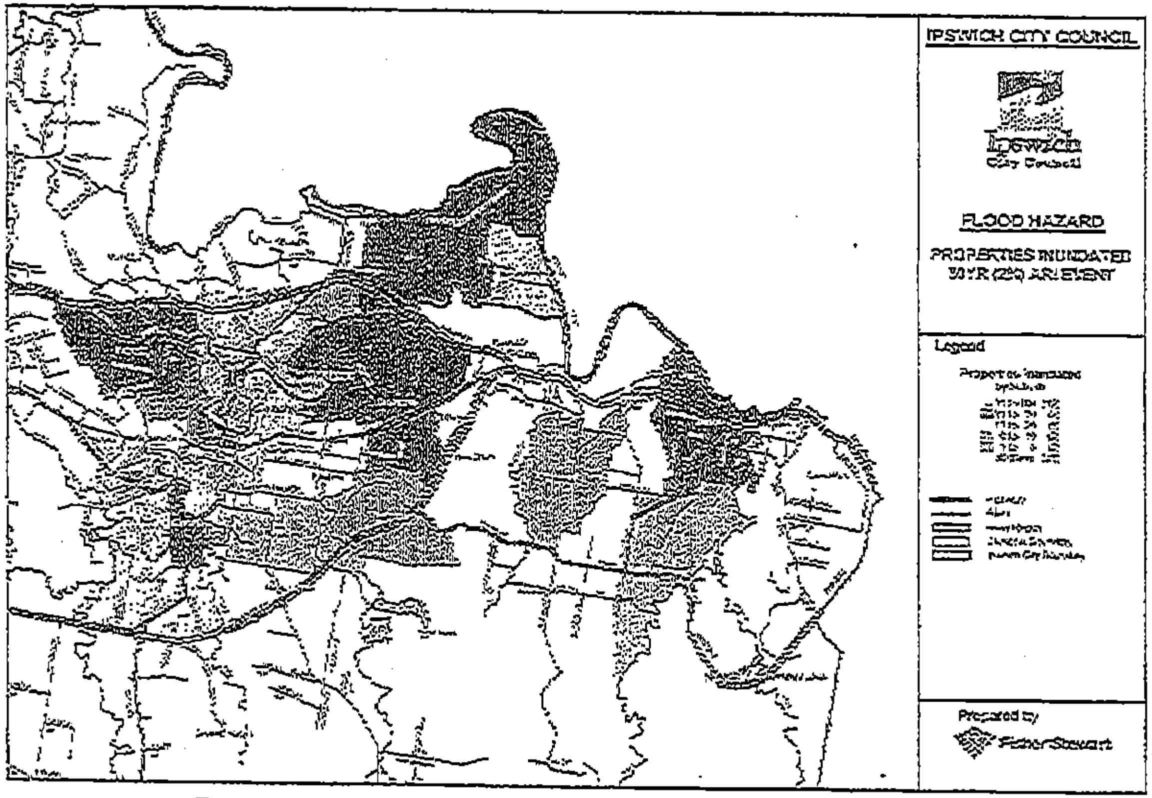


Figure 11 Properties Flooded by Suburb – 50 Year ARI Regional Flood

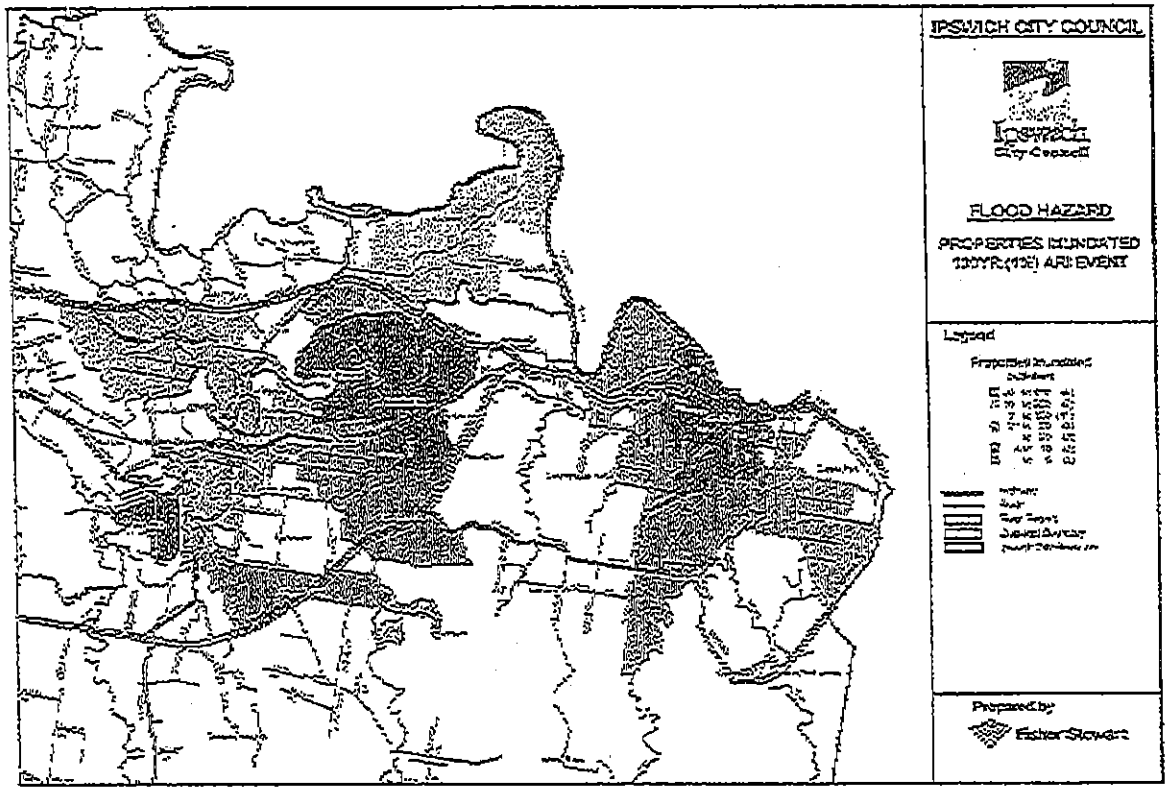


Figure 12 Properties Flooded by Suburb – 100 Year ARI Regional Flood

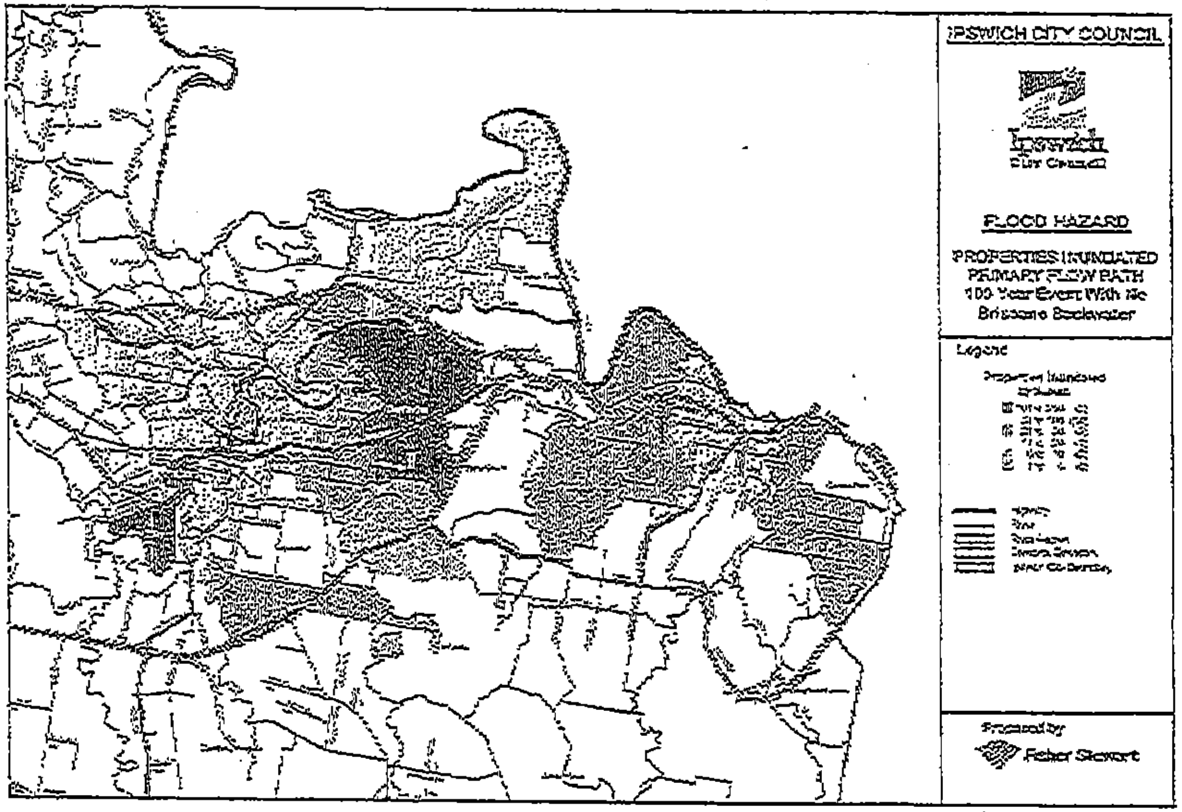


Figure 12 Properties Flooded by Suburb – 100 Year ARI Primary Flow Path

All of the property flooding information given herein is based on the current building database, which contains estimated floor levels based on photogrammetry (by subtracting an average floor to eaves height) from photogrammetric eaves heights. It would be beneficial in reducing the uncertainty in these figures of a ground survey of floor heights were carried out, say up to the 100 year flood levels. This has been included as an Action Plan Item.

The information currently available did not allow the building stock data to be classified into residential, commercial and industrial premises, nor does it record construction material. This information is necessary in order to be able to fully evaluate options of house raising and flood proofing. The work required to provide this information has been included in the treatment strategies (see sections **3.2.2** hereof).

3.1.4. Future Population

In respect of projected populations, the figures for the most flood prone suburbs are given in **Table 4**, which shows that in these suburbs the 2021 estimates average 27% increase, about half the average rate.

As the figures in **Table 4** are complete suburb figures, it is expected that the population at risk to flooding will grow at a lower rate. This would be expected both because these are high-density suburbs, so population growth is limited to infill development and redevelopment, and by provisions of the planning scheme.

Table 4 Population Projections in Flood Prone Suburbs

Suburb	2001 Population	2021 Population	Percent Increase
BOOVAL	2441	2963	21.4%
BRASSALL	7269	10630	46.3%
BUNDAMBA	5789	6977	20.5%
CHURCHILL	1792	2297	28.1%
COALFALLS	1694	1809	6.8%
EAST IPSWICH	2996	3553	18.6%
GOODNA	8062	11468	42.2%
IPSWICH	3758	4734	26.0%
KARALEE	2303	2690	16.8%
LEICHHARDT	4798	5279	10.0%
NORTH BOOVAL	2222	2923	31.6%
NORTH BOOVAL	2222	2923	31.6%
NORTH IPSWICH	4516	5135	13.7%
SADLIERS CROSSING	780	878	12.6%
WEST IPSWICH	547	613	12.0%
TOTAL	**51,191**	**64,872**	**26.7%**

In **Figure 14**, the projected population increase in suburbs affected by the 20 Year ARI flood has been plotted, as these would generally be expected to show little increase, due to development control restrictions.

