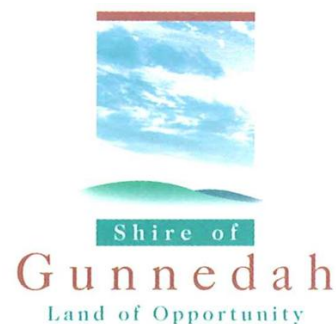




Environment,  
Climate Change  
& Water



## **GUNNEDAH SHIRE COUNCIL**

# **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN**

**OCTOBER 2010**

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15 June 2011

## FOREWORD

The State Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

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

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

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

This *Floodplain Risk Management Study and draft Plan* has been prepared for Gunnedah Shire Council with the support of the Department of Environment, Climate Change and Water and follows the *Blackjack Creek Flood Study, 2005* which defined the pattern of flooding in the study area. The study was undertaken under the direction of the Gunnedah Floodplain Management Committee, comprising community, DECCW, Gunnedah Council and Government Agency representatives.

## SUMMARY

### S1 Study Objectives

Gunnedah Shire Council commissioned the preparation of the *Floodplain Risk Management Study and Plan* for Blackjack Creek. The objectives of the *Floodplain Risk Management Study (FRMS)* were to assess the impacts of flooding, review existing Council policies as they relate to development of land in flood liable areas bordering Blackjack Creek, consider options for management of flood affected land and to develop a *draft Floodplain Risk Management Plan (FRMP)* which:

- i) Proposes modifications to existing Council policies to ensure that the development of flood affected land is undertaken so as to be compatible with the flood hazard and risk.
- ii) Proposes Flood Planning Levels for the various land uses in the Floodplain.
- iii) Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding.
- iv) Provides a program for implementation of the proposed works and measures.

The *FRMS* focusses on main stream flooding from Blackjack Creek. The solutions of problems resulting from surcharges of the piped stormwater drainage system, which may occur during localised storms on the residential sub-catchments on the eastern floodplain, are outside the scope of the present investigation.

### S2 Study Activities

The activities undertaken in this *Floodplain Risk Management Study (FRMS)* included:

- Review of flooding patterns on Blackjack Creek for flood events up to the Probable Maximum Flood (**Chapter 2**).
- Undertaking a consultation program over the course of the study to ensure that the Blackjack Creek community was informed of the objectives, progress and outcomes of the study (**Appendix C**).
- Assessment of the economic impacts of flooding, including the numbers of affected properties and estimation of damages (**Chapter 2** and **Appendix B**).
- Review of current flood related planning controls for Gunnedah and their compatibility with flooding conditions on Blackjack Creek catchment (**Chapter 2**).
- Review of potential floodplain management measures aimed at reducing flood damages, including an economic assessment of each measure (**Chapter 3** and **Appendix A**).
- Ranking of measures using a multi - objective scoring system which took into account community acceptance, technical, economic, financial, environmental and planning considerations (**Chapter 4**).
- Preparation of a *draft FRMP* for Blackjack Creek (**Chapter 5**).

### S3 Summary of Flood Impacts

The study area comprises the urbanised portion of the Blackjack Creek floodplain extending on the eastern floodplain from Lincoln Street to the Oxley Highway, a distance of 2 km along the main arm of the creek.

The catchment area of Blackjack Creek at the Oxley Highway is 24 km<sup>2</sup>. Flooding on the stream is “flash flooding” in nature, with flood levels peaking three to four hours after the commencement of heavy rainfall. **Figure 2.1** shows indicative extents of inundation and **Figure 2.2** shows the typical rate of rise of floodwaters at the Oxley Highway.

Floods up to the 5 year ARI are contained within the immediate vicinity of the channel. Damaging flooding would commence in existing residential development to the east of Wandobah Road in the event of a 20 year ARI flood and progressively increase as shown in **Table S.1**. Above-floor flooding would occur in 104 residences at the 100 year ARI level of flooding, when predicted flood damages would be about \$3.45 Million (**Table 2.3**) and depths of inundation up to 0.9 m would be experienced.

**TABLE S.1**  
**NUMBER OF PROPERTIES FLOODED**  
**BLACKJACK CREEK STUDY AREA**

Flood Event Years ARI	No. of Properties Flooded Above Floor Level		
	Residential	Commercial/ Industrial	Public Buildings
20	29	0	0
50	66	0	0
100	104	0	0
PMF	192	1	0

Note: These properties would experience flooding above floor level. Flood liable properties (100 year ARI) are shown on **Figure B8.3** of **Appendix B**.

#### **S4 Flood Hazards**

The floodplain has been divided into three hazard zones for the 100 year ARI flood, as shown on **Figure 2.3**. Hazard is related to the depths and velocities of flow, as well as other factors such as the rate of rise of floodwaters and ease of evacuation from the floodplain in the event of a flood emergency. On the basis of those factors, the creek and its eastern overbank extending to Wandobah Road is a zone of high hazard. There is an area of intermediate hazard in the residential area east of Wandobah Road where depths of inundation up to 800 mm may be experienced, but with little velocity of flow. In the low hazard zone the velocity of flow would not be significant and the depth of inundation would generally be limited to 300 mm. The significance of these hazard zones to the proposed flood related controls over future development is described in **Section 3.6** of the report.

#### **S5 The Floodplain Risk Management Plan**

The *draft Floodplain Risk Management Plan* showing recommended flood management measures for Blackjack Creek is presented in **Table S.2**. The *draft FRMP* includes three non-structural management measures which could be implemented by Council with the assistance of SES, using existing data and without requiring Government funding. These measures have been given a **Priority 1** assessment and are considered to be an essential part of the *FRMP*. The measures are as follows:

- **Measure 1** - The application of a graded set of planning controls for future residential development that recognises the location of the development in the floodplain; to be applied

through Council's existing Flood Policy DCP for Gunnedah, with specific amendments for Blackjack Creek, as proposed in **Section 2.8.6**. Application of these controls by Council in the period pending completion of either of the structural flood mitigation measures (either the riparian corridor/channel improvement scheme or the levee scheme – see below) will ensure that future development in the catchment is compatible with the flood risk. Either of the structural flood mitigation measures would provide protection from main stream flooding up to the 100 year ARI event. As a result, application of the Flood Policy would not be required following construction and existing residences would not then be subject to flood affectation notices.

- **Measures 2 and 3** - Improvements in the SES's emergency management planning for the catchment, including incorporation of the flood related information contained in this study into the Local Flood Plan for Gunnedah and preparation of a "FloodSafe Brochure" identifying the nature and extent of flooding, time of rise of floodwaters and evacuation routes for residents.

All of the other measures require Council and Government funding. Their priorities depend on the results of feasibility studies which are also part of the draft *FRMP*. They have been given a provisional priority ranking which would be confirmed by the results of the respective feasibility study. The measures are as follows:

- **Measure 4** - Further development of the design concept for the riparian corridor/channel improvement scheme along Blackjack Creek in the 1.9 km reach, commencing at a point about 400 m downstream of Lincoln Street and continuing to the Oxley Highway. This investigation would involve refining the concept design and cost estimates developed in **Chapter 3** of this report and would also include community consultation to assist in selection of the route and further survey and engineering analysis. This investigation is required to confirm the engineering feasibility and economic merit of the scheme and provide documentation to a standard necessary to support an application for Government funding for the project.
- **Measure 5** - Depending on the results of the above investigation and agreement on the provision of funding, preparation of detailed design and documentation of the riparian corridor/channel improvement scheme, followed by its construction as funding becomes available.
- **Measures 6 and 7** - In the event that the above investigations for the riparian corridor/channel improvement do not confirm its economic feasibility, a flood protection levee running over a similar extent could be considered as an alternative flood mitigation measure. However, further survey and technical investigation of this scheme would be required than is possible in this study, which is strategic in nature. The investigation would involve community consultation, additional survey and hydrologic analysis to assess requirements for the capture and disposal of runoff derived from the local stormwater catchments on the eastern side of Blackjack Creek. These investigations would be required to confirm the engineering feasibility and economic merit of the levee and provide documentation to a standard necessary to support an application for Government funding for the project.
- **Measures 8 and 9** - Further Investigation of the feasibility of a Flash Flood Warning System for the catchment and development of the scheme if justified. This scheme could be adopted to provide advance warning of flooding on the Blackjack Creek catchment in the event that the two structural measures (channel improvement/riparian corridor, or flood protection levee) do not proceed in a reasonable timeframe. The scheme would not affect the pattern of flooding in the study area but would allow residents to reduce damages to contents and safely evacuate prior to the arrival of floodwaters.



## **S6          Timing and Funding**

The total estimated cost to implement the preferred floodplain management strategy comprising **Measures 1 to 5** (the non-structural measures plus the feasibility study of the riparian corridor/channel improvement scheme, followed by its detailed design and construction) is \$2.52 Million, exclusive of Council and SES Staff Costs for the non-structural measures. The timing of the riparian corridor/channel improvement scheme will depend on Council's overall budgetary commitments and the availability of Council and Government funds.

**TABLE S.2**  
**RECOMMENDED MEASURES FOR INCLUSION IN BLACKJACK CREEK DRAFT FLOODPLAIN RISK MANAGEMENT PLAN**

Measure	Required Funding	Features of the Measure	Priority
1. Implement controls over future residential development based on Council's existing <i>Flood Policy</i> , as amended to incorporate flood data for Blackjack Creek.	Council's staff costs	<ul style="list-style-type: none"> <li>Control residential development in floodplain as summarised in <i>Flood Policy</i> (ref. <b>Section 3.6</b>).</li> <li>Graded set of flood controls based on location within the Flood Planning Area, defined as land inundated by the 100 year ARI flood plus 500 mm freeboard.</li> <li>Floodplain divided into four zones of decreasing flood hazard: <b>Floodway, Intermediate Floodplain, Flood Fringe and Outer Floodplain</b>.</li> <li>Flood Vulnerable development (e.g. housing for aged persons and persons with disabilities) are to be excluded from the floodplain (land inundated by the PMF).</li> <li>Council's evaluation of development proposals to use data presented in Blackjack Creek Flood Study, 2005 and in this <i>FRMS, 2010</i>.</li> <li>This would be an interim measure pending construction of the riparian corridor/channel improvement scheme, which would provide a 100 year ARI level of protection to residents bordering the creek.</li> </ul>	<b>Priority 1:</b> this measure has a high priority for inclusion in the <i>FRMP</i> . It does not require Government funding.
2. Ensure flood data in <i>this Floodplain Risk Management Study and Plan</i> are available to SES for inclusion in flood response procedures.	SES costs	<ul style="list-style-type: none"> <li>SES's <i>Gunnedah Local Flood Plan, 2002</i> should be updated using information on locations of flood prone development incorporated in the <i>FRMS</i> and shown in <b>Figure B8.3 of Appendix B</b>.</li> </ul>	<b>Priority 1:</b> this measure would improve emergency management procedures and has a high priority. It does not require Government funding.
3. Implement flood awareness and education program for residents bordering the creek.	SES, Council staff costs	<ul style="list-style-type: none"> <li>Council and SES should prepare a <i>FloodSafe Brochure</i> to inform residents of the flood risk, based on the information presented in the <i>FRMS</i>.</li> </ul>	<b>Priority 1:</b> this measure would reduce flood losses and has a high priority. It does not require Government funding.
4. Feasibility Study of riparian corridor/channel improvement scheme for Blackjack Creek in the Wandobah Reserve area.	\$80,000	<ul style="list-style-type: none"> <li>Survey along extent of riparian corridor.</li> <li>Prepare concept design; refine initial costing and economic analysis presented in this <i>FRMS</i>.</li> <li>Undertake Community Consultation .</li> <li>Prepare a submission for Council and Government funding.</li> </ul>	<b>Priority 1:</b> this measure is the first step in providing the scheme and has a high priority in view of the flood risk, as well as economic and social impacts resulting from flooding. It requires Council and Government funding.
5. Preparation of detailed design and construction of the riparian corridor/channel improvement scheme	\$2.44 Million	<ul style="list-style-type: none"> <li>Prepare detailed design and documentation of scheme.</li> <li>Scheme is to be implemented by Council when funding available.</li> <li>Costs comprise capital and annual maintenance costs.</li> </ul>	<b>Priority 1:</b> this measure would depend on a favourable outcome from the above Feasibility Study and on the availability of Council and Government funding.
6. Feasibility Study of a flood protection levee along the eastern bank of Blackjack Creek in the Wandobah Reserve area.	\$80,000	<ul style="list-style-type: none"> <li>Survey along levee route.</li> <li>Prepare concept design; refine initial costing and economic analysis presented in this <i>FRMS</i>.</li> <li>Undertake Community Consultation.</li> <li>Prepare a submission for Council and Government funding.</li> </ul>	<b>Priority 2:</b> this measure is an alternative to the riparian corridor/channel improvement scheme. It requires Council and Government funding.
7. Preparation of detailed design and construction of the levee scheme (dependent on the results of the above study)	\$2.67 Million	<ul style="list-style-type: none"> <li>Prepare detailed design and documentation of scheme.</li> <li>Works are to be implemented by Council when funding available.</li> <li>Costs comprise capital and annual maintenance costs.</li> </ul>	<b>Priority 2:</b> this measure would depend on a favourable outcome from the Feasibility Study and the availability of Council and Government funding.
8. Undertake investigation of feasibility of a Flash Flood Warning System.	\$50,000	<ul style="list-style-type: none"> <li>The system would be based on the "Total Warning System" outlined in <b>Section 3.9</b>.</li> <li>Floor levels of residential development bordering the creek which were surveyed for this present study and results of the Blackjack Creek Flood Study, 2005 would be used as basic data for the system.</li> <li>Further investigation is required to relate predicted rainfalls to the incidence and locations of flooding problems in the study area.</li> <li>The above investigation could be expanded to incorporate problems due to surcharging of the local stormwater system.</li> </ul>	<b>Priority 3:</b> this measure would alert residents to take action to reduce flood losses in the urban area on the eastern side of Wandobah Road. Its priority depends on whether or not either of the structural mitigation schemes (channel improvement/riparian corridor or levee) is implemented.
9. Implementation of Flash Flood Warning System	\$200,000	<ul style="list-style-type: none"> <li>Cost comprises capital cost only and allows for instrumentation, software, training and public flood awareness program.</li> <li>Allow an additional annual cost of \$15,000 for maintenance of the system (Council costs).</li> </ul>	<b>Priority 3:</b> implementation of this measure would depend on a favourable outcome from the above Feasibility Study and the availability of Council and Government funding.
<b>Total Estimated Cost (Preferred Strategy)</b>	<b>\$2.52 Million</b>	<b>Note: Preferred strategy comprises Measures 1 to 5.</b>	

## 1 INTRODUCTION

### 1.1 Study Background

Blackjack Creek runs along the western side of Gunnedah through the area known as the Wandobah Reserve. The stream crosses the Oxley Highway and the railway, before discharging to the floodplain of the Namoi River about 1.7 km downstream of the railway. Land use on the eastern floodplain between Lincoln Street and the highway is residential in nature. The creek and the western floodplain are grassed with isolated stands of trees. The creek channel is indistinct and of limited hydraulic capacity.

Flooding on Blackjack Creek has resulted in damage to residential properties on the eastern floodplain. Major storms in January 1984 and November 2008 are reported to have caused surcharging of the creek, resulting in flooding extending into the residential area. Flood waters extended into allotments and above-floor inundation occurred in several residences. Flooding in the catchment was of a “flash flooding” nature, with peak flood levels occurring about 2 to 3 hours after the commencement of heavy rainfall. During periods of heavy rainfall the local piped stormwater system also surcharges, with overland flows being conveyed to the creek along several of the streets. High water levels in Blackjack Creek coincident with storms on the local catchment could inhibit the escape of overland flows to the creek in the Wandobah Road area.

Gunnedah Shire Council commissioned the Blackjack Creek Flood Study (LACE, 2005), which assessed main stream flooding patterns. The Blackjack Creek Flood Study was the first part of the NSW Government’s Floodplain Risk Management process, which aims to reduce the impact of flooding and flood liability for flood prone land in the catchment and represented a detailed technical investigation of flood behaviour. Subsequently, Council commissioned the preparation of the *Floodplain Risk Management Study (FRMS)* and *draft Plan (FRMP)* for the catchment (this present investigation). The *FRMS* and *FRMP* represent the next phase of the Government’s management process.

**Figure 1.1** shows the study area, the focus of which is the residential area on the eastern floodplain between Lincoln Street and the Oxley Highway. The first steps in the *FRMS* were the collection of flood data via a Community Newsletter/Questionnaire which was distributed by Council to residents bordering Blackjack Creek and the review of the 2005 Flood Study. Based on the knowledge of flooding patterns and a survey of the floor levels of properties located within the floodplain, the economic impacts of flooding were assessed. Measures aimed at managing the flood risk for existing development and reducing the risk for future development, were then formulated and their feasibility assessed.