However, this is not clearly demonstrated in this figure. While this is partly explained by future development being outside the flood liable areas in these suburbs, it is also believed to be partly due to the projection methodology, which applies suburb-wide projections and is not sufficiently detailed to show variations within a given suburb. An item has been included in the Action Plan to improve these forward estimates within flood liable areas, in order to allow better planning of response requirements.

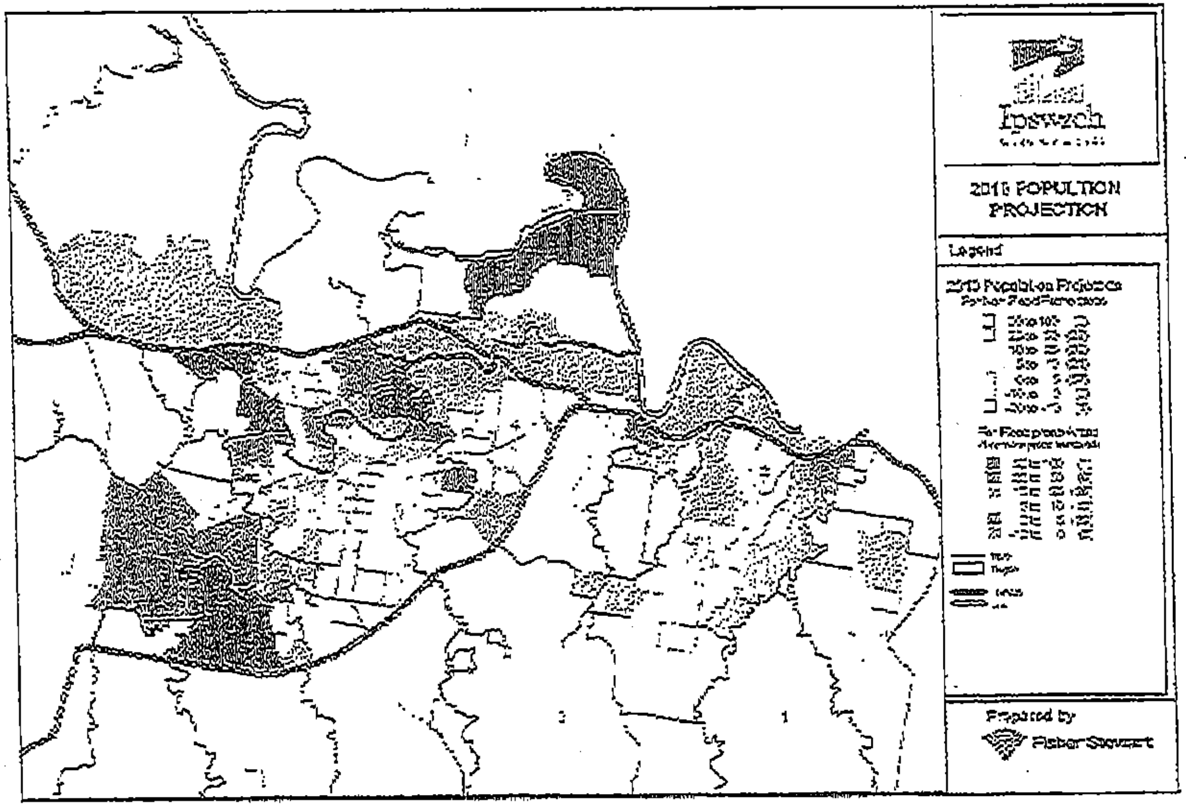


Figure 14 Projected Population Increases – 20 Year ARI Flood Extent

3.1.5. Town Planning Issues

Figure 15 shows the current zoning map, while in **Figures 16** and **17**, the 100 Year ARI flood extent and the Primary Flow Paths respectively, have been superimposed on the zoning maps. These show that although there are a considerable number of flood prone properties, development in these areas has already been restricted. Appropriate treatments to reduce the flood risk in these areas are outlined in **Section 3.2** hereof.

In Figures 15 to 17, where items are marked "PARTICULAR DEVELOPMENT", reference should be made to structure plan precinct designations in these areas.

3.1.6. Road Closure Sequence

A provisional list of road closures in each of the 20, 50 and 100 Year ARI floods were obtained from the flood extent maps. As these maps show the ground DTM only and not that of bridge structures, it will be necessary to check the road levels of the bridges and their approaches in order to determine whether they would indeed be inundated in these events.

The provisional list of closures is given in **Appendix A.** This showed a total of **113 roads** cut during only a **20 Year ARI** event.

Significantly this includes sections of:

- The Ipswich Motorway at the Goodna Creek, Woogaroo Creek and Six Mile Creek crossings;
- Brisbane Road at the Bundamba Creek, Deebing Creek crossings;
- The Warrego Highway at the Bremer River, Sandy Creek (North), and Ironpot Creek crossings; and
- The Cunningham Highway at the Warrill Creek, Purga Creek, Deebing Creek, and Bundamba Creek crossings.

These are all important regional routes as well as major routes through Ipswich.

Figure 18 shows the major traffic routes together with the 100 Year ARI flood extent.

3.1.7. Road Damage

Council has good records of road damage occasioned in the May 1996 flood, which was approximately 10 Year ARI. The damaged roads were mostly gravel roads in the rural parts of the City, and damage repair costs totalled some **$776,500**. Indexed to 2002 prices, this is equivalent to **$900,000.** These records are given in **Appendix B.**

3.1.8. Lifelines and Critical Facilities at Risk

Critical facilities at risk from flooding were identified by AGSO (2001), and this list is reproduced (modified for recent local government boundary changes) in **Table 5.**

Table 5 Impact of Sequence of Floods on Critical Facilities
Source AGSO (2001a)

Facility	Flood Impacts (Location)
Power supply – substation/transformers	1 at 20 Year ARI to 100 Year ARI (Yamanto) Several at PMF (Yamanto, Swanbank (4), Amberley, Ipswich, North Ipswich, Kholo))
Telephone Exchange	1 at 100 Year ARI (Ipswich) 3 at PMF (Ipswich, Booval, Brassall)
Oil/Fuel Depot	2 at 100 Year ARI (Bundamba, Wulkuraka) 3 at PMF (as above plus West Ipswich)
Ambulance Station	PMF only (Redbank, Ipswich)
Police Station	PMF only (Goodna)