The potential flood management measures were ranked by the Committee according to a scoring system based on economic, social and environmental criteria. Based on these results a draft *FRMP* was then prepared under the guidance of the Floodplain Risk Management Committee, made up of local and Government Agency representatives.

### 1.2 Background Information

In the preparation of the *FRMS* and draft *FRMP*, the Consultants drew on the experience gained from several investigations on flooding in the study catchment and Gunnedah area, as well as planning documentation which included:

- “Blackjack Creek Flood Study”, 2005, prepared by Lyall and Associates Consulting Water Engineers.
- “Gunnedah Local Flood Plan”, 2002, prepared by State Emergency Service.
- “Gunnedah and Carroll Floodplain Management Study and Plan”, 1999 prepared by Snowy Mountains Engineering Corporation.
- Council’s DCP “Principles of Development” containing guidelines for development in areas subject to flooding from the Namoi River.
- “Use of Geophysical Methods to Delineate Salt Affected Areas for Channel Reconstruction in Wandobah Reserve Gunnedah, NSW”, 2003 prepared by Department of Planning and Natural Resources (now DECCW) and delineating salt affected areas along floodplain of Blackjack Creek
- “Carroll to Boggabri Floodplain Management Plan”, 2006, prepared for Department of Planning and Natural Resources.

### 1.3 Overview of Report

This report sets out the findings of the *Floodplain Risk Management Study* and presents the *draft Floodplain Risk Management Plan*.

**Chapter 2** of the Report contains information on baseline flooding conditions on the floodplain, including a review of Council’s existing planning policies as they relate to flood affected land, assessment of the impacts of flooding on the community, a review of flood warning arrangements and review of environmental considerations which could influence the works and measures recommended for inclusion in the draft *FRMP*.

**Chapter 3** is a review of possible Floodplain Management Measures which could be included in the *FRMP*. Community views obtained from the Community Newsletter/Questionnaire issued to residents at the commencement of the study are summarised, leading to a list of potential flood management measures which are then tested for their feasibility.

**Chapter 4** details the selection of Floodplain Management Measures. Floodplain Management strategies comprising combinations of measures are assessed according to a multi-objective scoring system and a preferred strategy is outlined.

**Chapter 5** presents the draft *Floodplain Risk Management Plan*.

**Chapter 6** contains a list of References.

The Study is supported by **Appendices** which provide additional details of the investigations undertaken for the preparation of the Study and Plan.

- **Appendix A** contains indicative costings for the two structural flood mitigation schemes.
- **Appendix B** is an assessment of the economic impacts of flooding on the Blackjack Creek floodplain.

- **Appendix C** presents the responses of the Community Newsletter/Questionnaire.
- **Appendix D** presents the report of the Floodplain Management Committee to Council's Ordinary Meeting of 15 June 2011.

#### 1.4 Community Consultation

Following the inception meeting of the Floodplain Management Committee at Gunnedah, a Community Newsletter was prepared by the Consultants introducing the study and distributed to residents by Council. The Newsletter contained a Questionnaire seeking details from the community of flood experience and attitudes to potential floodplain management options. Community responses are summarised in **Section 3**, with further details in **Appendix C**.

At the inception meeting an inspection of the area was undertaken by the Consultants and Council representatives which assisted in gaining a good understanding of topographic conditions, historic flood behaviour and flooding issues.

Several additional meetings of the Committee were held over the course of the study to discuss technical features of the structural flood mitigation schemes and the suitability of measures for inclusion in the draft Plan. A draft Study report and a draft Plan were then prepared in October 2010 for submission to Council and Public Exhibition.

The draft Study and Plan were exhibited in February 2011. The document generated considerable community interest with over 100 responses being received.

Further meetings of the Community were held on 28 March and 19 April 2011, the latter meeting being open to the public and held in the Town Hall. Community concerns and Consultant's responses are summarised in this final report in **Appendix D**. (The final report also includes some minor corrections and amendments to the draft Study Report.)

#### **Post-Script**

The draft Study and Plan were adopted by Council at its ordinary Meeting of 15 June 2011. Subsequently, Council has committed to preparing the Feasibility Study and Concept Design of the Riparian Corridor/Improved Channel of Blackjack Creek, which was a high priority measure incorporated in the Plan. The Riparian Corridor/Improved Channel will provide security against flooding from Blackjack Creek to residential property on the eastern side of Wandobah Road for floods up to 100 year ARI magnitude. Council will then be able to remove notices of flood affectation from the properties.



100 0 100 200m

Scale: 1:10,000

## BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Figure 1.1  
LOCALITY PLAN

## 2 BASELINE FLOODING CONDITIONS

### 2.1 Catchment Description

The total catchment area of Blackjack Creek at the Oxley Highway crossing is about 24 km<sup>2</sup>. The main arm of Blackjack Creek flows northwards over a distance of 8 km from the catchment boundary to the Highway. The catchment headwaters are quite steep, with natural surface levels falling from RL 670 m at the highest point near the south-west boundary to RL 284 m at Lincoln Street over a distance of 5.5 km and at an average gradient of 7 per cent. At Lincoln Street the stream flattens, with an average bed slope of 0.78 per cent over the remaining 2.5 km to the highway bridge. The floodplain in this reach averages about 300 m in width and comprises cleared overbanks on the western side and urban areas on the eastern side. Downstream of Lincoln Street, the stream runs parallel with and close to the western edge of Wandobah Road.

A levee bank (shown on **Figure 2.1**) has been constructed on the eastern bank between George Street and Short Street to contain flows which surcharge the hydraulic capacity of the channel. However, in the event of major flooding, the stream would break its banks further upstream between Lincoln Street and McAndrew Park and outflank the levee. During those events, Wandobah Road would act as a floodway and flooding would extend into the residential area on the eastern side of the road.

The waterway at the Oxley Highway crossing comprises 12 box culverts with a total width of 33.7 m and height of 1.5 m. The channel from the Highway to the railway comprises a grassed trapezoidal floodway of around 30 m width. The railway crossing comprises a three span bridge, with each span 8 m wide and about 2.5 m high.

Between the Oxley Highway and the railway culvert, a large rectangular shaped concrete drain joins the right bank of Blackjack Creek. This drain, known locally as Ashfords Watercourse, conveys runoff from the 3.2 km<sup>2</sup> catchment to the east of Blackjack Creek. Council assessed that peak flows from this catchment could reach 17-18 m<sup>3</sup>/s in the event of major flooding. This discharge compares with a peak 100 year ARI discharge of 126 m<sup>3</sup>/s crossing the Oxley Highway. As Ashfords Watercourse is likely to introduce a backwater effect and influence flood levels at the Oxley Highway, contributions to flow from that catchment were included in the hydraulic modelling of Blackjack Creek undertaken in the Flood Study, 2005.

The hydraulic modelling undertaken in the Flood Study, 2005 continued below the Oxley Highway to a point about 150 m downstream of the railway culvert. Major flooding from the Namoi River extends as far as the downstream side of the railway and therefore does not influence flood levels in the study area.

### 2.2 Flood History

A major storm occurred on 30 January 1984, which was reported by residents in responses to the Community Questionnaire to have resulted in inundation of the Blackjack Creek floodplain, with flows extending into the residential area on the eastern side of Wandobah Road and overtopping the Oxley Highway culvert. The peak flood level on the upstream side of the culvert was about 600 mm over the deck. Other significant floods are reported to have occurred in the wet years 1971 and 1976, but there are no quantitative data available for those events.

Based on an analysis of the Gunnedah pluviograph, over the three hours of the most intense burst of rainfall on 30 January 1984, a total depth of 82.5 mm was recorded compared with 90 mm for the 1 in 100 year rainfall of the same duration. For the 5 hour duration, a total depth of 106 mm was recorded, which exceeds the 1 in 100 year depth of 103 mm. Storms of between 3 and 6 hours duration were found to maximise peak flows on the Blackjack Creek catchment. Consequently, on the basis of recorded rainfall depths, the January 1984 storm approximated a 1 in 100 year event. In view of the heavy rainfall experienced over the preceding days, rainfall losses would have been much less than the average loss rates used in design flood estimation. It is possible that the peak discharge experienced would have exceeded the 100 year ARI design discharge.

A major storm was experienced on the Blackjack Creek catchment on 28 November 2008. Residents reported similar flood experiences to those experienced in 1984, although there were no reports of the Oxley Highway culvert being surcharged. A depth of 72 mm of rain was recorded at the pluviograph over the peak 3 hour period, equivalent to a 20 to 50 year ARI storm for that duration. Residents reported the occurrence of main stream flooding from the creek, as well as surcharges of the local piped stormwater system.

## 2.3 Characteristics of Flooding

### 2.3.1 Main Stream Flooding

**Figure 2.1** shows the areas likely to be inundated by the 100 year ARI design storm and the PMF. The flood extents were originally determined in the 2005 Flood Study using the creek cross sectional survey used for hydraulic modelling, supplemented by 2 m interval ground surface contours and have been updated using natural surface levels in residential properties determined in the property survey used to assess flood damages (**Appendix B**).

The Blackjack Creek channel generally has a 5 year ARI capacity except in the immediate vicinity of George Street, where the creek is on the point of surcharging its banks and flooding Wandobah Road for that discharge. Larger floods break out in the McAndrew Park area and inundate the residential area on the eastern floodplain, with a progressive increase in extent as discharges increase. Flood flows continue to follow the line of the creek with increasing flood magnitude, with no new flow paths being created up to the PMF, which has peak levels about 1.9 m higher than the 100 year ARI flood at the highway and 1 to 1.5 m higher further upstream along the creek.

The extents of inundation shown on **Figure 2.1** are indicative only due to limitations in the accuracy of the available survey data and should not be used to assess the flood affectation or otherwise of individual properties. A site survey would be required to assess the degree of flood affectation of individual properties.

Because of the small size of the catchment and comparatively steep gradient of the creek, flooding is of a “flash flooding” nature and is usually of short duration. **Figure 2.2** shows the modelled rise of floodwaters at the Oxley Highway resulting from 20 and 100 year ARI design storms of 180 and 360 minutes durations. Floodwaters rise to a peak about 3 to 4 hours after the commencement of heavy rainfall.

Further details of the duration of high levels at other locations along the length of the creek are shown on **Figure 3.4**.



### 2.3.2 Local Catchment Flooding

Flooding also occurs in the residential area as a result of localised storms surcharging Council's stormwater drainage system. Numerous accounts of nuisance flooding from this source were reported by residents in their responses to the Questionnaire.

Council has recently prepared a numerical model of the piped stormwater system draining to Blackjack Creek from the eastern side of Wandobah Road using the DRAINS rainfall-runoff software. The results of modelling the system show considerable surcharge for major storms, confirming the responses of residents to the Questionnaire.

Details of the operation of the stormwater system are discussed in **Section 3.5** in connection with the possible completion of the protective levee along the western side of Wandobah Road. As noted therein, the main technical problem associated with the levee would be the capture and discharge of stormwater from the protected area over the duration of high water levels in the creek.

## 2.4 Flood Hazard Zones and Floodway Areas

### 2.4.1 Flood Hazard

Provisional flood hazard categories were assigned to flood affected areas in the Flood Study, 2005 in accordance with the procedures outlined in the *Floodplain Development Manual, 2005*. Flood prone areas may be provisionally categorised into *Low Hazard* and *High Hazard* areas depending on the depth of inundation and flow velocity.

Flood depths as high as 1 m in the absence of any significant flow velocity represent *Low Hazard* conditions. Similarly, areas of flow velocities up to 2.0 m/s but with minimal flood depth also represent *Low Hazard* conditions. Interpolation may be used to assess hazards for intermediate values of depth and velocity. Flood hazards categorised on the basis of depth and velocity only are *provisional*. They do not reflect the effects of other factors that influence hazard. These other factors include:

- Size of flood – major floods though rare can cause extensive damage and disruption.
- Effective warning time – flood hazard and flood damage can be reduced by evacuation if adequate warning time is available.
- Flood awareness of the population – flood awareness greatly influences the time taken by flood affected residents to respond effectively to flood warnings. The formulation and implementation of response plans for the evacuation of people and possessions promote flood awareness.
- Rate of rise of floodwaters – situations where floodwaters rise rapidly are potentially more dangerous and cause more damage than situations in which flood levels increase slowly.
- Duration of flooding – the duration of flooding (or length of time a community is cut off) can have a significant impact on costs associated with flooding. The duration is shorter in smaller, steeper catchments.
- Evacuation problems and access routes – the availability of effective access routes from flood prone areas directly influences flood hazard and potential damage reduction measures.

Provisional hazard categories may be reduced or increased after consideration of the above factors in arriving at a final determination.

A qualitative assessment of the influence of the above factors on the provisional flood hazard on Blackjack Creek (i.e. the hazard based on velocity and depth considerations only) is presented in **Table 2.1**. Factors which would increase the flood hazard in **Table 2.1** are balanced by considerations reducing the hazard. Consequently, there would be no reason to adjust the provisional flood hazard and the determination of hazard in the floodplains could be based on depth and velocity alone.

**TABLE 2.1**  
**INFLUENCE OF FLOOD RELATED PARAMETERS ON PROVISIONAL**  
**FLOOD HAZARD IN BLACKJACK CREEK FLOODPLAIN**

Parameter	Influence on Provisional Hazard	Flood Characteristics
Size of flood	0	Flooding is comparatively shallow, with no sudden increases in depth of flow or alternative flow paths developing with increasing severity of flooding for floods up to PMF.
Effective warning time	1	The warning time is short and presently limited to two or three hours, which would tend to increase the provisional flood hazard.
Flood awareness	-1	Flood awareness appears to be quite high due to the occurrence of a major storm in November 2008 and the record flood of January 1984 which was well remembered by residents in their responses to the Questionnaire.
Rate of rise and velocity of floodwaters	1	Flooding is of a "flash flooding" nature, with the stream rising to a peak within three to four hours of the commencement of heavy rainfall. This would tend to increase the flood hazard, although the hazard could be reduced by education the community about flood risk.
Duration of flooding	- 1	The duration of the flood peak is quite short, around two hours for the design storms shown on <b>Figure 2.2</b> .
Evacuation problems	- 1	There is easy evacuation from the residential area eastwards out of the flooded area to higher ground. Evacuees would not need to travel more than 200 m through rising ground to flood free land.

Legend    0 = neutral impact on provisional hazard  
              1 = tendency to increase provisional hazard  
             - 1 = tendency to reduce provisional hazard

**Figure 2.3** shows hazard zones for the area inundated by the 100 year ARI flood. Three zones have been adopted in the final determination:

- The *High Hazard* zone extends over the eastern floodplain as far as Wandobah Road. In this area depths of flow would average 1.5 m and flow velocities would be between 1 and

1.5 m/s. This area comprises the channel of the creek and its immediate overbank areas and is undeveloped, grassed land with some tree cover.

- The *Medium Hazard* zone comprises portion of the residential area to the east of Wandobah Road where depths of inundation could reach 0.8 m but flow velocities would be low; around 0.1 to 0.2 m/s.
- The *Low Hazard* zone comprises the remainder of the area inundated by the 100 year ARI flood, where the depth of flooding would average 0.3 m but velocity would not be significant.

#### 2.4.2 Floodways

According to the *Floodplain Development Manual, 2005*, the floodplain may be subdivided into the following zones:

- Floodways;
- Flood storage; and
- Flood fringe

**Floodways** are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if partially blocked, would cause a significant increase in flood level and/or a significant redistribution of flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

**Flood storage** areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

**Flood fringe** is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

In determining appropriate hydraulic categories, it is important that the *cumulative* impact of progressive development be evaluated, particularly with respect to floodway and flood storage areas. Whilst the impact of individual developments may be small, the *cumulative* effect of the ultimate development of the area can be significant and may result in unacceptable increases in flood levels and flood velocities elsewhere in the floodplain.

In practice, development of flood liable areas bordering a stream usually proceeds from the shallower flood fringe areas towards the channel. The *Floodplain Development Manual, 2005* provides guidelines on determining the boundary between the floodway and flood storage zones using the hydraulic model and what may be termed “encroachments” into the floodplain. In this approach, conceptual vertical boundary lines are progressively moved into the floodplain from both sides thereby constricting the flow to the degree where peak flood levels and peak flows are increased anywhere

within the extent of the model by a specific amount. The FDM, 2005 suggests a limiting increase of 100 mm in peak flood levels and 10% in peak downstream discharges.

The portions of the floodplain on the landward side of the encroachment lines represent that part of the floodplain which may be removed both in terms of conveyance capacity and flood storage without causing excessive adverse impacts on flood behaviour. The locations of the encroachment lines on each side of the stream represent the boundary between the floodway and the flood storage or flood fringe zones.