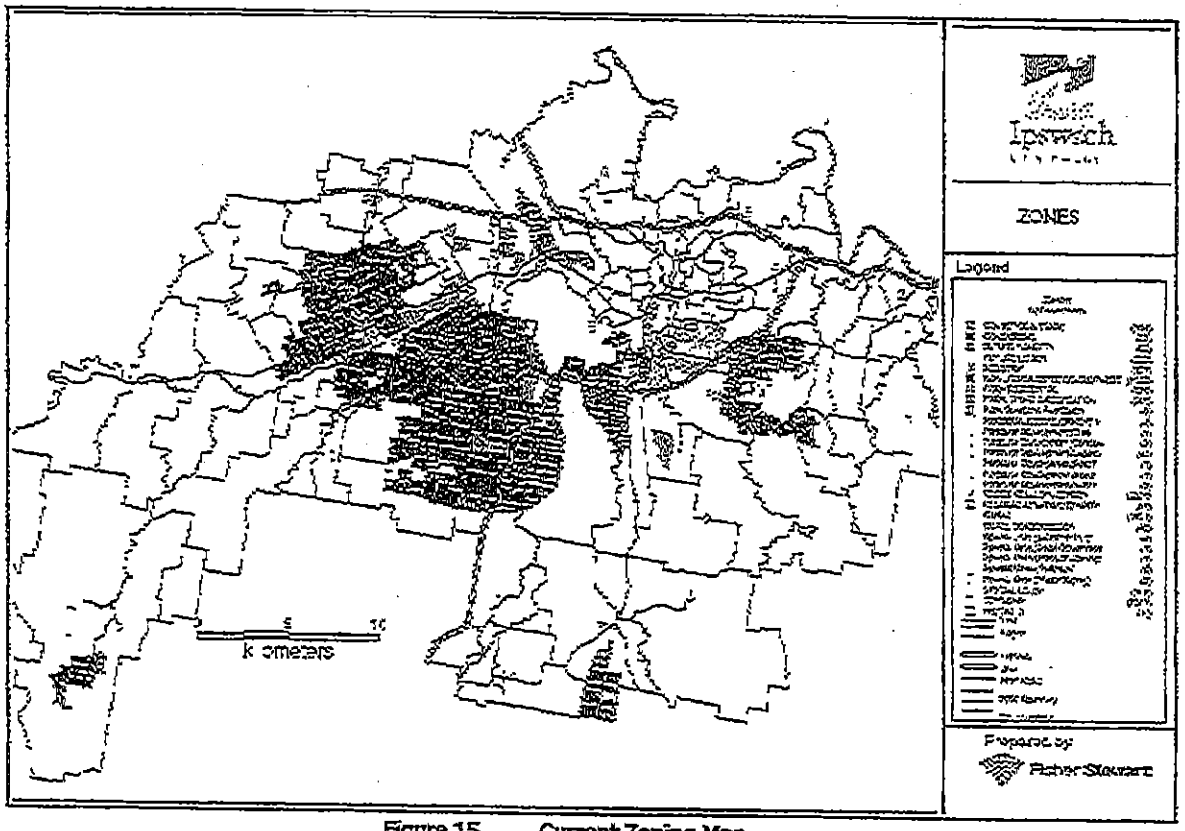


Figure 15 Current Zoning Map

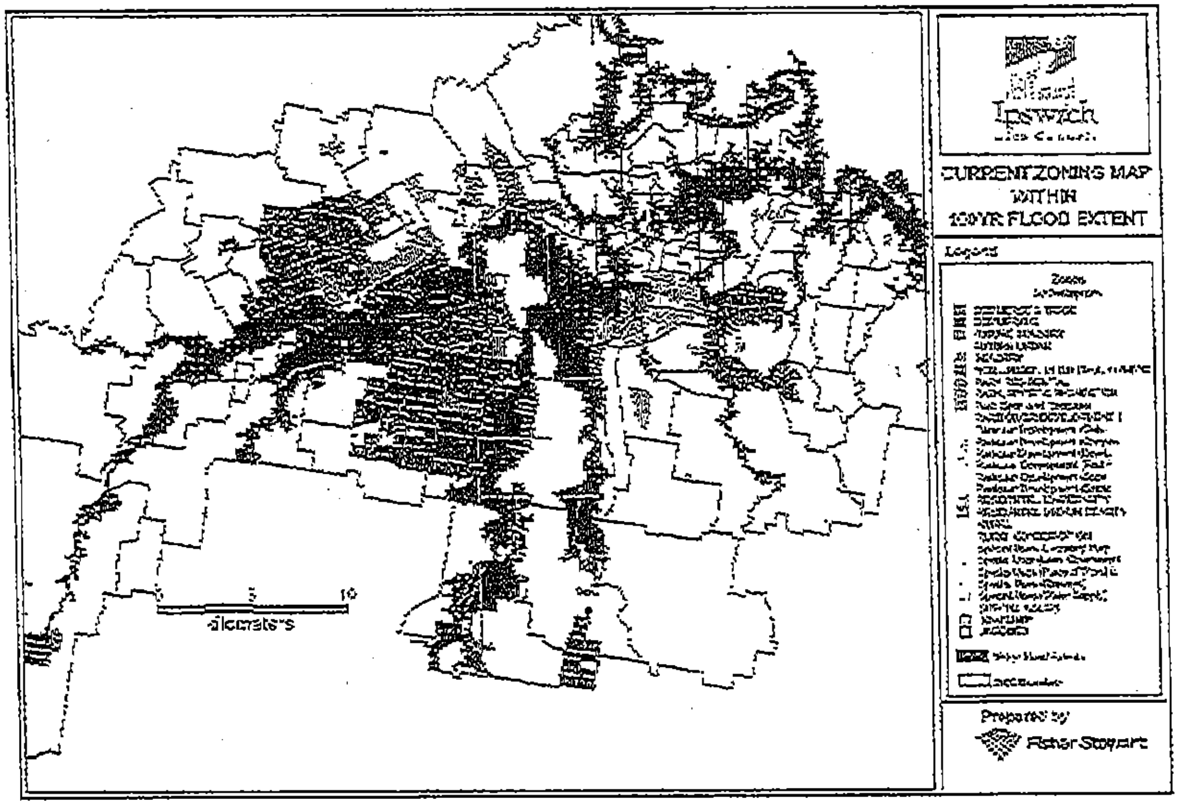


Figure 16 Current Zoning Map showing 100 Year ARI Regional Flood Extent

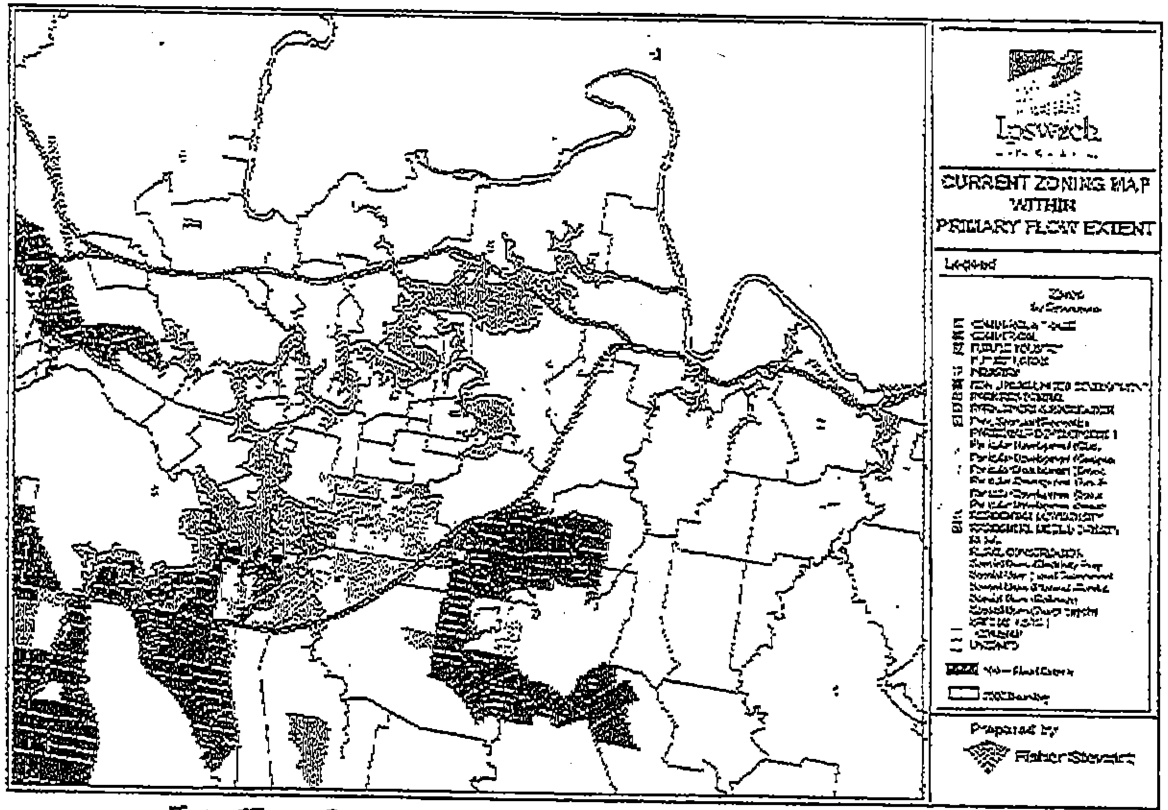


Figure 17 Current Zoning Map showing 100 Year ARI Local Flood Extent

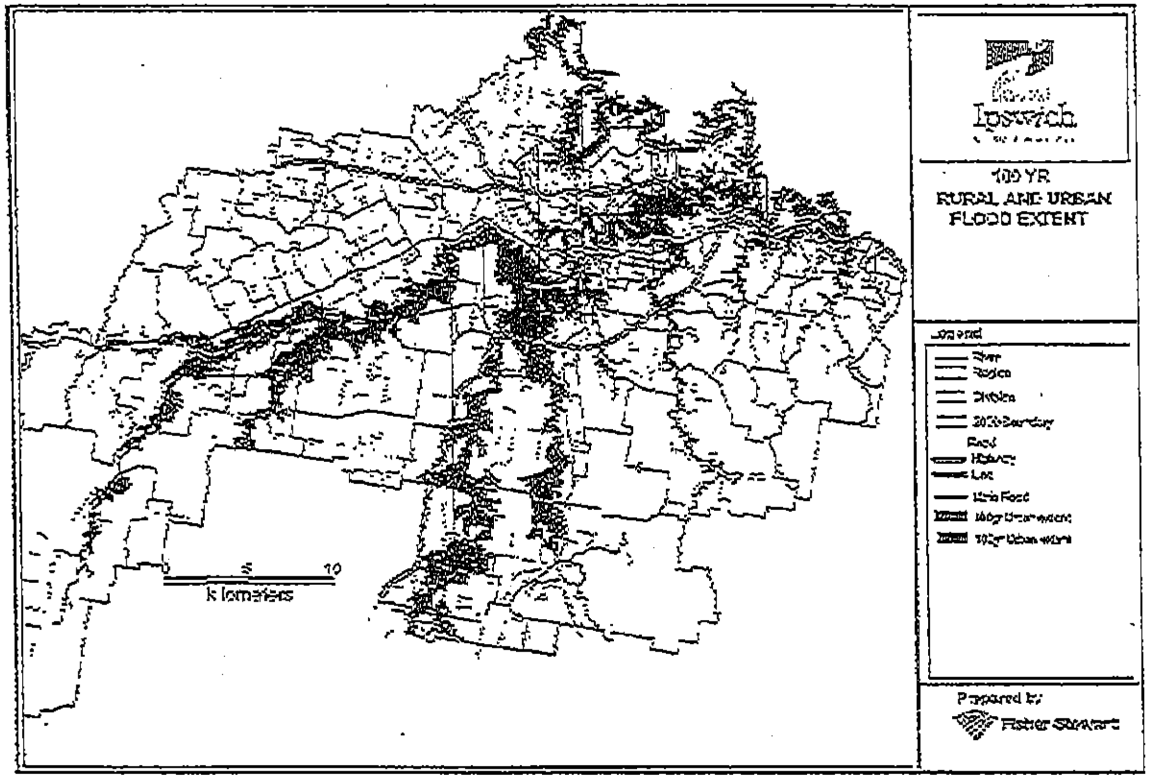


Figure 18 100 Year ARI Flood Extent showing Major Traffic Routes

AGSO (2001a) estimated the length of roads and rail lines, which would be inundated under the range of flood scenarios considered, and this is reproduced in **Figure 19.**

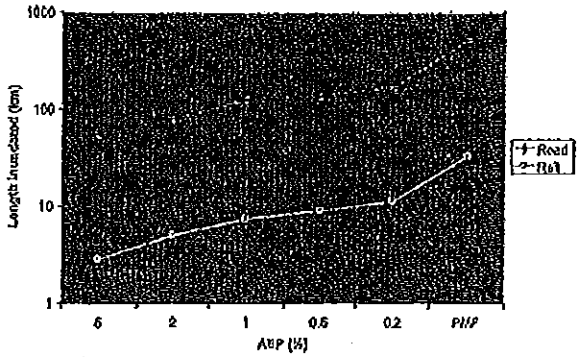


Figure 19 Road and Rail Inundation
Source AGSO (2001a)

3.2. Treatment Options- Prevention Measures

3.2.1. Town Planning Scheme

The new Town Planning Scheme should include measures to reduce the risk of flooding, by limiting further development within the floodplain. These should include the following:

- In already developed areas, development controls should be very strict within both the primary flow paths and the 20 Year ARI flood extent, with a view limiting the population at risk over time; and
- In undeveloped or *Greenfield* areas, development below the 100 Year ARI Regional Flood levels should be strictly limited;
- Developments should also take account of access to and egress from the areas during flood.

3.2.2. Reduction of Risk in Primary Flow Path

Properties within the primary flow paths are at high risk of damage or even of being washed away if not securely anchored.

Ideally, the long-term strategy would be to remove these properties so that the primary flow path is unencumbered by buildings. On the basis of there being approximately **1400** flood liable properties within the primary flow paths, (see **section 3.1.3.**), and at an average current price of **$80,000,** the cost to acquire all of these properties would be about **$112 million.** Significant external funding would be required before Council could embark on a program to acquire these properties.

3.2.3. Potential for House Raising

There are a large number of timber highset homes in Ipswich, which could potentially be raised so that their habitable flood level is above some flood level (to de designated).

At present the building database does not include information on construction materials, and includes only an estimate of floor level based on photogrammetric measurement of eaves level minus an assumed floor to eaves height.

In order to evaluate the effectiveness of house raising as a damage mitigation option, the building database needs to be augmented to include this information, initially for houses up to 100 Year ARI flood level, and then for rarer floods up to PMF.

This should also include noting which houses have a heritage listing, as it will not be possible to raise these.

With this information, it will be possible to evaluate the costs and benefits of house raising as a mitigation option.

As a preliminary estimate of cost, assuming approximately **1500** flood liable properties within the 100 Year ARI flood extent were raised, (see **section 3.1.3.)**, and at an average current price of **$20,000**, giving a total of about **$30 million.**

3.2.4. Flood Control Storage

Council has recently completed construction of a flood control storage at Rosewood, and is currently planning a similar storage at Marburg. These storages reduce the population at risk by limiting flood discharge and hence flood level.

Both of these projects have been funded under the *Regional Flood Mitigation Program.*

Council has also identified a number of other potential flood storage schemes, and these are listed in **Appendix C.**

All of these schemes require further investigation to determine their feasibility, effectiveness, economic viability and level of community acceptance.

3.2.5. Levees

Similarly, there are a number of areas where levees could be constructed to reduce the exposure of sections of the community to flood risk.

Some of the locations with potential for levee construction were identified in SKM (2000).

Given the new flood mapping now available, a thorough review of the potential for levees is warranted. All such potential schemes require further investigation to determine their feasibility, effectiveness, economic viability and level of community acceptance.

3.2.6. Road Damage Reduction

Gravel roads in rural areas are subject to flood damage. Where such damage occurs, repair claims under the Natural Disaster Relief Arrangements (NDRA) are limited to reinstatement to the previous standard. This leads to recurrence of similar damage in each successive flood.

Under current arrangements, the cost of any improvement in design standard is the responsibility of the local authority, giving it little or no incentive to raise the standard of construction.

One of the guiding principles of the current NDRM initiative is to mitigate damage to reduce the cost of future events, particularly where these are likely to recur. Rural roads fall into this category, and it is appropriate for their design standards to be raised to reduce recurrent damage.

As bitumen sealing of all such roads is unlikely to be achievable, other measures such as rock protection would be appropriate.

Possible measures are illustrated in **Figure 20.** Complete armouring of the downstream batter of the road embankment with rock riprap protruding 100 – 200mm above the road surface (as in **Figure 20 a**) will reduce erosion on the road surface and the embankment.

A lower cost treatment of placing a line of rock along the downstream edge of the roadway (as in **Figure 20b**) will increase depth and reduce velocity across the road itself but will not protect the embankment. Placing rock at the embankment toe will provide some protection against erosion. Type b) treatment will only be successful where conditions are appropriate.

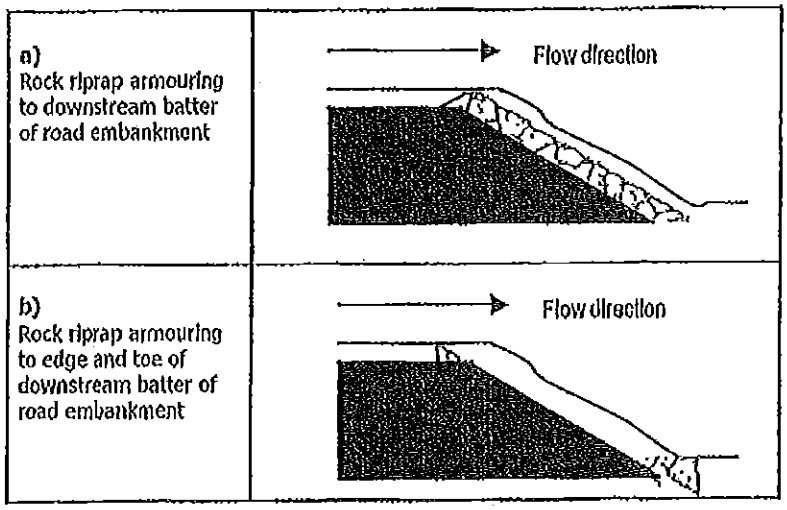


Figure 20 Possible Protection Works to Rural Roads

3.2.7. River Bank Erosion

In some locations, high velocity flow both within river channels and on the floodplain can lead to erosion. Whilst this is a natural process, it causes problems where the land has been developed due to encroachment on the developed areas. In extreme cases, river course change, or avulsion, may occur, with severe consequences where the new course is through a developed area. Also, such changes, by shortening the river's course and increasing its gradient, can initiate a cycle of channel deepening and widening.

The **Ipswich Rivers Improvement Trust (IRIT)** undertakes river erosion protection works within its limited budget. Both public (Council and Ipswich RIT) and private assets are at risk from bank erosion, for example on the Bremer River at North Station Road.

A legacy of the sand dredging in the Brisbane River, which ceased only in recent years, is that certain reaches of riverbank are subject to slip failure. This is a result of the geomorphic process by which deepening of a river's course generally leads to its widening.

An ongoing program of bank protection works is required to deal with these challenges.

3.2.8. Treatment of Lifelines

The provisional assessment of road closures due to flooding (see **Section 3.1.6**) shows that a considerable number of roads are inundated in even a 20 Year ARI event. The first step in treatment is to further evaluate these locations, to check whether the bridges or bridge approaches will actually be inundated as shown by the DTM. This evaluation should also check whether the structures are heritage listed, as this will impact on the treatment possible.

On the basis of the provisional assessment, the frequency of flooding of major roads, including sections of the Ipswich Motorway, Brisbane Road, Warrego Highway and Cunningham Highway at less than 20 Year ARI is considered to be unacceptable.

Responsibility for these major routes lies with the Department of Main Roads, who should be urged to upgrade these routes to at least 20 year ARI flood immunity as soon as possible.

The Mitigation Plan should include a program of works to upgrade the major routes, and any local roads, which will not have an alternative trafficable route during flood conditions.

In addition, there are a number of timber bridges, which are more vulnerable than their modern counterparts due to their age and condition. Council has a *Timber Bridge Replacement Program*. It is recommended that the priorities within this program be reconsidered in the light of road closures due to flood as well as on structural condition.

Timber bridge at Rosewood (Photograph BOM)

A number of other lifelines are dependant on bridges remaining intact, not only in regard to road and rail links, but also water supply, sewerage, power

and telecommunications, all of which often use bridges to cross rivers and other infrastructure.

AGSO (2001a) also estimated that about 10 km of railway would be inundated in a 100 Year ARI flood event. Queensland Rail should be urged to look at upgrading the track in these locations, but should not be required to not exacerbate flooding with any works they undertake.

Electricity and telecommunication lifelines may be damaged or cut as a result of flooding, storm, bushfire, earthquake, landslide and even extreme temperatures (if this results in capacity being exceeded). As many other lifelines and critical facilities are dependant on maintenance of these key lifelines eg water supply, sewerage and rail transport, the community is vulnerable to their interruption.

Whilst short interruptions of these lifelines, say of up to a few hours duration, can be tolerated, any extended period of loss of these lifelines will lead to widespread distress, and potential health and other problems.

A survey needs to be undertaken of all such infrastructure which is below the 100 Year ARI flood level, in order to develop a prioritised action plan. As much of this infrastructure is outside Council's control, it is recommended that Council coordinates these activities as well as dealing with its own buildings, road, water and sewerage infrastructure.

3.2.9. Treatment of Critical Facilities

As for lifelines, critical facilities are primarily dependant on power and telecommunications. Hospitals, for example, usually have sufficient on-site generation capacity to meet minimum requirements.

However, other facilities such as refrigerated food distribution centres may not have such facilities. In this case, even whilst the power grid being able to provide supply from an alternative source may give some protection, the facility may be vulnerable to power line failure if there is no duplication of reticulation. The provision or not, of onsite standby generation plant then becomes an issue in commercial risk management for the facility.

Critical facilities should also have duplication of water supply if possible.

Some critical facilities are located in flood prone or bushfire prone areas, and hence have a relatively high vulnerability. These were listed in **Table 5.**

The long terms strategy should be to relocate all critical facilities from the PMF floodplain. As none of these are the direct responsibility of Council, it is recommended that Council take a coordinating role in this treatment component.

3.3. Treatment Options -Preparedness Measures

3.3.1. Upgrading Flood Warning System

The flood warning system for the Brisbane and Bremer River systems has been upgraded considerably over recent years, with the installation of an ALERT real-time telemetry system.

The current system for the **Bremer River** is shown in **Figure 22** and for the **Lower Brisbane River** is shown in **Figure 23.**

It is the responsibility of the Bureau of Meteorology (BoM) to prepare and issue warnings for major river systems. However, the local authority is responsible for warnings of *flash flooding* in minor systems and tributaries where the warning time available is less than about 6 hours.

It can be seen from the network maps in **Figures 22** and **23** that most tributaries have some warning capability, but in some instances, there is no flood warning instrumentation in the catchment headwaters.

These maps indicate that the following creeks have no flood warning infrastructure: Sandy Creek, Goodna Creek, Six Mile Creek, Ironpot Creek, and Sandy Creek North.

The system could be further improved with additional streamflow and/or rainfall stations in the headwater reaches of Deebing Creek, and Western Creek (upstream of Grandchester).

The BoM runs hydrological models (using the URBS model) to predict river heights from upstream data. When the system is upgraded by the addition of new stations, the Bureau will update the model to incorporate data from the new station.

3.3.2. Flood Warning Interpretation and Dissemination

Flood warnings are issued by the Bureau of Meteorology to Council, Police and Emergency Services, and are broadcast to the public principally via the radio. These warnings are also available on the Internet.

The warnings are issued giving predicted flood heights using a classification scheme such as that in **Figure 21** for the Bremer River. The average member of the public has difficulty in interpreting warnings of this type to their own situation, especially where they have no previous flood experience there.

There are a number of possible measures to facilitate this interpretation:

- Distribution of flood maps to all residents in the flood prone areas, showing flood contours for each of a range of stage heights at their nearest flood warning gauge, together with information regarding reading and interpreting these maps;

- The erection of permanent flood markers through out the flood prone areas, say at street intersections, showing the level at that point for a range of heights at the nearest flood warning gauge, possibly showing the height of say the 1974 flood. These could make use of existing street furniture such as lighting poles or telephone poles.

- As an alternative to the above, the corresponding levels could be marked on each house, say on the inside of the electricity supply box. This would require more resources than marking each street block.

We recommend that, in the first year, these options be canvassed with the community, in order to determine which approach is most suitable. Implementation of the preferred action would then be undertaken in subsequent years. These recommendations have been included in the treatment strategies.

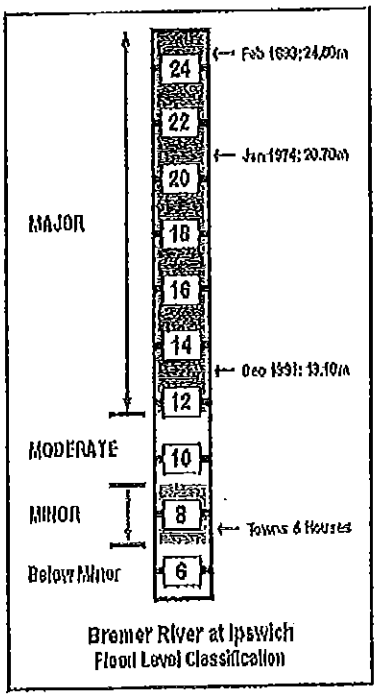


Figure 21
Bremer River at Ipswich
Flood Level Classification
(Source Bureau of Meteorology)