Hydraulic categories were determined for this investigation in accordance with the “encroachment” procedure. The hydraulic analysis showed that an encroachment to Wandobah Road (i.e. removal of the conveyance capacity of the floodplain east of that line) could increase flood levels by up to 150 mm in the McAndrew Park area. This result indicated that the Flood Policy should ensure that future development does not block the passage of overland flows on the eastern floodplain to a greater extent than occurs at present. Consideration would need to be given to the type and siting of fences and filling incorporated in any new development. Accordingly, the hydraulic categorisation of floodplain adopted in this study comprises “Floodway,” “Flood Storage” and “Flood Fringe” areas. **Figure 2.4** shows the resulting hydraulic categorisation for the 100 year ARI flood.

## 2.5 Impacts of Climate Change

CSIRO undertook investigations for the NSW Government (Hennessy et al, 2004) which indicated that whilst the region will become drier on average due to climate change, the frequency and intensity of climate extremes such as storms, floods and droughts will increase. That is, large flood producing storms will occur more often and be greater in magnitude. The investigations suggest that until 2030, there will be an increase in the 40 year ARI 24 hour rainfall of +3 per cent and an increase of +10 per cent by 2070.

DECCW recommends that its guideline *Practical Considerations of Climate Change, 2007* be used as the basis for examining climate change in projects undertaken under the State Floodplain Management program and the *Floodplain Development Manual, 2005*. The guideline recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities ranging between 10 and 30 per cent.

On current projections the increase in rainfalls within the service life of developments or flood management measures is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit. Under present day climatic conditions, increasing the 100 year ARI design rainfall intensities by 10 per cent would produce a 200 year ARI flood; and increasing those rainfalls by 30 per cent would produce a 500 year ARI event.

An assessment on the impacts of flooding could be achieved by assuming that the above increases in rainfall directly translate to an equivalent increase in flood peak discharges. Assuming a 10 per cent increase, the 100 year ARI flood peak of 124 m<sup>3</sup>/s would increase to 136 m<sup>3</sup>/s at the Oxley Highway bridge. By interpolation of the water surface profiles derived from the hydraulic modelling, the resulting increase in peak water levels would be no greater than 100 mm. The 30 percent increase in flows would result in an increase of no more than 200 mm. Therefore the future effects of climate change, as far as peak flood levels are concerned, could be accommodated within the 500 mm of freeboard

which is usually applied to the best estimate of flood levels, with a reasonable margin remaining for other uncertainties such as local hydraulic effects and wave action.

The impact of climate change on *flooding patterns* in Blackjack Creek may therefore be summarised as:

- A gradual widening of the extent of inundation along the length of the main arm of Blackjack Creek.
- A small increase in flow velocities within the inundated area running along the main arm, but no sudden increase in the provisional flood hazard due to increased flood depths and flow velocities.
- No islands or new flow paths would be created. Flow would continue to follow its existing course along the valley of the creek.
- There may be a small reduction in the time of rise of the floodwaters. Blackjack Creek is flash flooding with only a few hours of warning time available to residents (**Figure 2.2**). Effective flood warning may not be achievable even with the benefit of future technical improvements in systems. Therefore on-going community education of the nature of flooding via Council and SES is required to limit risks to people and property.

## 2.6 Economic Impacts of Flooding

The economic consequences of floods are discussed in detail in **Appendix B**, which assesses flood damages to property in the floodplain, which are almost exclusively of a residential nature. There are no data available on historic flood damages to the residential sector in the study area. Accordingly it was necessary to use data on damages experienced as a result of historic flooding in other urban centres. The residential flood damages were assessed using techniques developed and tested in numerous urban and rural flood situations in NSW and based on the recent publication *Floodplain Guideline Number 4, 2007* published by DECCW. **Figure B8.3 of Appendix B** identifies properties which would be subject to above-floor inundation in the event of the 100 year ARI flood. This diagram has been prepared after comparison of peak design flood levels derived with the floor levels obtained during the property survey used to estimate flood damages. The numbers of properties flooded above floor level are listed on **Table 2.2**.

**TABLE 2.2**  
**NUMBER OF PROPERTIES FLOODED**  
**BLACKJACK CREEK STUDY AREA**

Flood Event Year ARI	No. of Properties Flooded Above Floor Level		
	Residential	Commercial/ Industrial	Public Buildings
20	29	0	0
50	66	0	0
100	104	0	0
PMF	192	1	0

Note: These properties would experience flooding above floor level. Flood liable properties (100 year ARI) are shown on **Figure B8.3 of Appendix B**.

**Table 2.3** shows the damages experienced for each class of property.

**TABLE 2.3**  
**FLOOD DAMAGES IN BLACKJACK CREEK STUDY AREA**

Average Recurrence Interval Year ARI	Flood Damages to Each Category (\$ x 10 <sup>6</sup> )			Total Damage (\$ x 10 <sup>6</sup> )
	Residential	Commercial	Public	
20	1.39	0	0	1.39
50	2.43	0	0	2.43
100	3.45	0	0	3.45
PMF	9.07	0.05	0	9.12

Significant flood damages would be experienced at the 20 year ARI level. A total of 29 residential properties would experience flooding above floor level. At the 100 year ARI, additional properties would be flooded. A total of 104 residences would experience flooding above floor level with the greatest depth being 900 mm in King Street. In the event of a PMF, 192 residences would be flooded above floor level.

## 2.7 Existing Flood Modification Measures (Structural Works)

There are no structural flood management measures currently in place for the Blackjack Creek catchment. A levee was constructed between George Street and Short Street, but as mentioned previously, it would be outflanked during major flooding by breakouts from the creek further upstream.

Following the January 1984 flood a Council commissioned the design of a channel scheme extending through Wandobah Reserve from Lincoln Street to the Oxley Highway. The scheme comprised a grassed trapezoidal channel with an invert width ranging between 17.5 and 20 m. The channel was designed to convey the 100 year ARI discharge, but was not constructed.

More recently, DIPNR (now DECCW) carried out geophysical investigations to locate salt affected areas for the purposes of channel reconstruction in the Wandobah Reserve (DIPNR, 2003). Mapping of soil hazard zones is presented in **Figure 1.1**. Council has relocated the proposed channel route so that it bypasses areas with the highest salinity and also takes into account the need to minimise disturbance to existing trees and native vegetation. The feasibility of constructing improvements to the channel along Council's preferred route, as part of the development of a riparian corridor on Blackjack Creek, is discussed in **Section 3.3** of this study.

## 2.8 Council's Existing Planning Instruments and Policies

Planning Instruments used by Gunnedah Shire Council to manage development in Blackjack Creek comprise the following documents:

- Gunnedah Local Environmental Plan, 1998 (Updated 20 July 2008).
- Development Control Plan "Principles of Development", 2004.

### 2.8.1 Land Use Zoning

The area east of Wandobah Road extending to View Street is zoned Residential 2(a).

The area bordering the creek west of Wandobah Road is variously zoned:

*Special Uses 5(a)* – the cemetery to the north of Lincoln Street.

*Proposed Open Space 9(c)* – Lincoln Street to Howes Road.

*Open Space (Recreational) 6* – Howes Road to Oxley Highway including Wandobah Reserve.

On the western floodplain fronting the Oxley Highway there are also areas of:

*Special Uses 5(a)* and

*General Industrial 4(a)*

### 2.8.2 Flood Provisions of the Gunnedah LEP, 1998

Clause 3(7) of the LEP outlines its objectives relating to flooding:

*“(a) to reduce the incidence and level of hazard to areas subject to flooding by managing development in the floodplain and floodways, and*

*(b) to allow more detailed controls on development in the floodplain and in floodways to be provided in Council’s Interim Flood Prone Lands Policy.”*

The LEP nominates the conditions shown below for development of floodways or on flood prone land. The definitions of “floodway” and “flood prone land” in the LEP are inconsistent with the Glossary of the FDM, 2005. “Flood prone” land is identified in the LEP as land shown flooded on the Flood Inundation Map, dated 1978 and includes land that would be affected by the 1% AEP (100 year ARI) flood, whereas the true definition of flood prone land is land inundated by the PMF or the Extreme Flood. The Flood Inundation Map, 1978 relates to land flooded by the Namoi River. Until the preparation of the Flood Study, 2005, no information was available regarding the extent of flooding on Blackjack Creek.

Flood related clauses are contained in Clause 26 of the LEP entitled: “Is the development of flood prone land permitted by this plan?” and are presented below:

- (1) *A person must not erect a building or carry out a work for any purpose on flood prone land without the permission of Council.*
- (2) *The Council must not consent to the erection of a building or carrying out of a work for any purpose on land that is flood prone unless it is satisfied that:*
  - (a) the building or work would not unduly restrict the flow characteristics of flood waters , and*
  - (b) the building or work would not unduly increase the degree of flooding on land in the vicinity, and*
  - (c) the structural characteristics of the building or work, the subject of the application, are capable of withstanding flooding, and*
  - (d) the proposed building is adequately flood proofed.*
- (3) *The Council must not grant a consent required by this clause unless it has taken into consideration:*
  - (a) the cumulative effect of the building or work on flood behaviour, and*

- (b) the risk of pollution to the waterways caused by the building or work, and*
- (c) the availability of access to the building or work to ensure the timely, orderly and safe evacuation of people from the area should a flood occur.*
- (4) When granting such a consent, the Council may require each habitable floor of a building to be erected to a height which is sufficient, in its opinion, to obviate the frequent flooding of the building.*

### **2.8.3 Flood- Related Clauses in Updated LEP**

Gunnedah Council is currently in the process of updating its LEP in common with other Councils in NSW. DOP and DECCW have carried out extensive negotiations regarding the generic wording of flood related clauses to be included in new versions of LEP's in NSW.

The *provisionally* agreed (and subject to change) generic wording for new LEP's is shown below:

#### **“ 7.3 Flood planning [local d07]**

- (1) The objectives of this clause are as follows:*
  - (a) to minimise the flood risk to life and property associated with the use of land;*
  - (b) to allow development compatible with the land's flood hazard, taking into account projected sea level rise;*
  - (c) to avoid significant adverse impacts on flood behaviour and the environment.*
- (2) This clause applies to:*
  - (a) land that is shown as “Flood Planning Area” on the Flood Planning Map, and*
  - (b) other land at or below the flood planning level.*

#### **Drafting direction**

*Councils know of some areas that flood and those areas are mapped as “flood planning area”, but there are other areas where accurate mapping is not possible. Consequently, the wording of this sub-clause captures the land that can be accurately mapped and the land that cannot. Such unmapped land includes the “flood planning area” (as defined in the Floodplain Development Manual) up to the “flood planning level”.*

- (3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:*
  - (a) is compatible with the flood hazard of the land; and*
  - (b) will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and*
  - (c) incorporates appropriate measures to manage risk to life from flood, and*
  - (d) will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and*
  - (e) will not be likely to result in unsustainable social and economic costs to the community as a consequence of flooding.*



(4) *A word or expression used in this clause has the same meaning as it has in the NSW Government's Floodplain Development Manual published in 2005, unless it is otherwise defined in this clause.*

(5) *In this clause:*

**flood planning level** means the level of a 1:100 ARI (average recurrent interval) flood event plus [insert number 0.xx] metres freeboard.

**Flood Planning Map** means the [Name] Local Environmental Plan 2010 Flood Planning Map. ”

The **flood planning level** (FPL) referred to above is the 100 year ARI flood plus an allowance for freeboard, which is usually set at 500 mm. It is the minimum level set for future residential development. The area encompassed by the FPL is known as the Flood Planning Area and denotes the area subject to flood related development controls. It is now standard practice for the residential FPL to be based on the 100 year ARI flood plus freeboard unless exceptional circumstances apply (see **Section 3.6.2** for further discussion).

This wording recognises recent amendments to government policy that for residential land use, the area to be subject to flood-related development controls will be limited to land inundated by the 100 year ARI flood plus an allowance for freeboard.

Under the arrangements agreed to by DOP and DECCW, flood related development controls for other categories of development for which a higher level of protection may be required (e.g. hospitals, aged persons accommodation, critical utilities, etc), may be covered by Flood Policy DCP's.

#### **2.8.4 Section 149 Certificates**

Gunnedah Council currently use the Flood Study, 2005 results in setting minimum floor levels for residential property, based on the 100 year ARI flood level plus 500 mm freeboard.

Council provides flood related development information in S149 (2) certificates at Clause 7A therein. Wording is as follows:

*“The subject land is identified as being subject to flooding in the Blackjack Creek Flood Study 2005. Development of the land should take into consideration the contents of the study. Clause 26 of the Gunnedah Local Environment Plan 1998 outlines the development controls for flood prone land. Refer to the attachment.”*

The “attachment” referred to in the above wording is a Schedule containing the following information:

- A statement of the aims and objectives of the NSW Government's Flood Policy, setting out the sequential stages of investigations leading to the preparation of the Floodplain Risk Management Plan for Blackjack Creek. (The statement is similar to that contained in the Foreword to this present study report.)
- A short summary of the aims, objectives and results of the Flood Study, 2005.
- A re-statement of Clause 26 of Gunnedah Local Environment Plan, 1998.

The proposed updating of Gunnedah Council's LEP will necessarily require an updating of the flood related wording in Council's S149 (2) Certificates, because Clause 26 will probably be amended to conform with the above wording agreed to by DOP and DECCW (**Section 2.8.3**). It is not possible at this time to propose amended wording, in view of the fact that the currently agreed wording is provisional.

However it is suggested that the new wording of S149 (2) certificates could be greatly simplified along the following lines:

*"Based on flood investigations and mapping in Council's possession, this property may lie within the extent of the residential Flood Planning Area (land encompassed by the 100 year ARI flood level plus 500 mm) and is therefore subject to flood related development controls, which are set out in Council's Flood Policy and the Blackjack Creek Floodplain Risk Management Study, 2010. Further information may be obtained by enquiries of Council."*

### **2.8.5 Council's Existing Flood Policy**

Council's flood policy is set out in *Chapter 9 of Part 3 - Planning Issues* of the DCP entitled "*Principles of Development*". The policy follows the recommendations of the *Gunnedah and Carroll Floodplain Management Study* prepared by SMEC, 1999 and deals with main stream flooding from the Namoi River.

In keeping with modern flood policy, the flood policy structures the criteria to be adopted for assessing proposals which are potentially affected by flooding in recognition that different controls are applicable to different land uses and levels of potential flood inundation and hazard. The policy recognises two types of hydraulic conditions:

**"Floodway.** *The policy recognises these are areas subject to high hazard conditions where inappropriate development could result in an obstruction to the flow of floodwaters, which in turn leads to an increase in flooding elsewhere and increases the susceptibility for damage and risk to lives. The policy states that whilst existing developments may require minor alterations or improvements to the land (which would be permissible subject to controls) intensification of land use should not be encouraged. Accordingly the following conditions would apply to applications for development in the floodway:*

- (a) *no new buildings shall be permitted;*
- (b) *filling shall not be permitted in a floodway other than in conjunction with riverbank rehabilitation and stabilisation provided that the levels do not protrude above natural surface levels;*
- (c) *fences shall not be permitted except where it can be demonstrated to Council that they are essential in which case they must be of post and rail strand wire or shear connectors construction; and*
- (d) *no further intensification of floodways shall be allowed unless it relates to the conversion of floodways to natural waterway corridors.*

**Flood Fringe.** Applications will need to satisfy the following conditions:

#### **Floor levels**

Habitable floor levels of residential property to be equal to or greater than 1% AEP flood plus 0.5 m freeboard.

There is no minimum floor level for commercial properties. Property owners should consider issues of streetscape and access in conjunction with flood risk when proposing floor levels. However, where floor levels are below the 1% AEP flood level a Site Specific Response Plan must accompany the application to show that areas are available for the temporary storage of hazardous materials and valuable goods above the 1% AEP flood level plus 0.5 m freeboard.

Critical utilities and public facilities should have floor levels equal to or greater than the extreme flood event (defined as a flood with discharge equal to 3 times the 1% AEP flood) plus 0.5 m freeboard, or be protected from the extreme flood by other measures such as a levee.

#### **Building Components and Materials**

Any portion of the building constructed below the Flood Planning Level for that class of development must be constructed of flood compatible materials.

#### **Structural Soundness**

Applicants are to demonstrate that any structure subject to flooding should withstand the forces of floodwater, debris and buoyancy. For residential and commercial/ industrial development the design flood for this clause is the 1% AEP event and for critical utilities and public facilities it is the extreme flood.

#### **Flood Effects on Others**

Council may require a report on the impact of the development on local flooding patterns.