BUREAU OF METEOROLOGY
Queensland Regional Office

MAP 143.0

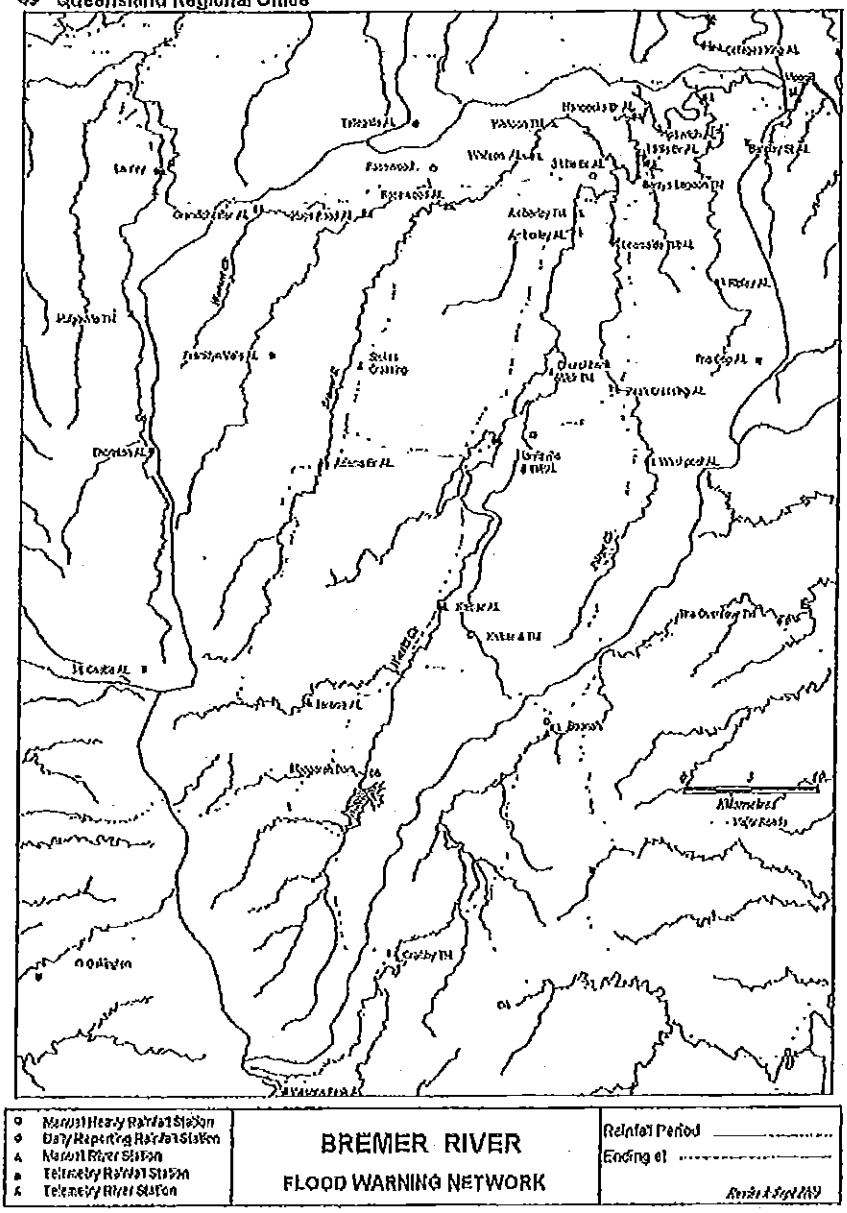
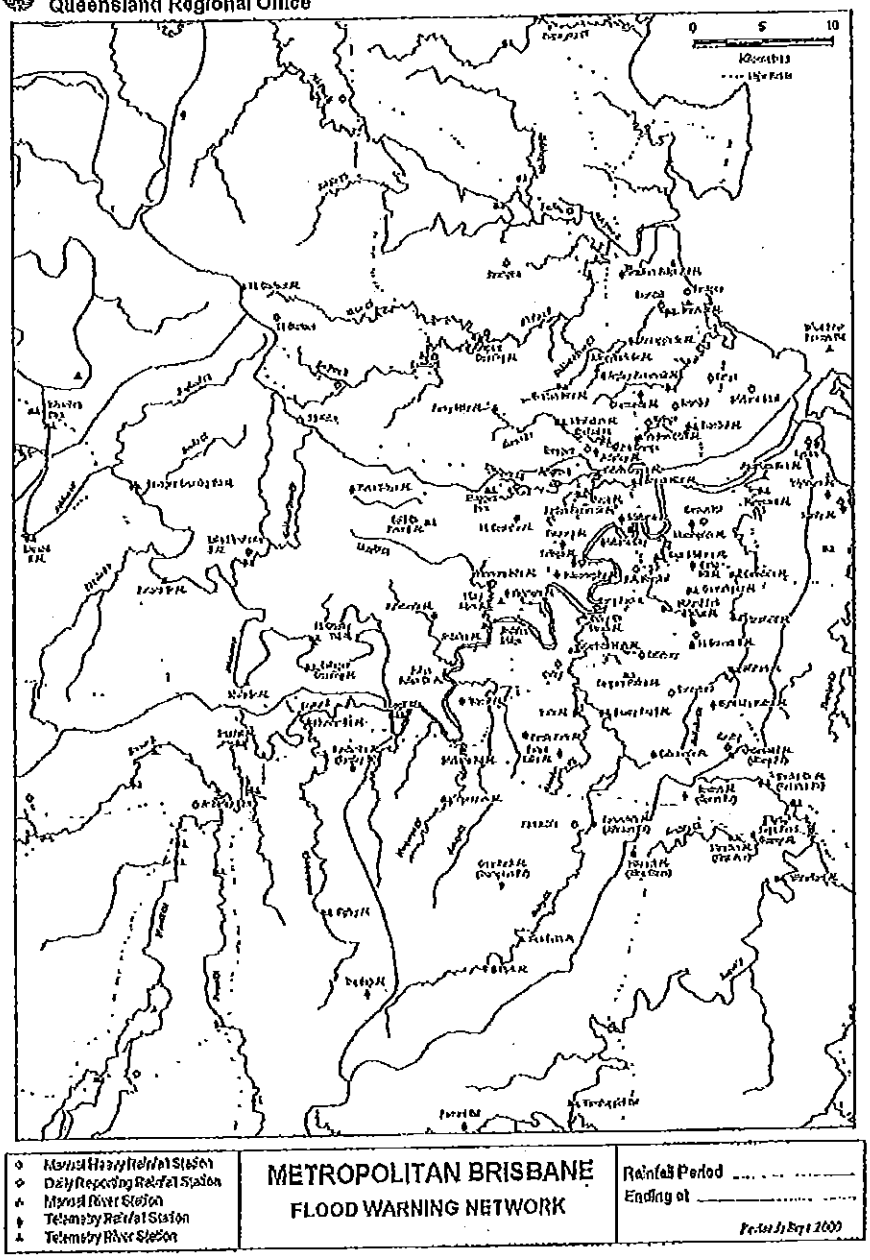


Figure 22 Bremer River Flood Warning Network
(Source Bureau of Meteorology)

BUREAU OF METEOROLOGY
Queensland Regional Office

MAP 143.3



Manual Heavy Rainfall Station
Daily Reporting Rainfall Station
Manual River Station
Telemetry Rainfall Station
Telemetry River Station

METROPOLITAN BRISBANE
FLOOD WARNING NETWORK

Figure 23 Lower Brisbane River Flood Warning Network
(Source Bureau of Meteorology)

3.3.3. Community Awareness

The raising of community awareness in respect of flooding issues is an important component of the treatment strategies.

In respect of awareness of flooding, it is proposed that the following strategies be adopted:

a) Information for the whole community

- General information regarding the nature of flooding in Ipswich
- Flood maps
- General information on being prepared for floods, and what each householder can do to reduce damage.

b) Information to householders affected by flooding

- As above, plus
- Specific information regarding flood levels at their property, and how to interpret flood warnings

c) Information to businesses affected by flooding

- As for a) and b) above, plus
- Information regarding preparation of a flood management plan for the business.

In order to encourage the latter, we have included h the recommended strategies, for Council to undertake or fund, the preparation of one or more such plans by way of a pilot program.

The material prepared for distribution to the community should take account of the multi-cultural nature of the Ipswich community, and should include non-English language brochures. It will be developed in conjunction with Council's Community Services Department, and coordinate with the latter's Facilities Plan.

Council has an Emergency Management section in its website. The newly developed material and that in the website will need to be consistent, and it will be beneficial for the new material to be available via the website.

3.3.4. Rural Addressing

The location of rural properties by Emergency Services personnel or by air for food drops or evacuation frequently causes problems for flood response personnel.

These requirements are met in large part by the Rural Addressing Initiative of the Department of Emergency Services and the Local Government Association of Queensland (DES and LGAQ 1996, ANZLIC 1996). Ipswich City Council is currently implementing these guidelines, which are based upon addressing each property according to its distance along a particular road.

We recommend that, in addition to implementation of the rural addressing according to these guidelines, that the map coordinates of each property be recorded within Council's GIS so that they can be reached directly from their coordinates, as may be necessary by air, should roads be impassable.

3.4. Treatment Options - Response and Recovery Measures

Response resources are in place and coordinated between Council, DES, SES and the Police, Ambulance and Fire services.

Whilst resource locations such as SES Depots should be sufficiently close to flood prone areas, they should not be within those areas, in order that they are accessible at all times. It is also important that these and other resources such as counter disaster response centres have power supplies and communication links, which are not themselves threatened by flooding.

Future resource requirements should be planned according to the above criteria, and taking account of projected future populations and forecast changes in population distribution.

As outlined in **section 3.1.4**, an item has been included in the treatment strategies to improve these forward estimates within flood liable areas, in order to allow better planning of response requirements.

Similar considerations apply in respect of recovery resources, although resource distribution is a lesser issue in this context, as these resources do not need to mobilise early in an event.

4. Severe Storms

4.1. Risk Evaluation Studies

4.1.1. History of Storm Damage

The Ipswich SES provided records of locations of their responses to storm damage since 1997, and these were summarised by CCD and by suburb via Council's GIS. These are plotted in **Figure 24**. This analysis was undertaken to see if there was any credence to perceptions raised at the CFG workshops that certain locations were more susceptible to storm damage. The distribution of storm damage responses in recent years given in **Figure 24** does not support this perception.

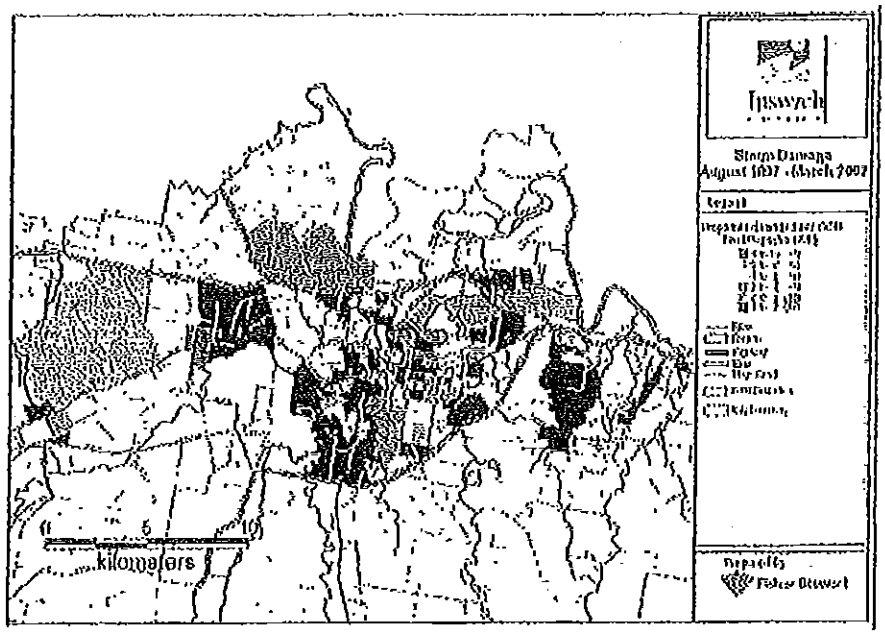


Figure 24 Location of Storm Damage 1997 – 2002

4.1.2. Lifelines at Risk

Strong winds can cause widespread damage to buildings and infrastructure, and in extreme cases, loss of life or serious injury. Strong winds are generally associated with tropical cyclones, tornados or storms. On average 1.2 cyclones pass within 500km of Brisbane each year. In the last 92 years, 15 cyclones have past within 100km of Brisbane.