#### **Evacuation and Access**

Development will only be permitted where effective warning time and reliable access are available for the evacuation of flood prone land."

### **2.8.6 Suggested Amendments to Flood Policy**

The amendments set out below would allow the existing Flood Policy developed by Council following the SMEC, 1999 study to apply for Blackjack Creek, as well as conform with the more recent requirements of the Circular issued by the Department of Planning on 31 January 2007. That Circular contained a package of information clarifying flood related controls on land located above the 100 year ARI flood level (i.e. land which is infrequently flooded).

The amended Flood Policy would be consistent with the flood related clauses in the new LEP agreed to by DOP and DECCW (see **Section 2.8.3**) and is supported by the results of the Flood Study, 2005

and the present investigation, which together have defined flood levels, flood extents and the hydraulic and hazard categorisation of the floodplain.

The suggested sub-division of the floodplain into hazard zones for the purposes of future development is shown on **Figure 2.5**, as follows:

- **Floodway.** This zone is analogous the Floodway zoning for the Namoi River adopted in Council's Flood Policy and would define the area conveying most of the flow in Blackjack Creek. Within this zone conditions (a) to (d) of **Section 2.8.5** above would apply, as is the case for areas inundated from river flooding.
- **Intermediate Floodplain.** This would be a new zoning not presently identified in Council's Flood Policy. It represents areas on the eastern side of Wandobah Road where flow velocities may be significant during major floods. Obstructions to the passage of flow may result in a re-direction of floodwaters to neighbouring property. In this zone there would need to be restrictions on fences and other potential flow obstructions such as site filling. Suggested wording which could be used by Council is given below.
- **Flood Fringe.** This zoning is presently used in Council's Flood Policy to identify areas outside the floodway. On Blackjack Creek it would represent the remaining area which would be inundated by the 100 year ARI flood. Flooding may reach up to about 300 mm in depth but flow velocities would not be significant. Only floor level controls would apply in this zone.
- **Outer Floodplain.** This would represent the zone between the 100 year ARI extent and that of the PMF. No controls over residential property would apply, but Council would check development proposals to ensure that the required freeboard on 100 year ARI flood levels was achieved. Otherwise, the situation may apply where properties just outside the extent of the 100 year ARI flood had floor levels lower than properties within that extent. The need for the check arises because the existing standard of mapping does not allow the line defining the *Flood Planning Area* (100 year ARI plus 500 mm) to be accurately identified. (This situation could be rectified by Council commissioning a survey to identify the extent of the *Flood Planning Area* between Lincoln Street and the Oxley Highway.)

The PMF flood levels should be used to control critical utilities and vulnerable development on Blackjack Creek instead of "*extreme flood levels*", as the latter term is relevant to Namoi River flooding. The "**Evacuation and Access**" Clause in Council's current Flood Policy (**Section 2.8.5**) is relevant to Namoi River flooding and should not be used to preclude development in areas of Blackjack Creek floodplain other than Floodway areas, because of the ready access out of that floodplain.

### **Suggested Additions to Council's Flood Policy to Cater for Fences and Filling in Intermediate Floodplain**

#### **A. Fencing**

"Any proposed fencing is to be shown on the plans accompanying a development application to allow Council to assess the likely effect of such fencing on flood behaviour. Fences which minimise

obstructions to flow should be adopted. Where impermeable fences such as Colorbond, galvanised metal, timber or brush are proposed, fencing panels should be either:

- a) removable so that panels can be laid flat; or
- b) horizontally hinged where a portion of at least 1.2 m high is capable of swinging open to allow floodwater to pass."

## **B. Filling**

"Building pads up to 1 m high are permitted for residential blocks. Not more than 50% of the width of the allotment at right angles to the direction of flow (which generally follows the direction of Wandobah Road) is to be impeded by fill. Subsurface drainage of building pads is required."

## **2.9 Flood Warning and Flood Preparedness**

### **2.9.1 Gunnedah SES Local Flood Plan**

The State Emergency Service is nominated as the principal combat and response agency for flood emergencies in NSW. The SES is responsible for the issuing of relevant warnings (in collaboration with the Bureau of Meteorology), as well as ensuring that the community is aware of the flood threat and how to mitigate its impact.

The *Gunnedah Local Flood Plan, 2002*, published by SES covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures for all levels of flooding within the Gunnedah area. The *Flood Plan* is administered by the Gunnedah SES Local Controller who controls flood operations within the Gunnedah Shire Council area, which is itself located within the Namoi SES Division.

The *Local Flood Plan* covers the Gunnedah Shire Council area, which includes the urban centre of Gunnedah, surrounding villages and rural land. The Flood Plan is divided into the following parts:

- **Preparedness**, the *Local Flood Plan* devotes considerable attention to flood alert and emergency response procedures to be followed in the event of imminent dam failure.
- **Response**. The Gunnedah SES maintains an operation centre at the Local SES Headquarters in Bennett Road, Gunnedah. The Bureau of Meteorology, Namoi SES Division headquarters, Gunnedah Shire Council and State Water's Keepit Dam Office are identified as Sources of Flood Intelligence. The BOM provides Flood Watches giving an early appreciation of developing meteorologic situations which could lead to flooding. They are provided on a whole of catchment basis for the Namoi River valley. The BOM also provides Flood Warnings which include Namoi River height readings and height-time predictions at Gunnedah. The SES also monitors the potential problem areas such as low points on roads, bridges, creeks and flood runners. However, there is no mention of roads being overtopped or details of flooding in the Blackjack Creek catchment.
- **Recovery**, involving measures to ensure the long term welfare for people who have been evacuated, recovery operations to restore services and clean up and de-briefing of emergency management personnel to review the effectiveness of the Plan.

### 2.9.2 Incorporation of Blackjack Creek Flood Data in the Gunnedah Local Flood Plan

The *Local Flood Plan* deals with main stream flooding in the Namoi River and its tributaries and contains no specific mention of flooding problems in Blackjack Creek.

SES should review the *Local Flood Plan* after the completion of this study to take into account information contained on the impacts of flooding on urban development bordering Blackjack Creek, as well as recommendations regarding flood warning and community education. The following information will be of assistance in this regard:

- Indicative extents of inundation and areas subject to high hazard during major floods (**Figures 2.1 and 2.3**).
- Typical times of rise of floodwaters (**Figure 2.2**).
- Locations of residential properties inundated by floodwaters of various recurrence intervals and depths of above floor flooding (**Figure B8.3**).
- Inundation of local access roads.
- Information on the operation of the local stormwater system (see **Chapter 3**).

The *Local Flood Plan* should also recognise that the flooding which occurs within the Blackjack Creek urban area is of a “flash flooding” nature in contrast with the slow rising nature of flooding on the Namoi River.

### 2.10 Environmental Considerations

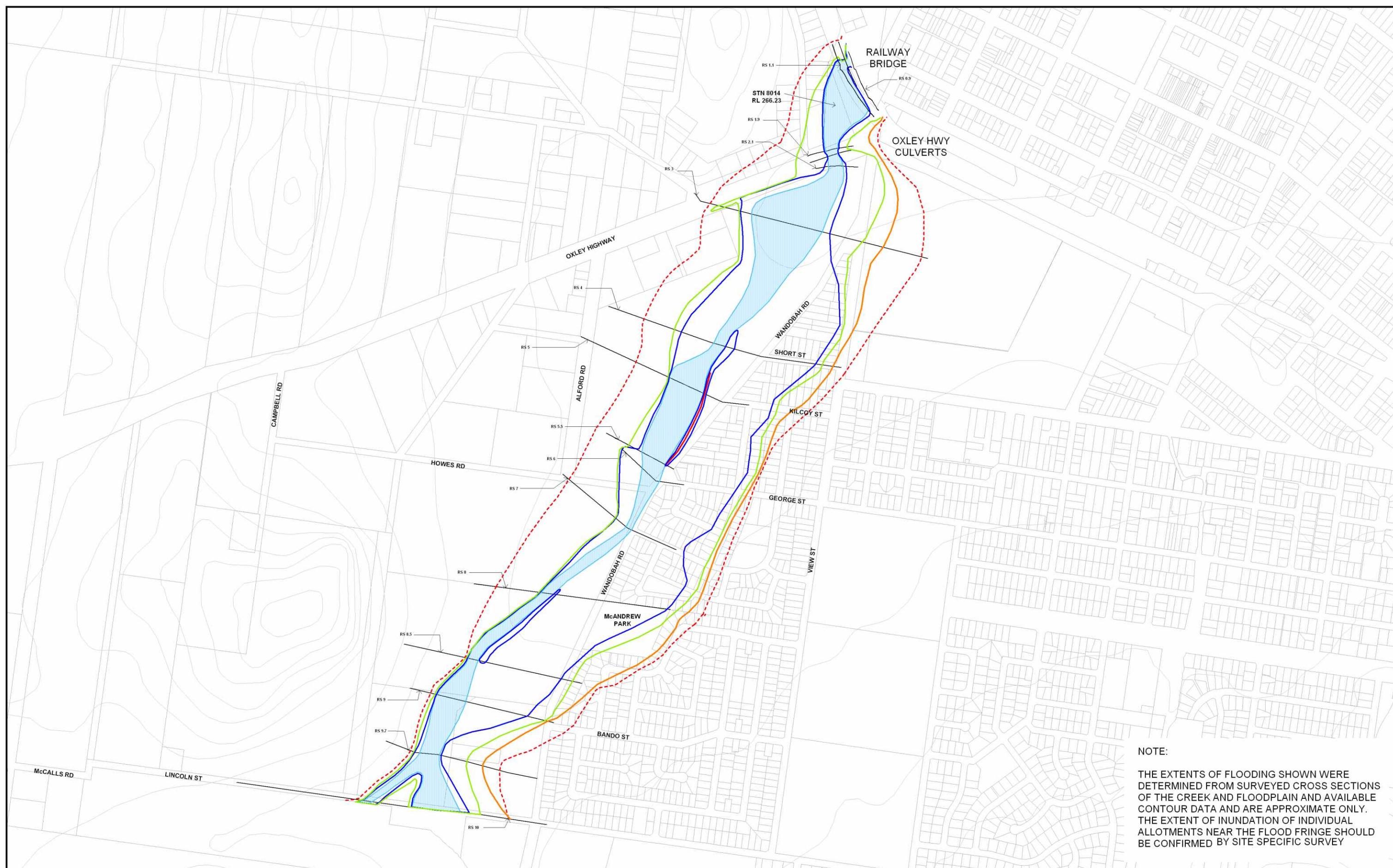
Mining along the Blackjack Creek corridor has resulted in erosion of the channel and salinity problems in the groundwater due to leaching from the saline-sodic soils due to extended wet periods. The Gunnedah Community Charrette held in 1997 made several proposals to mitigate adverse impacts including:

- The development of several shallow basins along the corridor to increase its capacity for storm water retention of runoff.
- Improvement of water quality and downstream ecosystems.
- Re-foliation of hillsides and planting of vegetation to absorb surface water and filter pollutants from surface runoff.

These suggestions were to be integrated with the overall design of the “continuous green space plan” aimed at improving the environment as well as providing recreational linkages to south-western Gunnedah and the koala habitat.

Subsequently the then DIPNR (now DECCW) undertook testing of soil salinity and mapping of problem areas in the Wandobah Reserve area. This work allowed the route of proposed improvements to the hydraulic capacity of the creek to bypass the most affected areas (**Chapter 3**).

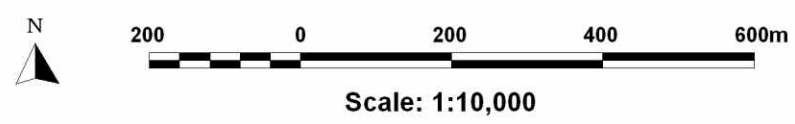




**BLACKJACK CREEK  
FLOODPLAIN RISK MANAGEMENT STUDY**  
Figure 2.1  
INDICATIVE EXTENTS OF FLOODING  
5, 20, 100 YEAR ARI AND PMF

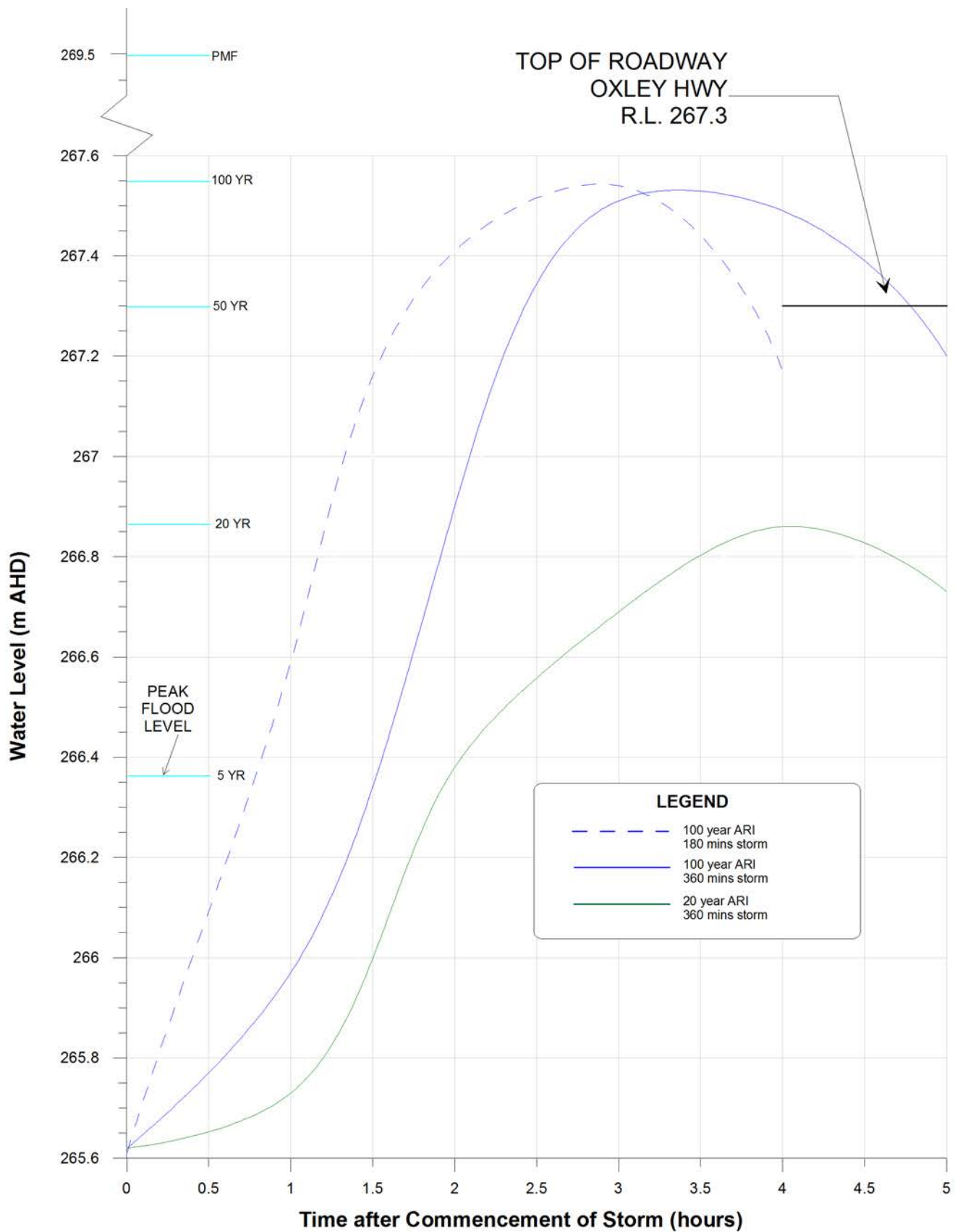
**LEGEND**

- 5 year ARI Flood Extent
- 20 year ARI Flood Extent
- 100 year ARI Flood Extent
- PMF Flood Extent
- Existing Levee
- Cross Section Location and HEC-RAS Model River Station Number
- Eastern Extent of Flood Planning Area (100 Year ARI + 500 mm)



NOTE: CROSS SECTION LOCATIONS EXTRACTED FROM STEWART SURVEYS CONSULTING SURVEYORS (NOV/04)





# **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY**

Figure 2.2

**TIME OF RISE OF FLOODWATERS AT OXLEY HIGHWAY**





200 0 200 400 600m

Scale: 1:10,000

- 100 year ARI High Hazard
- 100 year ARI Medium Hazard
- 100 year ARI Low Hazard
- 100 year ARI Flood Extent

#### LEGEND

- RS 9 Cross Section Location and HEC-RAS Model River Station Number
- Existing Levee
- 20 year ARI Flood Extent

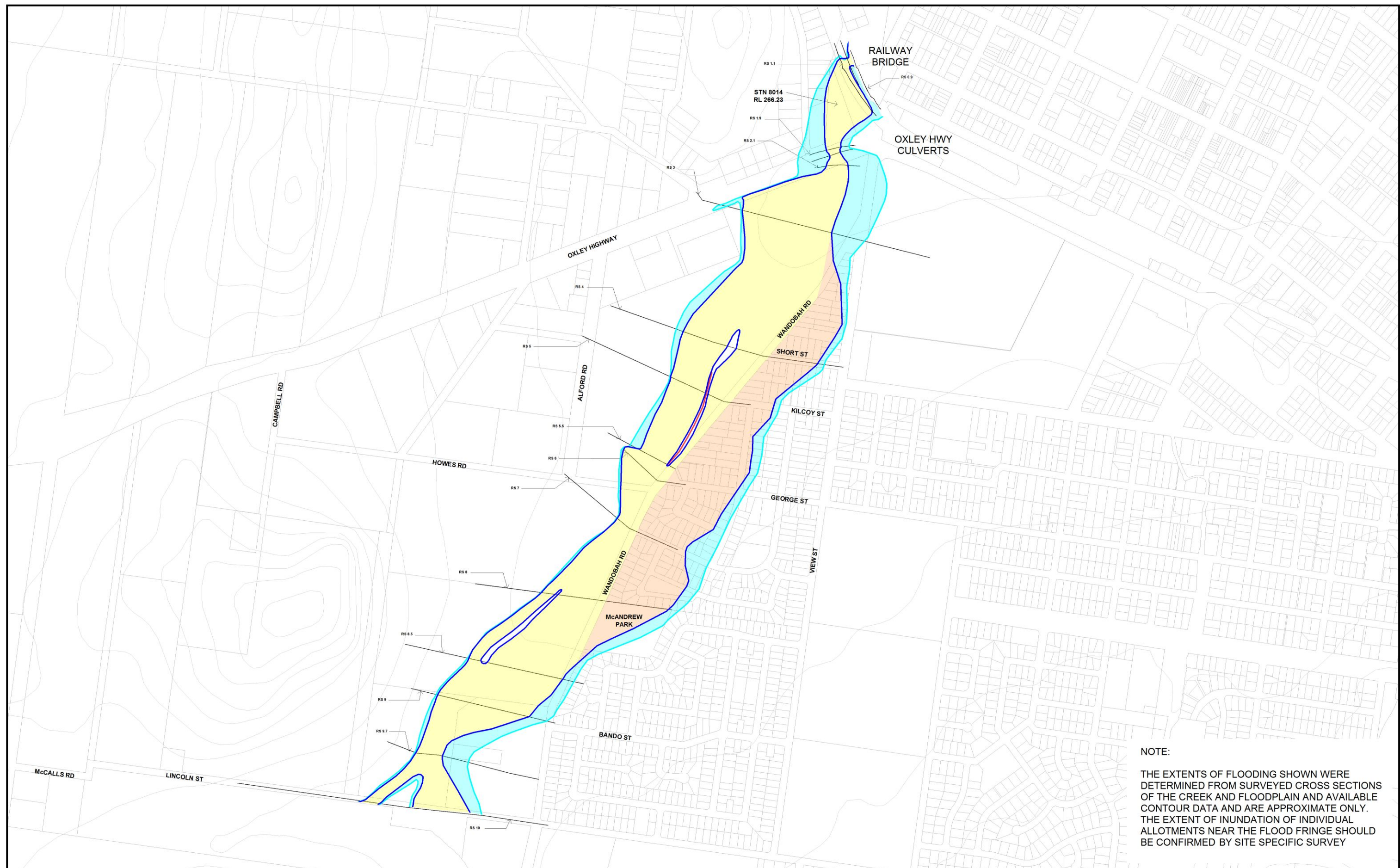
#### BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.3

FLOOD HAZARD ZONES 100 YEAR ARI

NOTE: CROSS SECTION LOCATIONS EXTRACTED FROM STEWART SURVEYS CONSULTING SURVEYORS (NOV/04)





NOTE:  
 THE EXTENTS OF FLOODING SHOWN WERE DETERMINED FROM SURVEYED CROSS SECTIONS OF THE CREEK AND FLOODPLAIN AND AVAILABLE CONTOUR DATA AND ARE APPROXIMATE ONLY. THE EXTENT OF INUNDATION OF INDIVIDUAL ALLOTMENTS NEAR THE FLOOD FRINGE SHOULD BE CONFIRMED BY SITE SPECIFIC SURVEY



200 0 200 400 600m

Scale: 1:10,000

# LEGEND

- 100 year ARI Floodway Extent
- 100 year ARI Flood Storage Area
- 100 year ARI Flood Fringe
- 100 year ARI Flood Extent

- Cross Section Location and HEC-RAS Model River Station Number
- Existing Levee
- 20 year ARI Flood Extent

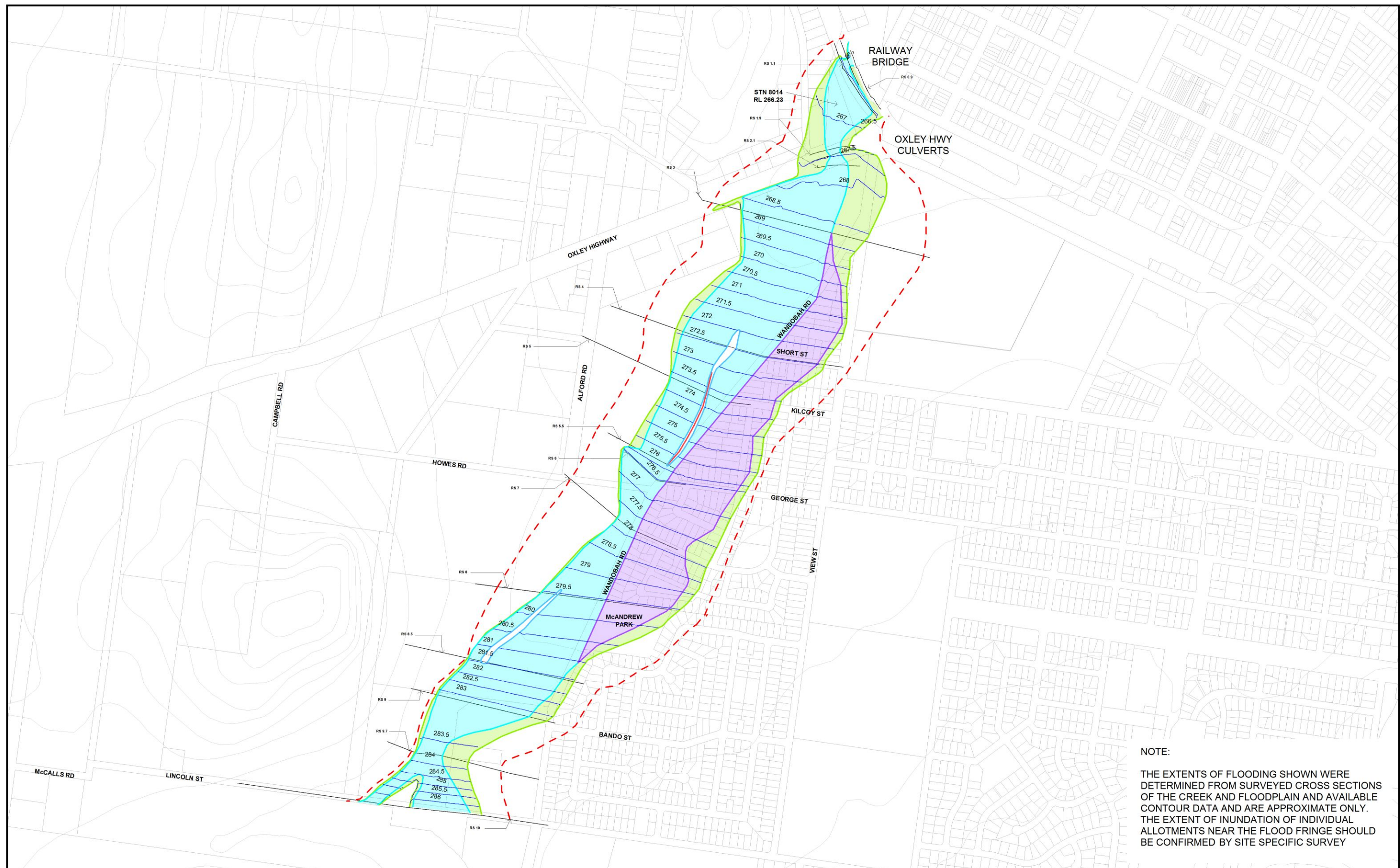
## BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.4

HYDRAULIC CATEGORISATION OF FLOODPLAIN 100 YEAR ARI

NOTE: CROSS SECTION LOCATIONS EXTRACTED FROM STEWART SURVEYS CONSULTING SURVEYORS (NOV/04)





NOTE:  
THE EXTENTS OF FLOODING SHOWN WERE DETERMINED FROM SURVEYED CROSS SECTIONS OF THE CREEK AND FLOODPLAIN AND AVAILABLE CONTOUR DATA AND ARE APPROXIMATE ONLY. THE EXTENT OF INUNDATION OF INDIVIDUAL ALLOTMENTS NEAR THE FLOOD FRINGE SHOULD BE CONFIRMED BY SITE SPECIFIC SURVEY



200 0 200 400 600m

Scale: 1:10,000

NOTE: CROSS SECTION LOCATIONS EXTRACTED FROM STEWART SURVEYS CONSULTING SURVEYORS (NOV/04)

### FLOOD PLANNING ZONES

- Floodway
- Intermediate Floodplain
- Flood Fringe
- Outer Floodplain

### LEGEND

- RS 9 Cross Section Location and HEC-RAS Model River Station Number
- Existing Levee
- Flood Contours (100 year ARI)

## BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY

Figure 2.5

FLOOD INUNDATION AND FLOOD PLANNING ZONES

### 3 POTENTIAL FLOODPLAIN MANAGEMENT MEASURES

#### 3.1 Range of Available Measures

A variety of floodplain management measures can be implemented to reduce flood damages, as follows.

**Flood modification** refers to changing the behaviour of floods in regard to discharges and water surface levels to reduce flood risk. This can be done by the construction of levees, retarding basins and channel improvements. Such measures are also known as “structural” options as they involve the construction of engineering works.

**Property modification** refers to reducing risk to properties through measures such as land use zoning, minimum floor level requirements, or house raising. Such options are largely planning measures, as they are aimed at ensuring that the use of floodplains and the design of buildings are consistent with flood risk. Property modification measures could comprise a mix of structural and non-structural methods of damage minimisation.

**Response modification** refers to changing the response of flood affected communities to the flood risk by increasing flood awareness by the installation of flood warning systems and the development of emergency management plans for property evacuation. These options are wholly non-structural.

#### 3.2 Community Views

Comments on potential flood management measures were sought from the local community by way of the Newsletter and Questionnaire distributed at the commencement of the study. The responses are summarised in **Appendix C**. Question 11 in the Questionnaire outlined a range of potential flood management options. The responses are shown on **Table 3.1**, together with initial comments on the feasibility of the measures, which are discussed in more detail in later sections of this Chapter.

The Community favoured the following measures:

- Management of vegetation in Blackjack Creek to maximise hydraulic capacity.
- Enlarging the channel to increase hydraulic capacity.
- Detention basins to store floodwaters and reduce downstream flood peaks.
- Construction of a levee along the eastern side of the creek to protect residential development.
- Controls over future development in flood liable areas.
- Improved flood warning, evacuation and flood response procedures, including evacuation and emergency assistance.
- Community education to promote flood awareness in the community.
- Provision of Flood advice certificates for properties located within the Flood Planning Area.
- Flood markers to show the extent and height of potential flooding.

These measures and the others included in the Questionnaire were examined at the strategic level of detail in **Chapter 3** and tested for feasibility on a range of assessment criteria in **Chapter 4**. Following consideration of the results by the Floodplain Management Committee, favoured measures were included in the draft *FRMP* in **Chapter 5**.



**TABLE 3.1**  
**COMMUNITY VIEWS ON POTENTIAL FLOOD MANAGEMENT MEASURES**

Flood Management Measure		Classification	Respondents' Views		Comments
			Yes	No	
a)	Maintenance programs to clear creek of vegetation and debris impeding flows.	FM	48	2	This option is strongly favoured by the Community and is reviewed in <b>Section 3.3</b> . It is not strictly a flood mitigation scheme as the hydraulic capacity of the channel would not be significantly increased and peak flood levels reduced; but it would have environmental benefits.
b)	Enlarge the Creek Channel	FM	38	3	This option is strongly favoured by the Community. The feasibility of this option is reviewed in <b>Section 3.3</b> . The augmenting the hydraulic capacity of the culverts beneath the Oxley Highway is also considered.
c)	Construct detention basins to store floodwaters.	FM	16	8	The community favours implementing detention basins on the creek to mitigate existing flooding problems. The feasibility of constructing basins to reduce downstream flood peaks is considered in <b>Section 3.4</b> .
d)	Construct permanent levees to contain floodwaters.	FM	27	8	This option is strongly favoured by the Community. The feasibility of providing a levee along the creek to contain floodwaters is considered in <b>Section 3.5</b> .
e)	Voluntary purchase of residential property within 100 year ARI flood extent.	PM	11	11	The community is evenly divided on this option, which is often adopted to remove residential property in high hazard areas of the floodplain. This option is reviewed in <b>Section 3.7</b> .
f)	Provide funding or subsidies to raise houses above 100 year ARI flood level.	PM	16	12	The community is evenly divided on this option. House raising is applicable to timber framed residences only, usually located in low hazard zones. This option is reviewed in <b>Section 3.8</b> .
h)	Controls on future development in flood-labile areas. (eg controls on location in the floodplain, minimum floor levels. etc.)	PM	25	3	Controls over development in flood prone land are very strongly supported by the community and would be an essential part of the FRMP. This issue is covered in the suggested development controls in <b>Section 3.6</b> .

Legend: FM = Flood Modification Option PM = Property Modification Option RM = Response Modification Option

**TABLE 3.1**  
**COMMUNITY VIEWS ON POTENTIAL FLOOD MANAGEMENT MEASURES**  
**(Continued)**

Flood Management Measure		Classification	No of Respondents		Comments
			Yes	No	
i)	Improve flood warning and flood response procedures	RM	33	3	There is presently no formal flood warning system for the creek, where flooding is of a "flash flooding" nature, with sudden rises in water levels after the onset of heavy rainfall. Improvements in flood warning procedures would be strongly supported by the community and are considered in <b>Section 3.9</b> .
j)	Improve evacuation and emergency assistance plans	RM	21	6	Emergency management in Gunnedah is covered by the SES's Gunnedah Local Flood Plan. Improvements would be strongly favoured by the community.
k)	Community education, participation and flood awareness programs	RM	30	2	Promotion of awareness of the flood risk would be strongly favoured among the community. This option is reviewed below.
l)	Provide a certificate to all residents stating whether their property is flood affected and to what extent	RM	32	1	Provision of information on flood affection of properties would be strongly favoured by the community. This is currently achieved by notation of flood affectation of allotments on Section 149 Certificates. This option is reviewed in <b>Section 3.6</b>
m)	Install flood markers	RM	26	3	This option probably as part of an integrated flood awareness program combining options k) and l) above would be favoured by the community.

Legend: FM = Flood Modification Option PM = Property Modification Option RM = Response Modification Option

### **3.3 Flood Modification Measures – Channel Improvements**

#### **3.3.1 Introductory Remarks**

The hydraulic capacity of a stream may be increased by widening, deepening or straightening the channel and by clearing the banks of obstructions. The scope of such improvements can vary from minor works such as de-snagging and bank clearing, which do not increase the waterway area but reduce hydraulic roughness, to major channel excavations. Careful attention to design is required to ensure stability of the channel is maintained and scour or sediment build-up is minimised. The potential for channel improvements to increase downstream flood peaks also needs to be considered. In general, channel improvements need to be carried out over a substantial stream length to have any significant effect on flood levels. Proposals also need to conform with Government Policies in regard to retention of native vegetation, maintenance of fish habitat and other environmental considerations.

#### **3.3.2 Management of Vegetation and Stream Clearing**

The existing channel of Blackjack Creek is relatively indistinct and of low hydraulic capacity. It is capable of containing only minor flood flows. Under major flooding conditions most of the flow is conveyed on the floodplain, extending over Wandobah Road into the residential area on its eastern side, as well as onto the grassed, western floodplain.