In contrast to floods, which occur infrequently, some wind damage occurs most years, and is the most common cause of emergency response in

Ipswich. AGSO (2001a) estimated that, on average, there is 1 tornado day per year and 2 damaging storms in the Ipswich area.

The most intense rainfalls occur during thunderstorms and may be accompanied by hail. Heavy rain may cause building damage by water penetration particularly when accompanied by wind damage to roofs, and by overflowing of roof water systems and stormwater pipes which may in turn cause localised erosion.

Hail is most likely to cause damage to property and infrastructure (eg roofs, cars and power supplies, telecommunications), although if people are unable to find suitable shelter, serious injury or even death could result. Windows are the most susceptible to damage from hail (usually occurs at size between 30-40mm). Aluminium awnings, external shades and vinyl sidings are also susceptible. Roofs and guttering can become damaged and in severe cases (eg Sydney Hail Storm) can result in damage to contents if the roof integrity is broken. The roofs likely to be worst affected are aged asbestos cement sheeting, brittle tiles and corrugated iron.

While the Bureau of Meteorology monitors thunderstorms and issues advice and warnings associated with severe thunderstorms, the location and intensity of the storm is difficult to predict. Within the SEQ region there are reliable reports of hail up to the size of 120mm. The most significant hailstorm on record for Brisbane occurred in January 1985 (hailstones as large as 63mm). A hailstorm in Brisbane in November 1995 reportedly damaged the roofs of more than 300 homes.

AGSO (2001a) estimated that there are, on average, 20 severe thunderstorms per year in the Ipswich area, which generally occur between the months of October to April. Lightning is produced by almost all thunderstorms at an average rate of 2 flashes per minute. Hail is produced by approximately 30% of thunderstorms.

Lightning strikes claim approximately 10 lives per year in Australia (650 deaths between 1803-1991). Telephone use during thunderstorms results in a common form of injury related to lightning strikes, due to earth potential rise (PER). People are warned against using telecommunications during thunderstorms. Due to the random spatial spread of strikes, the location of cloud to ground strikes is impossible to predict.

Secondary hazards include:

- High rates of stormwater runoff resulting in flash flooding;
- Initiation of landslides/mudslides in susceptible areas;
- Significant public safety risk from fallen powerlines and trees; and
- Fallen powerlines and lighting strikes can initiate bushfires.

The major risks are the public safety risks resulting from fallen trees along roads, especially at night, and from fallen powerlines that remain energised.

4.1.3. Critical Facilities at Risk

No critical facilities are specifically at risk from severe storms. The main risk is loss of electricity supplies, which may be damaged by storms. Critical facilities should have a standby or a duplicate power supply.

4.2. Treatment Options - Prevention Measures

During Stage 3, Energex the local electricity supply agency and Telstra were contacted to obtain information in respect of their strategies for dealing with and supply locations that had been found to be particularly vulnerable to storm damage. Unfortunately, no information was provided by those sources.

The following have been proposed in the treatment strategies:

- Review the potential for relocating vulnerable power lines and telecommunications cables underground (first year), with implementation in subsequent years;
- Review with Energex, the rescheduling of their tree maintenance program to maximise its effectiveness (in spring).

4.3. Treatment Options - Preparedness Measures

The following preparedness measures have been proposed in the treatment strategies:

- Reduce the vulnerability of the community at risk by education and awareness raising of storm related issues, including house maintenance issues;
- Reviewing with the Bureau of Meteorology the scope for improving the timeliness and effectiveness of severe storm warnings;
- Reduce the risk to pre-1980 building stock by way of pre-sale inspections and building approval inspections encouraging raising standards to meet current building codes, and in order to meet increasingly stringent insurance requirements.
- Implementing rural addressing as for floods (see **section 3.3.4**).

4.4. Treatment Options - Response and Recovery Measures

Response resources are in place and coordinated between Council, DES, SES and the Police, Ambulance and Fire services.

It is also important that response resource depots and counter disaster response centres have duplicated or standby power supplies and communication links that are not themselves threatened by storm damage.

Future resource requirements should be planned taking account of projected future populations and forecast changes in population distribution.

Similar considerations apply in respect of recovery resources.

5. Bushfires

5.1. Risk Evaluation Studies

The primary risks associated with bushfires in Ipswich are properties and infrastructure (eg wooden power poles and bridges) that are located on the urban fringe, and in rural areas. The likelihood of bushfires in urban areas is low as vegetation clearing is undertaken during the development of commercial, industrial and sewered residential development.

Bushfire prone areas in the urban areas of Ipswich are in Camira, Carole Park, Opossum Creek and Pine Mountain. However, the majority of rural land in Ipswich is dominated by grassland and pasture and is consequently, of low risk. Bushfire hazard maps were obtained from the rural fire authority, and given in the Stage 1 Report. This is reproduced in **Figure 25**, which shows areas of high and moderate bushfire risk.

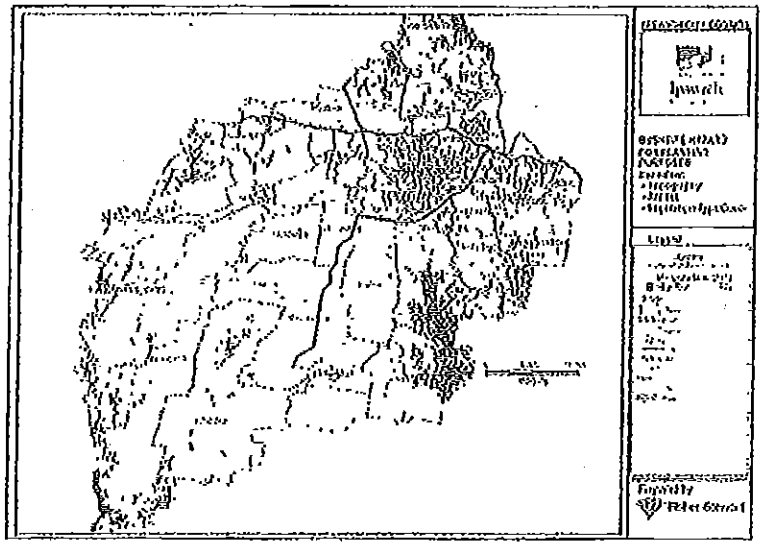


Figure 25 Bushfire Hazard Map
Source - Rural Fire Service

Vulnerability of the community relates primarily to their location vis-à-vis these risk areas. In addition to buildings and infrastructure within these areas, and the people occupying these buildings, people in vehicles or on foot in or crossing these areas are also vulnerable. The vulnerability of buildings is minimised by adherence to the building codes.

There are about **1,380** properties (about **4,200** people) located within areas of **high bushfire risk**, and a further **5,350** properties (about **16,000** people) in areas of **moderate bushfire risk**.

Secondary hazards include:

- Road, electricity supply and telecommunication lifelines may be damaged and interrupted;
- Fallen powerlines which can ignite further fires;
- Increased runoff after fire can lead to soil erosion and nutrient transport leading to water pollution or eutrophication; and
- Smoke pollution can be a traffic hazard and in extreme cases a health hazard.

5.1.1. Rural Residential Development in Bushfire Prone Areas

Council has requirements in its Planning Scheme for the design of rural residential developments. Also, all buildings in rural residential areas should comply with the Guideline *Siting and Design of Residential Buildings in Bushfire Prone Areas* (DLGP 1997) and Australian Standard AS3959-1991 "*Construction of buildings in bushfire prone areas*" as required under the Queensland Building Act (1993).

Measures in place or under consideration to reduce vulnerability or improve disaster response include:

- Water supply requirements to full urban reticulation standards to ensure fire fighting capability;
- The requirement for a minimum 20m road reserve width to act as a fire break;
- No cul-de-sacs are permitted in such areas, to minimise access/egress problems.

5.2. Treatment Options - Prevention Measures

The following have been proposed in the treatment strategies:

- Review the potential for relocating vulnerable power lines and telecommunications cables underground (first year), with implementation in subsequent years in order to reduce risk to lifelines;
- Review with Energex, the rescheduling of their tree maintenance program to maximise its effectiveness (in spring) in order to reduce public safety risk;
- Reduce lifeline risk in bushfire prone areas by implementation of the Timber Bridge Replacement Program;

- Monitor and evaluate the effectiveness of current fire management and fuel reduction strategies, and recommend any changes to the responsible agencies.

5.3. Treatment Options - Preparedness Measures

The following preparedness measures have been proposed in the treatment strategies:

- Reduce the vulnerability of the community at risk by education and awareness raising of bushfire related issues, including house maintenance issues;

- Reduce the risk to building stock predating bushfire provisions in the building codes by way of pre-sale inspections and building approval inspections encouraging raising standards to meet current building codes;

- Implementing rural addressing as for floods (see **section 3.3.4**).

5.4. Treatment Options - Response and Recovery Measures

Response resources are in place and coordinated between Council, DES, SES and the Police, Ambulance and Fire services.

It is also important that response resource depots and counter disaster response centres have duplicated or standby power supplies and communication links that are not themselves threatened by bushfire. For example, the SES' Bellbird Park Depot is located in a high bushfire risk area.

Future resource requirements should be planned taking account of projected future populations and forecast changes in population distribution.

Similar considerations apply in respect of recovery resources.

6. Summary of Risk Treatment Strategies

Details of the proposed risk treatment strategies are given in the Natural Disaster Risk Management Report (Fisher Stewart 2002a) and the Natural Disaster Mitigation Plan (Fisher Stewart 2002b). A summary is given below.

The risk treatment strategies were divided into 3 categories, namely:

d) Actions already in hand or implemented;

e) Actions endorsed by Council for implementation; and

f) Proposed future actions subject to funding availability

Actions listed under c) require major funding and are beyond Council's ability to fund totally. This section also includes actions that are not within Council's responsibility.

Due to the scale of some of these actions, a ten-year implementation program is proposed.