Hydraulic modelling was undertaken to assess the reductions in peak flood levels which could be achieved by clearing the stream and reducing the height of vegetation on the western floodplain. The waterway area would not be increased by excavation, but any reduction in water levels would be achieved by a reduction in the resistance to flow (that is, a reduction in the “hydraulic roughness” of the natural surfaces in contact with the floodwaters).

The modelling showed that stream clearing (which would require continuing maintenance to remain effective) would not result in reductions in flood level greater than about 200 mm and therefore would not be a viable mitigation measure for major floods, although it would have environmental benefits and could possibly be justified on those grounds. Any program of vegetation management would need to be continually maintained to achieve the modelled reductions in flood levels.

#### **3.3.3 Channel Improvements**

Following the January 1984 flood, Council commissioned the design of a channel improvement scheme aimed at containing major floods up to the 100 year ARI level (Kelley and Associates, 1984). The scheme involved the construction of a grassed floodway of trapezoidal cross-section, with a low-flow concrete invert. The proposed floodway was not constructed, but would have extended over a 2 km reach from a point about 600 m downstream of Lincoln Street to the Oxley Highway.

The proposed cross section had a bed width of 20 m and 1 vertical to 5 horizontal side slopes and was sized for to contain the 100 year discharge, which was estimated at the time as 90 m<sup>3</sup>/s. That discharge approximated the hydraulic capacity of the culvert at the Oxley Highway, which had been designed by the then DMR (now RTA) to convey up to 80 m<sup>3</sup>/s without surcharging. No enlargement of the culverts beneath the Oxley Highway was proposed. The peak depth of flow and velocity in the channel were estimated at 1.2 m and 3 m/s respectively. The hydraulic roughness value adopted in the design of the channel was 0.029. This value is characteristic of a very hydraulically efficient, grassed channel and would have required a rigorous and continuing program of maintenance to remain as hydraulically smooth as was assumed in the design.



The more recent Flood Study, 2005 assessed the peak of the 100 year ARI discharge at 126 m<sup>3</sup>/s at the Oxley Highway, which is about 30 per cent greater than Kelley and Associates' estimate of that flood peak. The models developed in the Flood Study were verified using historic flood data and consequently, are likely to have produced a more accurate estimate of the 100 year ARI discharge than the discharge adopted by Kelley and Associates. Consequently, a larger waterway area would be required to contain the 100 year ARI flood than was adopted in their design.

Over the last 20 years there has been a move away from achieving channel improvements by relatively straight, engineered grassed floodways, to designs more in keeping with the appearance and morphology of natural streams. More recently, the Department of Water and Energy (DWE), now DECCW, has noted that construction in the bed of streams or within 40 m of the banks would be regulated by the Water Management Act, 2000 and that approval for works would be required. It is likely that a design similar to the Kelley and Associates' concept would not be supported by DECCW, or the Namoi Catchment Management Authority for environmental reasons.

Modern practice is to consider creeks as functioning as riparian corridors and recognise that they form a transitional zone between terrestrial and aquatic environments, performing a range of important environmental functions, in addition to conveying flood flows.

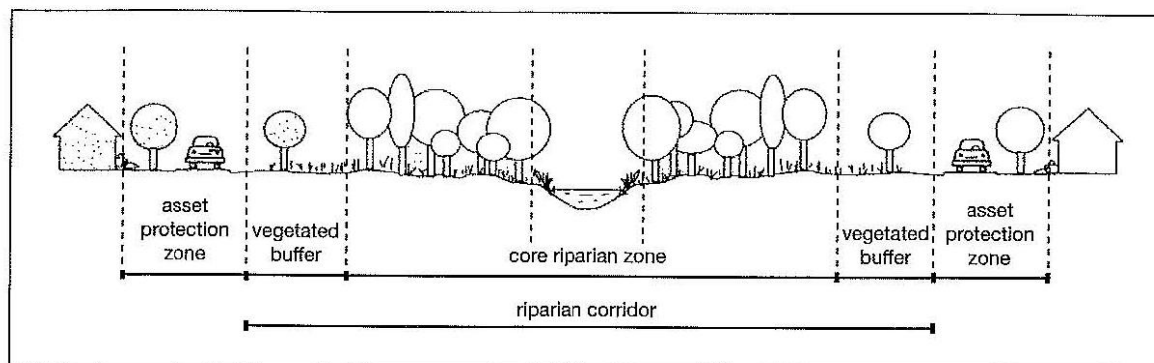
As noted in DWE's *Guidelines for Riparian Corridors, 2008* the functions are:

- Provide bed and bank stability and reduce channel and bank erosion.
- Protect water quality by trapping sediment nutrients and other contaminants.
- Provide a diversity of habitat for terrestrial riparian and aquatic flora and fauna species.
- Allow for the conveyance of flood flows and control their direction.
- Provide an interface between developments and waterways.

As shown on the schematic cross section Figure 1, extracted from DWE, 2008 a riparian corridor would typically comprises three zones:

- The core riparian zone (CRZ) contained within and adjacent to the channel.
- A vegetated buffer protecting the CRZ from weed invasion.
- An asset protection zone protecting houses from bushfire damage.

Figure 1. Riparian corridor zones.



### 3.3.4 Potential for Riparian Corridor/Improved Channel on Blackjack Creek

Blackjack Creek is a typical ephemeral stream with long dry periods and intermittent surface runoff events and occasional major flood flows such as occurred in January 1984 and November 2008. In view of the proximity of development on the eastern floodplain, mitigation of flooding would probably be a more important objective of the development of the riparian corridor than on other streams which do not have urban flooding problems. In order to achieve a flood mitigation objective, the overall hydraulic capacity of the waterway would need to be substantially increased.

As the vegetated zones on the floodplain associated with a riparian corridor on Blackjack Creek may result in an increase in hydraulic roughness compared with the existing grass cover on the floodplain, there will need to be a large increase in the area of the channel to contain floodwaters. Consideration will need to be given to limiting the density of planting in the area bordering the channel to ensure that flood levels for the very large events which surcharge the channel are not increased, compared with present day conditions. Because of the comparatively steep slope of the creek (averaging about 0.8% between Lincoln Street and the Oxley Highway) it would be desirable to vary the bed gradient and also provide a sinuous channel (in plan) more in keeping with natural streams, with occasional sections of transverse rock banking across the invert for the creation of ponds and control of bed scour.

Hydraulic modelling was carried out of a riparian corridor involving the above features. The objective was to contain the extent of flooding up to the 100 year ARI event to the confines of the channel. For preliminary analysis the channel was assumed to follow a route which had previously been determined by Council to minimise impacts on existing trees and native vegetation and is shown on **Figure 3.1**. For the purposes of modeling, the improved channel section was assumed to extend from model cross section RS9.7 about 200 m downstream of Lincoln Street, to RS3 a similar distance upstream of the Oxley Highway. Between cross sections RS3 and RS2.1 the channel invert would “tail out” to existing levels. The existing waterway area in the section of creek from RS3 to the Oxley Highway would not be increased, as flood levels in this reach are largely controlled by the hydraulic capacity of the road crossing. It is not proposed to increase the number of culverts elements. Under 100 year ARI conditions the roadway would be overtopped for a short time, as occurs at present.

From **RS 9.7** to **RS8** a trapezoidal channel of 20 m bed width and 1 vertical to 4 horizontal side slopes was modelled. Downstream of **RS8** a 30 m wide channel was modelled, to cater for the increase in flows from the local residential sub-catchments on the eastern side of the creek. Typical modelled cross sections are shown in **Figure 3.2**.

In practice the side slopes would be varied along the length of the channel to mimic natural streams. The invert and batters would be vegetated with local grass and plant species, selected and planted at a density which ensures that hydraulic capacity is not reduced over time. On-going maintenance would be required to control growth. Five or six rock structure would be located in the invert to control scour and allow the formation of ponds during dry periods. The overbanks would be planted with stands of trees to simulate natural creek conditions.

### 3.3.5 Indicative Cost of Riparian Corridor/Improved Channel

**Table 3.2** provides an indicative capital cost of the riparian corridor scheme. For preliminary costing a 20 m width along each bank was adopted as the riparian corridor/vegetated buffer of Figure 1 of DWE's Guidelines for Riparian Corridors, 2008.

The costing shown in **Table 3.2** has been developed using existing sources of survey data. This is appropriate for a strategy study such as the present *FRMS*, where the principal objective is to evaluate projects on a comparative basis. However, in order to gain Government funding, it would be necessary to refine the analysis and costing using more detailed survey and cost data. A concept design study is proposed as a project for inclusion in the draft *Floodplain Risk Management Plan* for Blackjack Creek. Concept design studies, along with the preparation of detailed designs quality for Government funding, along with the construction of the works.

Annual maintenance costs amounting to 1.5 percent of the capital cost have been converted to a present worth value and added to the capital cost to obtain an indicative total cost of the scheme, which has been used in the economic analysis of **Section 3.3.6**.

**TABLE 3.2**  
**INDICATIVE CAPITAL COST RIPARIAN CORRIDOR/IMPROVED CHANNEL**

Item	Cost \$
Preliminaries (Establishment, Geotechnical Testing, Sediment Control)	15,000
Clear and Grub Floodplain	170,000
Strip and Store Topsoil for later re-use on excavated surfaces	138,000
Excavate Channel over 1.9 km reach , spread spoil on floodplain	438,000
Spread stored topsoil over excavated surfaces	149,000
Sow and maintain native plants/grasses over excavated channel batters	252,000
Grass seed channel invert	250,000
Supply and place rock in channel invert to form rock pools and control scour	90,000
Riparian Zone plantings along channel overbanks (20 m each side)	133,000
Survey, investigation and design (7.5%)	123,000
Un-estimated items and contingencies (20%)	352,000
<b>TOTAL ESTIMATED CAPITAL COSTS</b>	<b>\$2.1 M</b>

### 3.3.6 Economic Assessment of Riparian Corridor/Improved Channel

Surcharging of the channel of Blackjack Creek commences at the 5 year ARI and significant damaging flooding occurs at the 20 year ARI level of flooding in the residential developments bordering the creek. From the economic assessment of flooding presented in **Appendix B**, the *present worth value* of damages for all floods up to the 100 year ARI magnitude is \$2.02 Million for a 7 per cent discount rate and over an economic life of 20 years. In an economic analysis, the damages prevented by a flood mitigation scheme represent its benefits. Therefore, provided damages up to the 100 year ARI level of flooding were eliminated by the proposed scheme, expenditure of the above amount could be economically justified.

**Table 3.3** shows the results of the economic analysis. The analysis has been carried out for the three discount rates nominated by NSW Treasury Guidelines for the economic analysis of public works. The table includes an allowance for annual maintenance costs of 1.5 percent of the capital cost brought back to a present worth value over a period of 20 years. The total indicative cost is about \$2.44 Million, The benefit/cost ratio of the riparian corridor scheme is less than 1.

However, the scheme would protect the residential area against main stream flash flooding up to the 100 year ARI. It would mitigate main stream flooding in approximately one hundred residential properties which presently would be flooded in the event of a 100 year ARI flood. Therefore, the scheme would have considerable social benefits in terms of a reduction in flood risk to residents.

**TABLE 3.3**  
**ECONOMIC ANALYSIS OF RIPARIAN CORRIDOR/IMPROVED CHANNEL ON**  
**BLACKJACK CREEK**

Discount Rate %	4	7	10
Present Worth Value of Benefits* (Damages Prevented) \$ x 10 <sup>6</sup>	2.6	2.02	1.62
Cost of scheme (capital and annual maintenance costs) \$ x 10 <sup>6</sup>	2.54	2.44	2.38
Benefit/Cost Ratio	1.0	0.8	0.7

Note: \* Section 8.3 of Appendix B includes a definition of terms used in the economic assessment of flood impacts

### 3.4 Flood Modification Measures - Construction of Detention Basins

Detention basins provide a temporary storage of floodwaters additional to that contained in the natural floodplain, which can reduce the flood peak in downstream reaches of the creek. "Offline" basins, remote from the streams, with intake and outlet channels to and from the stream, are preferred over embankments constructed across the channel to maintain the continuity of the creek system. However, an offline basin is not feasible on Blackjack Creek due to the limited extent of the floodplain and the nature of existing land use.

The basin should also be located in the middle or lower reaches of the catchment, sufficiently close to the area intended to be protected, that its attenuating effects over flood peaks is not negated by downstream tributary inflows. Typically the basin should command in excess of 60 to 70 percent of the total catchment at the damage centre. An on-line basin could in theory be constructed across the channel and its overbanks downstream of Lincoln Street. The catchment area at this site amounts to 17 km<sup>2</sup>, about 70 percent of the 24 km<sup>2</sup> at the Oxley Highway.

Another requirement is that the basin be of sufficient size to store a significant percentage of runoff from the design storm. Basins attenuate the flood peak (i.e. reduce the downstream peak rate of runoff) by temporarily storing the incoming discharge hydrograph and releasing it at a controlled rate.

Flows up to the 100 year ARI would usually be controlled by low level pipes. A portion of the embankment crest in the vicinity of the channel would be depressed and armoured with reno-mattress or equivalent to act as a spillway for the conveyance of higher flows. (Alternatively an armoured by-wash spillway in one of the abutments could be provided.)

Small basins are quickly overwhelmed by the incoming flood waters, with the result that the level of stored water quickly rises to the level of the emergency by-wash spillway. Because the spillway is

able to pass a large rate of flow, with little rise in level, the rate of outflow rapidly rises to the rate of inflow, negating the purpose of the basin.

For a basin on Blackjack Creek, the objective would be to reduce the 100 year ARI inflow discharge to an outflow of no more than 20 m<sup>3</sup>/s, in order to reduce flows to no greater than the pre-basin 5 year ARI peak, which may be conveyed within the floodplain without surcharging Wandobah Road. Under 100 year ARI conditions, the total volume of runoff entering the basin for storms of duration likely to maximise flows on Blackjack Creek would be around 10<sup>6</sup> m<sup>3</sup>, of which 125,000 m<sup>3</sup> is in that part of the hydrograph above the rate of 20 m<sup>3</sup>/s and would need to be stored, with the remainder below 20 m<sup>3</sup>/s released through the low level outlets. Containment of this volume would require a rectangular storage area of 300 m by 300 m at an average depth of 1.4 m.

The potential basin site downstream of Lincoln Street has not been surveyed. On the basis of available 2 m contour mapping, it appears that a volume of 40,000 m<sup>3</sup> could be achieved by storing water to an average depth of 1 m on the overbank areas. Greater depths would extend outside the available area. Within the channel, the depth of ponding would be around 3 m. The available volume of 40,000 m<sup>3</sup> is less than one third of the required volume.

These values indicate that detention basins would not be a feasible flood management measure for Blackjack Creek and should not be included in the list of management measures for the draft *Floodplain Risk Management Plan*.

### **3.5 Flood Modification Measures - Levees**

#### **3.5.1 General**

Levees are an effective means of protecting flood affected properties up to the chosen design flood level. In designing a levee, it is necessary to take account of potential adverse re-direction of flood flows, the requirements for disposal of internal drainage from the protected area and the consequences of overtopping the levee in floods greater than the design event.

Reinforced concrete and concrete block walls are often used in situations where there is insufficient land available for earth banks. Such walls are provided with reinforced concrete footings of sufficient width to withstand overturning during flood events. A recent example of this form of construction is the levee scheme for the town of Lismore which protected the town from a severe flood a short time after its opening.

A major difficulty with urban levee schemes is the provision of facilities for the collection, temporary storage and disposal of stormwater runoff derived from the local sub-catchments within and upstream of the protected area. In some situations, evacuation of local runoff by pumping over the levee has been adopted where there is insufficient area available to store runoff for later disposal by gravity as the flood recedes. In other situations, separate provisions are made for the collection and transfer of stormwater runoff along the protected side of the levee, downstream to a location where the flood gradient in the main stream allows its conveyance back to the main stream by gravity. (This latter method of disposal has been adopted in the Blackjack Creek levee proposal described below).

#### **3.5.2 Potential for Levees along Blackjack Creek**

**Figure 3.3** shows a proposal for a levee aimed at providing a 100 year ARI level of flood protection.

The levee would commence at Bando Street and continue for 850 m along the western side of Wandobah Road to meet the existing section of levee, which extends over 400 m from George Street to Short Street. The levee would then continue 400 m to a point about 200 m upstream of the Oxley Highway. The purpose of terminating the levee at that location is to allow local stormwater drainage to be discharged by gravity to the creek. Under the concept, runoff from Council's local stormwater system would be collected and conveyed in the channel shown on **Figure 3.3** running northwards between the levee and Wandobah Road. At the proposed discharge point, it appears from existing survey that main stream flood levels have fallen to the level where the stormwater runoff may be safely discharged without backwater levels from the Oxley Highway influencing flooding in the residential area.