A summary of the costs of the actions proposed under b) and c) is given in **Table 6.**

Table 6 Costs of Proposed Risk Treatment Actions

Hazard	Estimated Costs Year 2002-2003	Estimated Costs Year 2003-2012	Estimated Costs Total
Floods – People and Buildings	$2.07 million	$164 million	$166.1 million
Floods – Environment, Lifelines and Critical Facilities	$0.35 million	$137 million	$137.4 million
Floods Sub-total	**$2.42 million**	**$301 million**	**$303.5 million**
Severe Storms	$0.25 million	$23.1 million	$23.4 million
Bushfires	$0.19 million	$20.6 million	$20.8 million
TOTAL	**$2.9 million**	**$345 million**	**$348 million**

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Appendix A

Provisional List of Road Closures

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Duncan	Street			
Dunlop St				
Halletts	Road		Collingwood drive	
Ipswich	Motorway			
Redbank Plains	Road			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Mt Crosby	Road			
Warrego	Highway			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Addison St	Camira			
Cochrane Street	Camira			
Ishmael Road	Camira			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Fernvale	Road	All roads at a the 20yr plus	All roads at a the 50yr plus	
Haig	Street			
Hunter	Street			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Gregory	Street	All roads at a the 20yr plus	All roads at a the 50yr plus	Toongarra/Karrabin Rosewood Road Cunningham Highway
Sydney	Road			
Warrego	Highway			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT	50 YR EVENT	100YR EVENT	Alternate Route
Warrill Creek	All roads at a the 20yr plus	All roads at a the 50yr plus	
Cunningham Highway	Suffield Drive		
South Amberley Road	Behms St		
Purga Creek Berry St Cunningham Highway Lobb St Midland St			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		150 YR EVENT	100YR EVENT	Alternate Route
Lobb	Street	All roads at a the 20yr plus	All roads at a the 50yr plus	
Ash	Street	Briggs Rd		
Cunningham	Highway			
Huxham	Street			
Toongarra Rd/Brisbane Road				
Warwick	Road			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

ROAD CLOSURE SEQUENCE

20 YR EVENT		50 YR EVENT	100YR EVENT	Alternate Route
Andrew St		All roads at a the 20yr plus	All roads at a the 50yr plus	
Barclay	Street			
Barrams	Road	Intersection of Mine, Chalk and Collingwood Dr		Fox and Law St South
Bergin Hill	Road	Bridge St		
Brisbane	Road			
Brisham	Road			
Cunningham	Highway			
David	Street			
Gledson	Street	Alternate route - Wildey St		
Mary	Street			
North Station Road				
Oxford St				
Rippley	Road			
South Station	Road			
Swanbank	Road			
Thomas/ BlackStone	Street			
Videroni	Street			
Wards	Road			
Watsons	Road			

High Priority Roads: Roads where are no obvious alternate route available
Roads are completely inundated

Appendix B

Rural Road Damage and Repair Costs May 1996

Key	Division	Road Number	Road_Name	Suburb	Road Length (m)	Type	Width	Length_m	Damage	Cost
39	0	2024	Minden Post Office Road		1900	G		100	Flood Damage - Gravel Resheeting	$2,505
43	10	2025	Neuendorfs Road		500	G		90	Flood Damage - Gravel Resheeting	$2,240
M1	8	2226	Haigslea Amberley Road	Amberley	9620	B		500	Debris removal, edge & pavement repairs	$9,328
57	10	2071	Stevens Road	Ashwell	2710	G		100	Flood Damage - Gravel Resheeting	$2,074
2K	2	4211	Devon Drive	Bellbird Park	320	B	7.3	0	Remove silt from road and restore roadside drainage	$450
2C	2	4003	Jones Road	Bellbird Park	850	B	6.7	0	Takeup and relay collapsed outlet cells of RCBCs including concrete base and endwall with rock	$12,000
2F	2	4222	Jones Road	Bellbird Park	730	B	7.1	0	Remove silt from road and restore roadside drainage and relay collapsed stormwater pipes.	$7,650
2FE3	1	4003	Jones Road	Bellbird Park	0			0	Install hazard signs/barriers, underground drainage repairs	$1,428
2E	2	4160	Nugent Street	Bellbird Park	250	B	7.7	0	Reinstate damaged gravel pavement and wearing surface around manhole	$45,000
2B	2	4157	Oak Street	Bellbird Park	220	B	9.7	0	Remove and relay collapsed stormwater pipes and reinstate road pavement	$4,000
2FE7	2	4202	Peelia Street	Bellbird Park	0			0	Install hazard signs/barriers, underground drainage repairs	$1,091
2G	2	4204	Rosemary Street	Bellbird Park	1010	B	8	50	Remove silt from road and restore roadside drainage	$200
2A	1	4020	Woogaroo Creek	Bellbird Park	1260	G	5.8	80	Flood Damage - Gravel resheeting and drainage repairs	$2,000
2	10	2120	Boundary Road West	Calvert	2120	G		200	Claimed Damage	$3,000
4	10	2109	Franklin Vale Creek	Calvert	1520	G		220	Claimed Damage	$5,504
15	10	2012	Henderson Road	Calvert	2960	G		700	Flood Damage - Gravel Resheeting	$7,854
17	10	2080	Hiddenvale Road	Calvert	8080	B		1000	Flood Damage - Shoulder Resheeting	$7,717
31	10	2072	Kuss Road	Calvert	4020	G		150	Flood Damage - Gravel Resheeting	$2,385
44	10	2074	Neumann Road	Calvert	1150	G		250	Flood Damage - Gravel Resheeting	$4,530
1A	1	5018	Addison Road	Camira	215	B	6.4	80	Restore roadside drainage, remove debris from u/g drainage	$225
1G	1	5410	Cairns Road	Camira	0	B		30	Reinstate collapsed 900dia RCP outlet, desilt inlet & outlet and restore pavement	$21,000
1FE4	1	5021	Cochrane Street	Camira	0			0	Road closure/Hazard signs/Barriers	$679
1B	1	5067	Ishmael Road	Camira	210	B	5.8	15	Restore roadside drainage, remove debris from u/g drainage	$450
1C	1	5117	Josephine Street	Camira	570	B	5.3	25	Remove silt from road and restore from u/g drainage	$225
1D	1	5121	Mikkelson Court	Camira	440	B	7.9	8	Restore roadside drainage, remove debris from u/g drainage	$450
1F	1	5002	Old Logan Road	Camira	0	G		0	Restore outlet from pipe in private property, dumped rock and clean fill	$6,500
1FE11	1	5371	Woodbine Avenue	Camira	0			0	Sandbagging	$2,108
5A	5	1053	Allawah Road	Chuwar	2500	G	6	300	Flood Damage - Gravel Resheeting	$10,780
5B	5	1117	Robin Street	Chuwar	2200	G	4	150	Flood Damage - Gravel Resheeting	$4,020
34	10	2001	Lees Road	Ebenezer	600	G		110	Flood Damage - Gravel Resheeting	$3,551
3FE9	9	4592	Swanbank Road	Flinders View	0			0	Install hazard signs/barriers, pothole patching	$352
1FE6	2	7520	Woogaroo Creek	Gailes	0			0	Road closure/Hazard signs/Barriers	$126
1FE8	2	7562	Woogaroo Creek	Gailes	0			0	Road closure/Hazard signs/Barriers	$126
2FE2	2	9270	Woogaroo Street	Goodna	0			0	Install hazard signs/barriers, underground drainage repairs	$520
5	10	2055	Deenara Road	Grandchester	3540	G		1500	Claimed Damage	$22,101
7	10	2076	Gatton Street	Grandchester	500	G		75	Claimed Damage	$2,686
3	10	2133	Gilbert Road	Grandchester	440	G		75	Claimed Damage	$1,528
9	10	2120	Gordon Road	Grandchester	850	G		80	Claimed Damage	$1,122
20	10	2059	Hornbuckle Road	Grandchester	1400	G		140	Flood Damage - Gravel Resheeting	$2,678
22	10	2140	Ipswich Street	Grandchester	1050	G		700	Flood Damage - Gravel Resheeting	$16,603
49	10	2145	Park Road	Grandchester	500	G		50	Flood Damage - Gravel Resheeting	$1,961
52	10	2142	Road	Grandchester	410	G		200	Flood Damage - Gravel Resheeting	$5,035
58	10	2057	Stokes Road	Grandchester	200	G		110	Flood Damage - Gravel Resheeting	$2,134
64	10	2132	Tommy Road	Grandchester	600	G		90	Flood Damage - Gravel Resheeting	$1,857
16	10	1110	Henry Road	Haigslea	1170	G		95	Flood Damage - Gravel Resheeting	$2,453
35	10	1102	Livingstone Lane	Haigslea	2000	G		70	Flood Damage - Gravel Resheeting	$1,801
40	10	1105	Mierdigs Road	Haigslea	2200	G		300	Flood Damage - Gravel Resheeting	$11,072
47	10	3022	Old Warwick Road	Harrisville	4300	G		400	Flood Damage - Gravel Resheeting	$12,820
M7	10	3222	Warrill View Peak Crossin	Harrisville	14500	B		600	Debris removal, edge & pavement repairs	$12,008
65	10	3000	Webers Road	Harrisville	3000	G		1300	Flood Damage - Gravel Resheeting	$17,617
68	10	3023	Wilsons Plains Road	Harrisville	6400	B		30	Flood Damage - Bridge Repair	$18,751
21	10	1405	Huth Road	Ironbark	1500	G		120	Flood Damage - Gravel Resheeting	$3,015

Rrual Road Flood Damage May 1996

Key	Division	Road Number	Road_Name	Suburb	Road Length (m)	Type	Width	Length_m	Damage	Cost
24	10	1069	Ivan Lane	Ironbark	1620	G		300	Flood Damage - Gravel Reshealing	$4,123
23	10	1107	Ivan Lane	Ironbark	2720	G		300	Flood Damage - Gravel Reshealing	$3,787
36	10	1032	Road	Ironbark	700	G		50	Flood Damage - Gravel Reshealing	$1,719
35	10	1040	Schultze Road	Ironbark	1820	G		200	Flood Damage - Gravel Reshealing	$2,404
M2	10	2217	Bremer Road	Jeebropilly	12040	B		600	Debris removal, edge & pavement repairs	$10,033
4	10	2023	Bremer Road	Jeebropilly	800	G		830	Claimed Damage	$10,033
80	6	2034	Dooley Road	Karrabin	770	G	4	50	Flood Damage - Gravel Reshealing	$3,975
82	6	2203	Dale Road	Karrabin	770	G	4	50	Flood Damage - Gravel Reshealing	$3,680
8K	6	2216	Grace Street	Karrabin	1560	G	6	200	Flood Damage - Gravel Reshealing	$2,205
84	6	2226	Harwoods Road	Karrabin	1530	G	4	250	Flood Damage - Gravel Reshealing	$7,540
8F	6	2219	Mozambik Road	Karrabin	700	G	4	50	Flood Damage - Gravel Reshealing	$7,259
8G	6	2248	Rochill Road	Karrabin	1240	G	4	150	Flood Damage - Gravel Reshealing	$1,405
81	6	2232	Road	Karrabin	700	B	4	50	Flood Damage - Gravel Reshealing	$4,486
45	10	2009	Old Grandchester Road	Lanefield	680	G		50	Flood Damage - Shoulder Reshealing	$1,405
34	10	2002	Rollyz Road	Lanefield	2650	G		300	Flood Damage - Gravel Reshealing	$3,587
33	10	2160	Waters Road	Lanefield	1500	G		400	Flood Damage - Gravel Reshealing	$12,150
32	10	2139	Waters Road	Lanefield	1070	G		1470	Flood Damage - Gravel Reshealing	$11,288
29	10	2073	Western Creek	Lanefield	1540	G		500	Flood Damage - Gravel Reshealing	$2,963
1	10	2021	Blandes Road	Lower Mount V	1740	G		200	Flood Damage - Gravel Reshealing	$2,844
28	10	1370	Kennedy Street	Marburg	200	C		350	Claimed Damage	$6,428
27	10	1367	Marburg Fernvale Road	Marburg	650	B		60	Flood Damage - Gravel Reshealing	$1,666
M5	10	2215	Marburg Calvary Road	Marburg	10650	B		110	Flood Damage - Shoulder Reshealing	$2,277
31	10	1091	Piepers Road	Marburg	1800	B		600	Flood Damage - Culvert repairs, scouring.	$6,162
13	10	3041	Griffiths Road	Mount Forbes	900	G		420	Flood Damage - Underground Drainage	$20,056
14	10	2002	Hedrides Road	Mount Forbes	1070	G		50	Flood Damage - Gravel Reshealing	$1,442
42	10	2006	Mount Forbes School Roa	Mount Forbes	1200	G		150	Flood Damage - Gravel Reshealing	$4,961
63	10	2127	Road	Mount Forbes	1270	G		210	Flood Damage - Gravel Reshealing	$2,201
10	10	2029	Hoopers Road	Mount Morrow	320	G		175	Flood Damage - Gravel Reshealing	$5,913
6	10	2086	Franklyn Vale Road	Mount Mort	830	G		40	Flood Damage - Gravel Reshealing	$333
16	10	2205	Grandchester Mount Mort	Mount Mort	6810	G		60	Claimed Damage	$1,977
12	10	2062	Greys Plains Road	Mount Mort	3060	G		475	Erosion at pipes, Landslip	$18,282
15	10	2061	Hodges Road	Mount Mort	1110	G		600	Flood Damage - Gravel Reshealing	$20,370
39	10	2159	Kings Road	Mount Mort	1250	G		50	Flood Damage - Gravel Reshealing	$1,272
38	10	2126	Mclean Road	Mount Mort	350	G		50	Flood Damage - Gravel Reshealing	$1,359
67	10	3011	Road	Muddapilly	500	G		100	Flood Damage - Gravel Reshealing	$2,014
60	6	1025	Boyton Road	Pine Mountain	1220	G	5.7	75	Flood Damage - Gravel Reshealing	$1,675
61	6	1022	Durik Road	Pine Mountain	770	G	3.3	75	Flood Damage - Gravel Reshealing	$1,980
6C	6	1048	F Hoks Road	Pine Mountain	1730	G	6	50	Flood Damage - Gravel Reshealing	$1,180
6H	6	1142	Farrell Road	Pine Mountain	900	B	4	50	Flood Damage - Gravel Reshealing	$1,400
6E	6	1073	James Road	Pine Mountain	1550	G	6	45	Flood Damage - Shoulder Reshealing	$1,200
6B	6	1035	Pine Mountain Quarry Roa	Pine Mountain	1740	G	4	200	Flood Damage - Gravel Reshealing	$15,100
6I	6	1029	Pine Mountain Road	Pine Mountain	1400	C	4	50	Flood Damage - Gravel Reshealing	$3,520
6D	6	1028	Riverside Drive	Pine Mountain	1080	G	3.5	75	Flood Damage - Gravel Reshealing	$1,200
6G	6	1114	Wycolera Road	Pine Mountain	1300	G	4	50	Flood Damage - Gravel Reshealing	$1,330
2FE4	2	7031	Kruger Parade	Redbank	0			0	Install hazard signs/barriers, debris removal	$1,220
3B	1	4054	Cedar Road	Redbank Plains	147	B	6.2	20	Remove silt from road and restore roadside drainage	$145
3FE3	3	4025	Eagle Street	Redbank Plains	0			0	Install hazard signs/barriers, open drainage repairs	$650
3D	3	4074	Highbury Drive	Redbank Plains	200	B	12	0	Desilt outlet channel and backfill behind scoured stormwater headwall structure	$304
3K	3	4046	Knight Street	Redbank Plains	100	H	7.2	0	Reinstate collapsed stormwater outlet structure, including restoration to private property 27 Knight	$0
2D	2	4035	Kruger Parade	Redbank Plains	200	B	7.8	25	Restore roadside drainage	$0
3F	3	4007	School Road	Redbank Plains	1402	G	5	150	Flood Damage - Gravel reshealing and drainage repairs	$525
3FE5	3	4007	School Road	Redbank Plains	0			0	Install hazard signs/barriers, open drainage repairs	$12,500
										$1,670

FS_Flood_Damage_May_1996

Key	Division	Road Number	Road_Name	Suburb	Road Length (m)	Type	Width	Length_m	Damage	Cost
3G	3	4222	Shannon Street	Redbank Plains	350	b	7.2	15	Restore roadside drainage	$275
2FE8	3	4222	Shannon Street	Redbank Plains	0			0	Install hazard signs/barriers	$195
3K	3	4252	Tonia Street	Redbank Plains	46	B	7.4	35	Remove silt from road and restore roadside drainage	$300
3I	1	4081	Vicki Street	Redbank Plains	533	H	7.2	35	Remove silt from road and restore roadside drainage	$350
3J	1	4003	Willow Road	Redbank Plains	720	B	6	35	Remove silt from road and restore roadside drainage	$650
2G	10	2104	Kannes Road	Rosewood	1550	G		1200	Flood Damage - Gravel Resheeting	$7,595
33	10	2110	Langton Road	Rosewood	1670	G		40	Flood Damage - Gravel Resheeting	$1,217
45	10	2303	Calleigh Colliery Road	Rosewood	770	G		10	Flood Damage - Underground Drainage	$5,538
3FE7	3	4011	Ripley Road	South Ripley	0			0	Install hazard signs/barriers	$185
1E	1	5002	Old Logan Road	Springfield Lak	1824	G	5	90	Profile (200mm depth) using CBR 15 samplings and restore roadside drainage	$20,000
3A	3	4905	Blackheath Road	Swanbank	500	G	5.2	80	Flood Damage - Gravel resheeting and drainage repairs	$5,550
3C	3	4005	Griffiths Road	Swanbank	525	G	5.2	30	Flood Damage - Gravel resheeting and drainage repairs	$5,000
25	10	2022	Ivy Harrons Road	Tallegalla	1250	G		65	Flood Damage - Gravel Resheeting	$1,632
30	10	2107	Krautz Road	Tallegalla	550	G		50	Flood Damage - Gravel Resheeting	$1,314
61	10	2221	Tallegalla Two Tree Hill R	Tallegalla	3530	B		10	Flood Damage - Underground Drainage	$4,781
69	10	2025	Woolshed Creek Road	Tallegalla	1870	G		225	Flood Damage - Gravel Resheeting	$4,207
11	10	2015	Groat Road	The Bluff	3000	G		125	Flood Damage - Gravel Resheeting	$2,010
27	10	2205	Kalls Road	Walloon	285	G		80	Flood Damage - Gravel Resheeting	$1,877
52	10	2104	Poplar Street	Walloon	1200	G		50	Flood Damage - Gravel Resheeting	$1,442
55	10	2231	Rohl Road	Walloon	730	G		200	Flood Damage - Gravel Resheeting	$2,721
62	10	2043	Taylors Road	Walloon	2530	G		40	Flood Damage - Gravel Resheeting	$1,168
6Q	6	1025	Boyles Road	Pine Mountain	1230	G	3.7	75	Flood Damage - Gravel Resheeting	$1,580
1FE1	1	5015	Addison Road	Camira	0			0	Road closure/Hazard signs/Barriers	$241
1FE7	1	5037	Ishmael Road	Camira	0			0	Road closure/Hazard signs/Barriers	$210
1FE3	1	5140	Molar Road	Camira	0			0	Road closure/Hazard signs/Barriers pavement repairs	$892
1FE9	1	7483	Newman Street	Camira	0			0	Road closure/Hazard signs/Barriers Deep scour repairs	$3,592
5C	5	1014	Francis Street	Chuwar	2230	G	4	200	Flood Damage - Gravel Resheeting	$7,190
3FE5	3	0	Redbank Plains Road	Collingwood Pk	0			0	Install hazard signs/barriers, pothole patching	$1,628
1FE5	2	9122	Woogaroo Creek	Gailes	0			0	Road closure/Hazard signs/Barriers	$1,564
2FE1	2	7496	Albert Street	Goodna	0			0	Install hazard signs/barriers	$135
2FE2	2	7499	Alice Street	Goodna	0			0	Install hazard signs/barriers, debris removal	$316
1FE2	2	7508	Bertha Street	Goodna	0			0	Road closure/Hazard signs/Barriers	$337
2FE5	2	7557	Lower Williams Street	Goodna	0			0	Install hazard signs/barriers	$122
1FE10	2	7564	Mill Street	Goodna	0			0	Road closure/Hazard signs/Barriers	$123
6A	6	1029	Riverside Drive	Pine Mountain	5200	G	4	250	Flood Damage - Gravel Resheeting	$8,590
3FE4	3	0	Redbank Plains Road	Redbank Plains	0			0	Install hazard signs/barriers, pothole patching	$3,121
M5	10	2233	Rosewood Warrill View Rd	Rosewood	31010	B		700	Debris removal, edge & pavement repairs	$19,553
3FE1	3	4220	Abednego Road	South Ripley	0			0	Install hazard signs/barriers	$202
3FE2	3	4013	Bundamba Creek	South Ripley	0			0	Install hazard signs/barriers, underground drainage repairs	$2,231
60	10	2210	Tallegalla Road	Tallegalla	6440	B		150	Flood Damage - Gravel Resheeting	$3,752
M3	6	2228	Karrabin Rosewood Road	Walloon	15020	B		200	Debris removal, edge & pavement repairs	$34,579
M4	10	2214	Road	Grandchester	18890	B		600	Flood Damage - Culvert repairs, scouring.	$58,303
								25440		$776,522
									CPI ratio 2002/1996 (135.0/119)	$1
									Equivalent in 2002 $	$891,370

Appendix C

Possible Flood Mitigation Schemes

An Internal Workshop at Ipswich City Council developed the following list of potential flood mitigation schemes in February 2002.

- Dam site on Bremer River at Mt Walker ('Water Supply Sources in South-East Queensland' Volume 2 Report, January 1991 by Water Resources Commission Department of Primary Industries)
- Dam site on Warrill Creek, Aratula
- Levees on Bremer River as per SKM flood study report particularly proposals for CBD area
- Detention basins on Woogaroo, Bundamba and Deebing Creeks (proposed by Mr R Gamble and documentation of affect of Springfield lakes and dry retention basins)
- Detention Basins above Rosewood and Marburg (Rosewood completed, Marburg project approved for funding)
- Flooding in lower parts of Harrisville, Peak Crossing and Rosewood
- Flooding at Walloon and Karrabin
- Flooding in Calvert
- Flooding in Grandchester (damage from recent flood)
- Flooding above Harrisville (local Storm, SKM's reports, March 1998 & May 1999)
- Flooding Ebenezer Road at Ebenezer (local storm)
- Stream works at Bundamba Creek, Bundamba (JWP's report, April 1999)
- Flooding at Ripley (local storm, SKM's report, 1998)
- Protection of good agricultural land in Warrill Valley irrigation area and other catchments
- Protection and raising of strategic bridges and roads affected by major stream flooding
- Alternative local accesses for properties cut off during flood events
- Continue riparian restoration program