Hydraulic modelling showed that 100 year ARI flood levels in Blackjack Creek would be increased by up to 330 mm due to the constricting effects of the levee. For the purposes of this analysis it was assumed that the crest of the levee would be 1 m above the level of the 100 year ARI flood under post-levee conditions. The freeboard is a factor of safety which allows for wave action, uncertainties in the assessment of 100 year ARI flood levels, construction tolerances and potential settlement of the levee.

Survey information along the route of the levee is sparse, with information on natural surface levels being confined to the cross sections of the creek incorporated in the hydraulic model of the floodplain developed for the flood studies (their locations are shown on **Figure 3.3**), as well as Council's 2 m contour data. Based on this information, the height of the levee would range between 900 mm and 2.1 m.

To achieve the design crest level, the section of existing levee would need to be raised by up to 1 m. It has been assumed for costing purposes that the existing levee will be incorporated in the new works. However, this assumption is subject to geotechnical testing at the design stage, as the engineering properties and compaction of the fill material are presently unknown.

### **3.5.3 Provisions for Discharge of Stormwater**

The provision of facilities for the temporary detention and release of runoff from the protected areas whilst creek levels are maintained was an important issue in planning for the levee. During major floods, elevated water levels will be maintained in the creek for a period of up to four hours.

**Figure 3.4** shows the stage hydrographs at the outlets of Council's piped stormwater system resulting from the occurrence of a 100 year ARI storm of 180 minutes duration (the critical storm for Blackjack Creek). This diagram also shows discharge hydrographs at the outlets of the stormwater system resulting from the occurrence of a 100 year ARI storm of 60 minutes duration (the critical storm for the local sub-catchments). The stormwater hydrographs have been moved in time to correspond with the peak of the Blackjack Creek flood to demonstrate the time over which high levels are maintained in the creek, relative to the time of high flows in the local sub-catchments.

In the absence of the proposed channel running between the levee and Wandobah Road, these stormwater flows would have to be stored, pending drainage to the creek as floodwaters recede. To prevent back flooding from the creek when water levels are near their peak, the piped drains running under the levee would need to be flap gated. Volumes of around 40,000 m<sup>3</sup> would have to be stored in dedicated storage areas behind the levee. There are no sites capable of being developed to accommodate such a large volume. Absence of a suitable storage site led to the proposal for disposal

of local stormwater runoff via the channel running along the protected side of the levee. Under that proposal the stormwater pipes would discharge directly to the channel, without the need for flap gates.

The ability to achieve the discharge of the local stormwater runoff via the channel and return the flow to Blackjack Creek upstream of the Oxley Highway (as shown on **Figure 3.3**) under gravity conditions would need to be confirmed by additional survey should the levee option proceed further.

#### 3.5.4 Indicative Cost of Levee

The indicative capital cost estimate for the levee is given in **Table 3.4**. The cost contains a larger cost allowance for un-estimated items and contingencies than the riparian corridor/improved channel scheme (35 per cent versus 20 per cent). This is to account for the greater uncertainties associate with the levee scheme regarding the capture and disposal of local stormwater runoff.

**TABLE 3.4**  
**INDICATIVE CAPITAL COST OF LEVEE**  
**100 YEAR ARI DESIGN STANDARD**

Item	Cost \$
Preliminaries (Establishment, Geotechnical Testing, Sediment Control)	15,000
Clear and Grub Site	55,000
Strip and Store Topsoil for later re-use on excavated surfaces	44,000
Excavate 300 m reach to relocate channel and fill and compact existing channel of Blackjack Creek near George Street	31,000
Grass seed invert and batters of re-located channel of Blackjack Creek	37,500
Roll and compact levee foundation	107,000
Supply and compact impervious fill for levee embankment	880,000
Excavate from stockpile and spread topsoil over all excavated surfaces	54,000
Grass seed levee batters	115,000
Excavate for channel to convey stormwater runoff from the urban catchments to the outfall at the intersection of Wandobah Road and View Street	115,000
Grass seed stormwater channel batters	123,000
Survey, investigation and design (10%)	158,000
Un-estimated items and contingencies (35%)	607,000
<b>TOTAL ESTIMATED CAPITAL COSTS</b>	<b>\$2.34M</b>

Annual maintenance costs amounting to 1.5 percent of the capital cost have been converted to a present worth value and added to the above capital cost to obtain an indicative total cost of the scheme, which has been used in the economic analysis of **Section 3.5.5**.

#### 3.5.5 Economic Assessment of Levee

**Table 3.5** provides indicative costs of a levee scheme to mitigate damages. The total cost including capital and annual maintenance costs is about \$2.67 Million for the 7 per cent discount rate,

compared with \$2.02 Million in terms of flood damages prevented. The benefit/cost ratio of the scheme at the 7 per cent discount rate is about 0.7.

**TABLE 3.5**  
**ECONOMIC ANALYSIS OF LEVEE SCHEME ON**  
**BLACKJACK CREEK**

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) \$ x 10 <sup>6</sup>	2.6	2.02	1.62
Cost of scheme (capital and annual maintenance costs) \$ x 10 <sup>6</sup>	2.77	2.67	2.61
Benefit/Cost Ratio	0.9	0.7	0.6

### 3.5.6 Environmental Constraints

By comparison of the data in **Tables 3.3** and **3.5**, the riparian corridor/improved channel is more economically attractive than the flood protection levee and is likely to score considerably higher than the levee scheme on the multi-objective scoring system of **Chapter 4** of the report. The creation of the visually attractive riparian corridor is likely to score highly on both environmental grounds and conforming with Government policies and is also likely to be viewed favourably as meeting community objectives.

On the other hand the levee scheme, although scoring well in terms of meeting flood mitigation objectives may not be viewed favourably by the community because of its visual impact. At present there is a clear visual and physical linkage between the creek and the residential community on the eastern floodplain, as well as for users of the new cycleway running along Wandobah Road. Construction of a levee up to 2 m in height would impact on this linkage.

## 3.6 Property Modification Measures – Development Controls

### 3.6.1 Considerations for Setting Flood Planning Level

Selection of the **Flood Planning Level (FPL)** for an area is an important and fundamental decision as the standard is the reference point for the preparation of floodplain management plans. It is based on adoption of the peak level reached by a particular flood plus an appropriate allowance for freeboard. It involves balancing social, economic and ecological considerations against the consequences of flooding, with a view to minimising the potential for property damage and the risk to life and limb. If the adopted *FPL* is too low, new development in areas above the *FPL* (particularly where the difference in level is not great) may be inundated relatively frequently and damage to associated public services will be greater. Alternatively, adoption of an excessively high flood planning level will subject land that is rarely flooded to unwarranted controls.

Councils are responsible for determining the appropriate *FPL*'s within their local government area. Whilst the flood used to determine the residential *FPL* is a decision of the Council, the FPM, 2005



highlights that *FPL*'s for typical residential development would generally be based around the 100 year ARI flood, plus an appropriate freeboard (typically 500 mm).

### 3.6.2 Current Government Policy

The circular issued by the Department of Planning on 31 January 2007 contained a package of changes clarifying flood related development controls to be applied on land in low flood risk areas (land above the 1 in 100 year flood). The package included an amendment to the Environmental Planning and Assessment Regulation 2000 in relation to the questions about flooding to be answered in Section 149 planning certificates, a revised ministerial direction (Direction 15) regarding flood prone land (issued under Section 117 of the EP&A Act, 1979) and a new Guideline concerning flood-related development controls in low flood risk areas.

The Circular advised that Councils will need to follow both the Floodplain Development Manual, 2005 as well as the Guideline to gain the legal protection given by Section 733 of the Local Government Act.

The Department of Planning Guideline confirmed that **unless exceptional circumstances applied, councils should adopt the 100 year ARI flood (1 in 100 year flood) with appropriate freeboard as the *FPL* for residential development.** In proposing a case for exceptional circumstances, a Council would need to demonstrate that a different *FPL* was required for the management of residential development due to local flood behaviour, flood history, associated flood hazards or a particular historic flood. Unless there were exceptional circumstances, Council should not impose flood-related development controls on residential development on land with a low probability of flooding, that is land above the residential *FPL*.

Nevertheless, the safety of people and associated emergency response management needs to be considered in low flood risk areas, which may result in:

- Restrictions on types of development which are particularly vulnerable to emergency response, for example, developments for aged care.
- Restrictions on critical emergency response and recovery facilities and infrastructure. These aim to ensure that these facilities and the infrastructure can fulfil their emergency response and recovery functions during and after a flood event. Examples include evacuation centres and routes, hospitals and major utility facilities. There are currently no critical developments of this nature in the Blackjack Creek floodplain.

### 3.6.3 Proposed Flood Planning Levels

Consideration of the data supports retaining the 100 year ARI flood plus a freeboard allowance of 500 mm for floor levels of residential development, along with a graded set of controls depending on the location of the development within the area flooded by that event.

### 3.6.4 Amendments to Council's Flood Policy

Features of the existing *Flood Policy* for Gunnedah were described in **Chapter 2** of the study and proposed amendments outlined (ref. **Sections 2.8.5** and **2.8.6**). As noted, Council's existing policy is based on flooding from the Namoi River and does not specifically relate to the Blackjack Creek floodplain. However, it is considered that the existing policy (with the minor amendments outlined in **Section 2.8.6**) could be adopted to control future development on Blackjack Creek.

It was proposed that the flood prone land in Blackjack Creek be divided into four planning zones:

- The **Floodway** is a narrow strip of land running along the centreline of the creek and extends eastwards to Wandobah Road and is the most flood affected land. The Policy considers that *new residential development* is an unsuitable use for land which is located in the **Floodway**.
- The **Intermediate Floodplain** comprises areas to the east of Wandobah Road, which may convey flows during major floods. There, flood related controls relate to setting minimum floor levels of new properties above the **Flood Planning Level**. The Policy recognises that because overland flow velocities may be significant, new development in this area could result in an adverse re-direction of flows towards existing developments in the floodplain and that special precautions need to be taken to prevent this occurrence. Accordingly, the Policy requires development to be designed to minimise obstructions to the passage of floodwaters caused by site filling and fences, as well as providing minimum floor levels above the peak 100 year ARI flood level plus 500 mm of freeboard. These requirements will ensure that floor levels are above the level of major flooding and reduce the potential for flood damages both to the development itself as well as surrounding properties.
- In the **Flood Fringe**, the Policy nominates the peak 100 year ARI flood level plus 500 mm freeboard as the **Flood Planning Level** for *new residential development*. The policy considers that flow velocities are not likely to be significant in the **Flood Fringe**.
- There would be no flood related development controls over residential development in the **Outer Floodplain**, apart from the minimum floor level requirement of peak 100 year ARI flood level plus 500 mm of freeboard. This requirement will ensure that floor levels of new developments located on ground slightly outside the extent of the 100 year ARI flood are no lower than equivalent properties within that extent.

### 3.7 Property Modification Measures - Voluntary Purchase of Residential Properties

Removal of housing from high hazard floodway areas in the floodplain is generally accepted as a cost effective means of correcting previous decisions to build in such areas. The voluntary purchase of residential property in hazardous areas has been part of subsidised floodplain management programs in NSW for over 20 years. After purchase, land is subsequently cleared and the site redeveloped and rezoned for public open space or some other flood compatible use. A further criterion applied by State Government agencies in assessing eligibility for funding is that the property must be in a high hazard area such as floodway, that is, in the path of flowing floodwaters where the depth and velocity at the peak of the flood are such that life could be threatened, damage of property is likely and evacuation difficult.

Under a voluntary purchase (VP) scheme the owner is notified that the body controlling the scheme, Council in the case of Blackjack Creek, is prepared to purchase the property when the owner is ready to sell. There is no compulsion whatsoever to sell at any time. The price is determined by independent valuers and the Valuer General, and by negotiation between Council and the owners. Valuations are not reduced due to the flood affected nature of the site.

Hydraulic calculations described in **Chapter 2** showed that strictly speaking, none of the residences flooded on the eastern floodplain were located in high hazard areas. Flow velocities are low and the principal effect of flooding in most properties would be a relatively short duration of shallow, above-floor inundation.

**Table 3.6** shows locations of the maximum depths of inundation for the 10 properties subject to the greatest depths of inundation at the 20 year and 100 year ARI flood magnitudes. For example, 5 of the “top ten” properties are located in the King Street area and the maximum depth of above-floor inundation in those properties is 0.88 m for the 100 year ARI flood and 0.71 m for the 20 year ARI event. For the purposes of illustration, an economic analysis was carried out for a VP scheme which would involve the purchase of the two properties with the greatest depth of flooding at the 100 year ARI (0.88 m and 0.65m).

**Table 3.7** shows the results of the economic analysis. The analysis has been carried out for the three discount rates nominated by NSW Treasury Guidelines for the economic analysis of public works. The benefits of the scheme comprise the present worth value of the flood damages for the residential two properties which would be saved by their purchase. For the analysis the costs were based on an average purchase cost of \$300,000 per property, typical of recent sale prices in the area.

**TABLE 3.6  
DETAILS OF TEN RESIDENCES SUBJECT TO  
DEEPEST ABOVE-FLOOR INUNDATION**

Location	Flooded by 100 Year ARI Flood		Flooded by 20 Year ARI Flood	
	No. of Residences in Sample	Max Depth of Inundation – m	No of Residences in Sample	Max Depth of Inundation – m
King Street Area	5	0.88	5	0.71
Schwager Street Area	2	0.65	2	0.18
Short Street Area	2	0.40	2	0.16
View Street Area	1	0.31	1	0.10
<b>Total</b>	<b>10</b>	<b>0.88</b>	<b>10</b>	<b>0.71</b>

**TABLE 3.7  
ECONOMIC ANALYSIS OF VOLUNTARY  
PURCHASE SCHEME FOR TWO DEEPEST FLOODED PROPERTIES**

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) \$ x 10 <sup>6</sup>	0.13	0.10	0.08
Cost of Scheme \$ x 10 <sup>6</sup>	0.60	0.60	0.60
Benefit/Cost Ratio	0.22	0.17	0.14

It is clear from the above analysis that a voluntary purchase scheme would not be justified on economic grounds and was not favoured by the community in their responses to the Questionnaire.

A VP scheme is, however, sometimes implemented to clear properties located in high hazard areas on social grounds even though the scheme is not economically feasible. Although the area is subject to “flash flooding” with little warning time, flooding in the street system is relatively shallow, of short duration and there is ready access eastwards to high ground. Accordingly, it is considered that a voluntary purchase scheme would not be justified on social grounds.

### **3.8 Property Modification Measures - Raising Floor Levels of Residential Properties**

This term refers to procedures undertaken, usually on a property by property basis, to protect structures from damage by floodwaters. The most common process is to raise the affected house by a convenient amount so that the floor level is at or above the *FPL*. For weatherboard and similar buildings this can be achieved by jacking up the house, constructing new supports, stairways and balconies and reconnecting services. Alternatively, where the house contains high ceilings, floor levels can be raised within rooms without actually raising the house. It is usually not practical to raise brick or masonry houses. Most of the costs associated with this measure relate to the disconnection and reconnection of services. Accordingly, houses may be raised a considerable elevation without incurring large incremental costs.

The State and Federal Governments have agreed that flood mitigation funds will be available for house raising, subject to the same economic evaluation and subsidy arrangements that apply to other structural and non-structural flood mitigation measures. In accepting schemes for eligibility, the Government has laid down the following conditions:

- House raising should be part of an adopted Floodplain Management Plan.
- The scheme should be administered by the local authority.

The Government also requires that Councils carry out ongoing monitoring in areas where subsidised voluntary house raising has occurred to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level. In addition, it is expected that Councils will provide documentation during the conveyancing process so that subsequent owners are made aware of restrictions on development below the design floor level.

Council's principal role in subsidised voluntary house raising would be to:

- Define a habitable floor level, which it will have already done in exercising controls over new house building in the area.
- Guarantee a payment to the builder after satisfactory completion of the agreed work.
- Monitor the area of voluntary house raising to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level.

The current cost to raise a medium sized (150 square metres) house is between \$60,000 and \$75,000 based on recent experience in other centres. For the purposes of the economic analysis, a cost of \$70,000 was adopted.

**Table 3.8** is an economic analysis of a house raising strategy of the same ten properties examined in the VP analysis of **Table 3.6** and for the three discount rates, assuming that all of the properties could

be raised. The benefits of the scheme comprise the present worth value of the flood damages for the residential properties which would be saved by their raising. If the houses were raised to at least the 100 year ARI flood level plus an appropriate freeboard then the scheme's benefits would comprise the damages up to that flood.

**TABLE 3.8**  
**ECONOMIC ANALYSIS OF RAISING**  
**FLOORS OF TEN RESIDENCES SUBJECT TO**  
**DEEPEST ABOVE-FLOOR INUNDATION**

<b>Discount Rate %</b>	<b>4</b>	<b>7</b>	<b>10</b>
Present Worth Value of Benefits (Damages Saved) \$ x 10 <sup>6</sup>	0.55	0.42	0.34
Cost of Scheme \$ x 10 <sup>6</sup>	0.7	0.7	0.7
Benefit/Cost Ratio	0.8	0.6	0.5

This strategy is not economically feasible for the study area. The community were evenly balanced in their responses to the Questionnaire. Site inspection showed that some of the properties were of brick construction and therefore would be technically difficult to raise. As mentioned, there is ready access to high ground for all of these properties. Accordingly, it is considered that a scheme for raising flood prone houses could not be justified on social grounds and has not been considered further.

### **3.9 Response Modification Measures - Flood Forecasting, Warning and Evacuation Plans**

#### **3.9.1 Flash Flood Warning Systems**

Flood forecasting and warning can be an effective flood management measure if there is sufficient warning time for the community to react to the warning. An effective flood warning system has three key components, i.e. a flood forecasting system, a flood warning broadcast system and an evacuation plan.

Flood response to rainfall on the Blackjack Creek catchments is relatively short and is expected to be between around three to four hours (i.e. from the commencement of heavy rainfall to the occurrence of the flood peak in the lower reaches of the creek near the Oxley Highway – ref. **Figure 2.2**).

A workshop was sponsored by Bureau of Meteorology in 2007 to develop guidelines for the NSW Flood Warning Consultative Committee to co-ordinate funding proposals for local flash flood warning systems. Three levels of local flash flood warning system were identified:

- **General System** – relies on existing warning services provided by the Bureau of Meteorology for severe weather and thunderstorms as well as Flood Watches. These services are typically issued on a regional basis, or for a larger catchment than Blackjack

Creek. These warnings can be augmented by real time information from local weather radars, automatic weather stations and existing rainfall and river gauges. They do not involve additional rainfall or river gauge instrumentation in the catchment. **Indicative cost:** Initial cost zero to \$20,000 and annual costs of \$1,000 to \$7,000 for a public awareness program.

- **Intermediate System** – General system plus additional rain and river gauges within the targeted flash flood catchment to help local emergency personnel to assist the community through improved evaluation and management of the flash flood threat. **Indicative cost:** Initial cost \$60,000 and annual costs of \$10,000 to \$15,000 for a public awareness program and maintenance of instrumentation.
- **Total Warning System** – Intermediate system plus a targeted warning dissemination system to people located on the high flood hazard sites where evacuation may be necessary. **Indicative cost:** Initial cost \$100,000 to \$300,000 and annual costs of \$10,000 to \$15,000 for a public awareness program and maintenance of instrumentation.

While all systems need to be underpinned by an appropriate public flood awareness program, the **Total Warning System** would require a more comprehensive and recurrent public flood awareness campaign.

Provisionally, the **Total Warning System** is recommended for further consideration in the *FRMP* for Blackjack Creek. It would be based on the “READY”, “SET”, “GO” warning phases as follows:

- READY – flooding is possible in a general area; monitoring of weather is required.
- SET – flooding is more likely in a specific area; prepare to act.
- GO – flooding is very likely in a specific area; Action required.

The advantages of the **Total Warning System** over the two lesser systems are:

- Enhanced reduction in risk to life and property from flash flooding through precautionary actions triggered by general warnings, as per the **General System** (i.e. READY and SET phases), and targeted Bureau of Meteorology Flash Flood Warnings based on the predicted exceedence of flash flood thresholds (GO phase), being directly communicated to the affected community.
- Reduction (compared with the **Intermediate System**) in risk to life and property from flash flooding by better local emergency response and management, through the Bureau providing forecasts for the exceedence of flood thresholds for the area.

The six components of the **Total Warning System** are:

#### 1. Predictions

- Bureau of Meteorology warnings and information from radar, AWS and rain and river gauges as per the **Intermediate System** used to trigger “READY” and “SET” phases.
- Targeted Flash Flood Warnings issued by the Bureau of Meteorology for the exceedence of Flash Flood Thresholds based upon information from the *FRMS* for the area to trigger the “GO” phase. Depending on the information from flood modelling, predictions may be issued for flood/no flood scenarios or for levels of flooding resulting from floods of various probabilities of occurrence.

## 2. Interpretation

- Areas likely to be flooded determined from **flood maps**, from the flood modelling results or studies for the area, and from SES flood intelligence.

## 3. Warning message Construction

- Pre-determined flash flood warning messages for the specific areas.

## 4. Communication

- Warnings broadcast by media and available on the BOM website.
- Warnings directly communicated to the affected area either automatically or manually, depending on the size of the catchment, population size and available SES resources.

## 5. Response

- Pro-active community and SES response underpinned by local recurrent public flood awareness/education program.

## 6. Review

- Performance of the system after each major flood.
- Regular review of the readiness and maintenance of system components such as gauges, communications, public education and planning.

Funding to establish local flash flood warning systems has traditionally been made available on the basis of no Council contribution to the initial capital cost in recognition of the high maintenance costs which Council would have to meet. The costs of maintaining the system would include such items as rain and river gauges, warning communication systems and ongoing public awareness/education programs. The maintenance obligations would need to be identified and included in any initial funding grant. Upon installation of the local flash flood warning system, the SES Local Flood Plan for the area could be used to document the operation and maintenance specifications of the system, including the public education/awareness components.

### 3.9.2 Flash Flood Warning System – Discussion

Assuming an initial capital cost of \$200,000 and annual cost of \$15,000 for maintenance, the total cost of the Total Warning System at the 7 per cent discount rate would be about \$360,000 over an economic life of 20 years. Assuming the system was effective in mitigating damages to contents up to the 100 year ARI flood, it would need to reduce damages to contents by about 50 per cent to be economically feasible. This would probably not be achievable and therefore the system would have to be justified on social and other non-economic grounds.

Further, if either of the structural mitigation schemes (riparian corridor or levee) were constructed in a reasonable timeframe then it may be difficult to justify implementation of the system (even though a flash flood warning scheme was strongly favoured by the community), as those schemes would provide protection to the 100 year ARI level of flooding. The system would then have to be justified on the warning it provides against flooding due to surcharges of the local stormwater system.

### 3.10 Response Modification Measures - Public Awareness Programs

#### 3.10.1 General Comments

Community awareness and appreciation of the existing flood hazards in the floodplain would promote proper land use and development in flood affected areas. A well informed community would be more receptive to requirements for flood proofing of buildings and general building and development controls imposed by Council. One aspect of a community's preparedness for flooding is the "flood awareness" of individuals. This includes awareness of the flood threat in their area and how to protect themselves against it. It is fair to assume that the level of awareness drops as individuals' memories of previous experience dim with time.

Means by which community awareness of flood risks can be maintained or may be increased include:

1. Sending out regular information with rates notices. The information contained in this present study could be edited and used by Council and SES to prepare a *Flood Information Brochure* for Blackjack Creek.
2. Displays at Council offices using the information contained in the present study and photographs of historic flooding in the area.
3. Talks by SES officers with participation by Council and longstanding residents with first hand experience of flooding in the area.

#### 3.10.2 Flood Information Brochure

The *Flood Information Brochure* (also known as a "FloodSafe" brochure) which could also form a component of the education process associated with the Flash Flood Warning system should contain information on:

- What steps for residents to take in advance to protect themselves from flooding.
- Developing procedures for lifting contents above flood level and evacuating property.
- An Evacuation Plan for the area showing the best routes for egress from the floodplain.
- Evacuation routes would have to be developed in the light of further analyses by Council to assess streets which are vulnerable to surcharges from the local stormwater system. Council could undertake additional analyses using their recently developed DRAIN D model of the system to provide this information.

The benefits of a regular flood-preparedness campaign would extend to more than just reducing monetary losses. The campaign would also have social benefits by improving people's feeling of control, since they would have a better idea of how to respond to a flood emergency. Given the recent history of flooding in the area and the Community's high state of flood awareness evidenced in responses to the Questionnaire, it would not appear difficult to generate the interest and co-operation required.

### 3.11 Summary

This Chapter has reviewed a number of potential floodplain management measures. Preliminary analysis of the flood modification measures (i.e. involving the construction of engineering works) has been undertaken and indicative cost estimates prepared on the basis of available survey data. The findings are summarised in **Table 3.9** and outlined below.

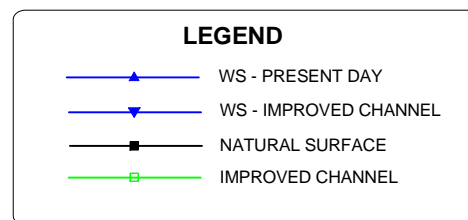
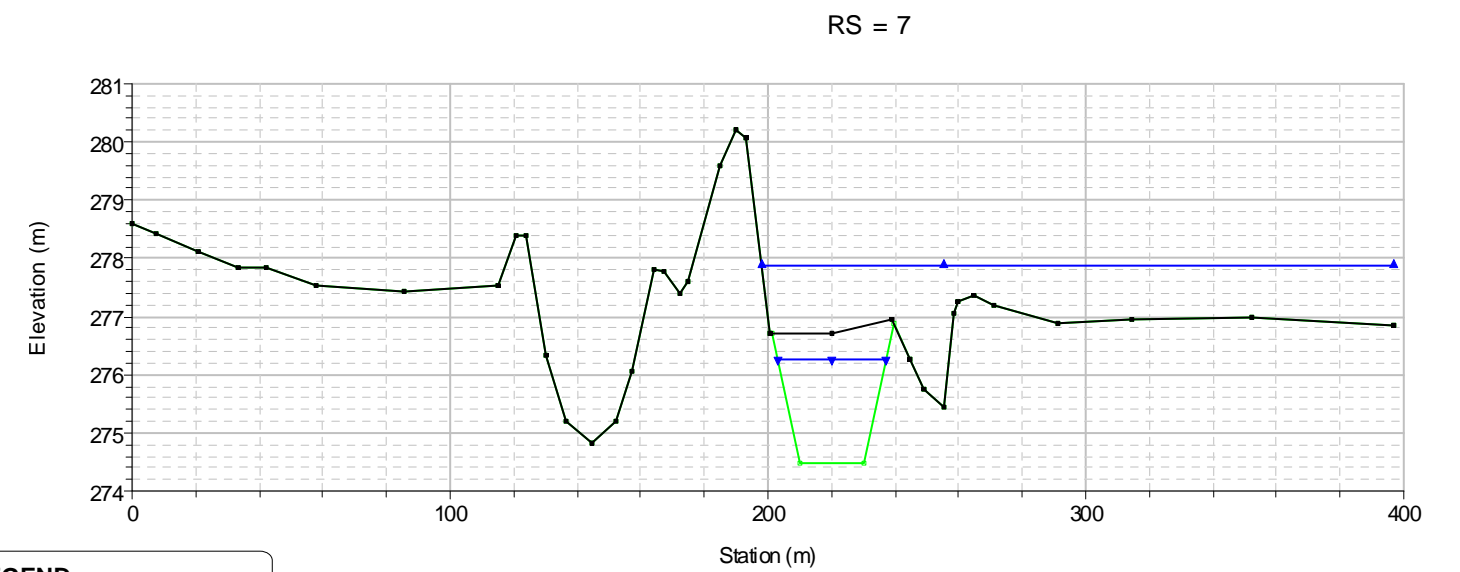
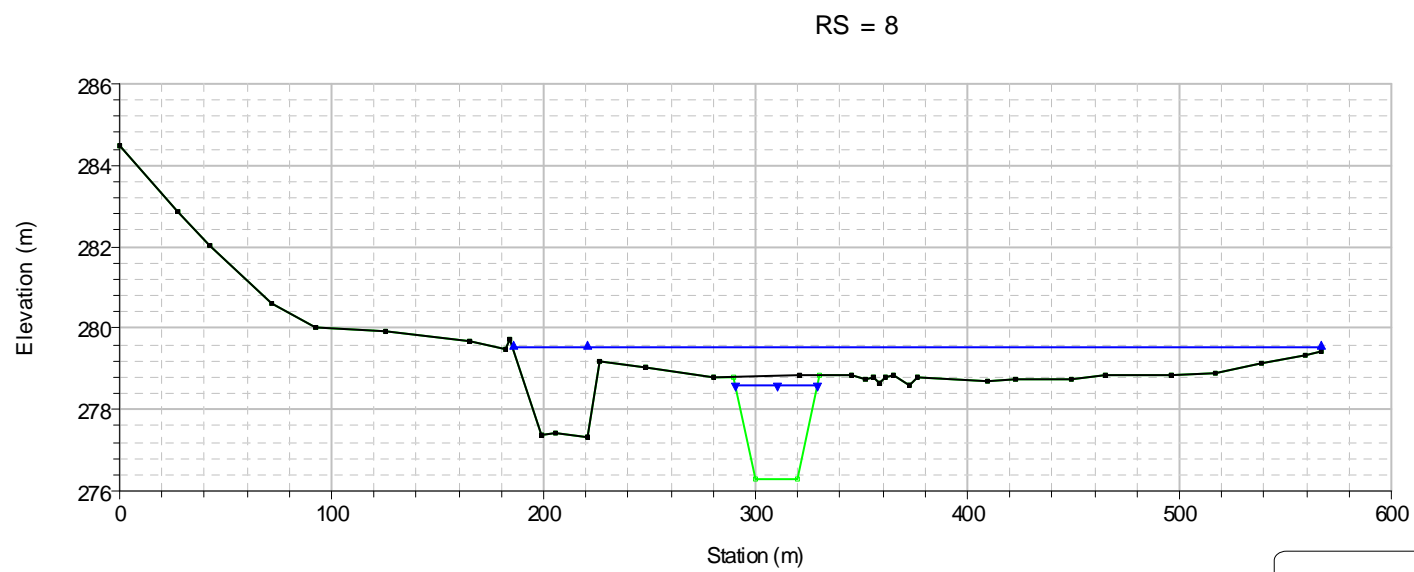
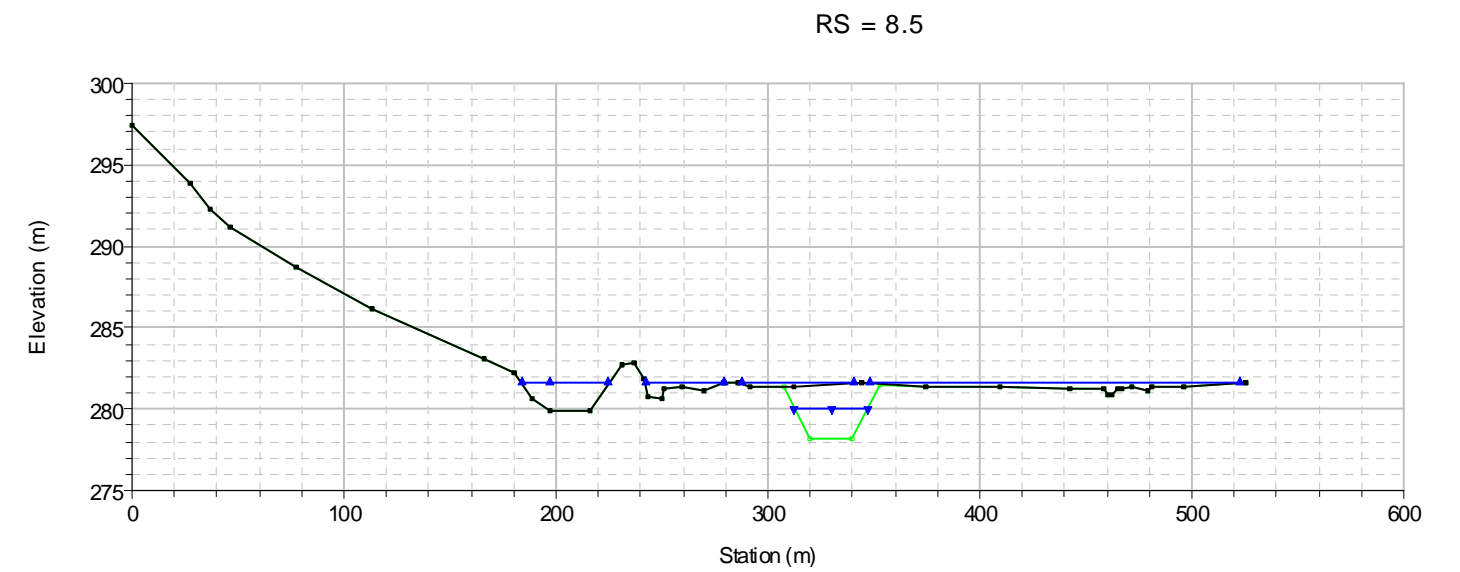
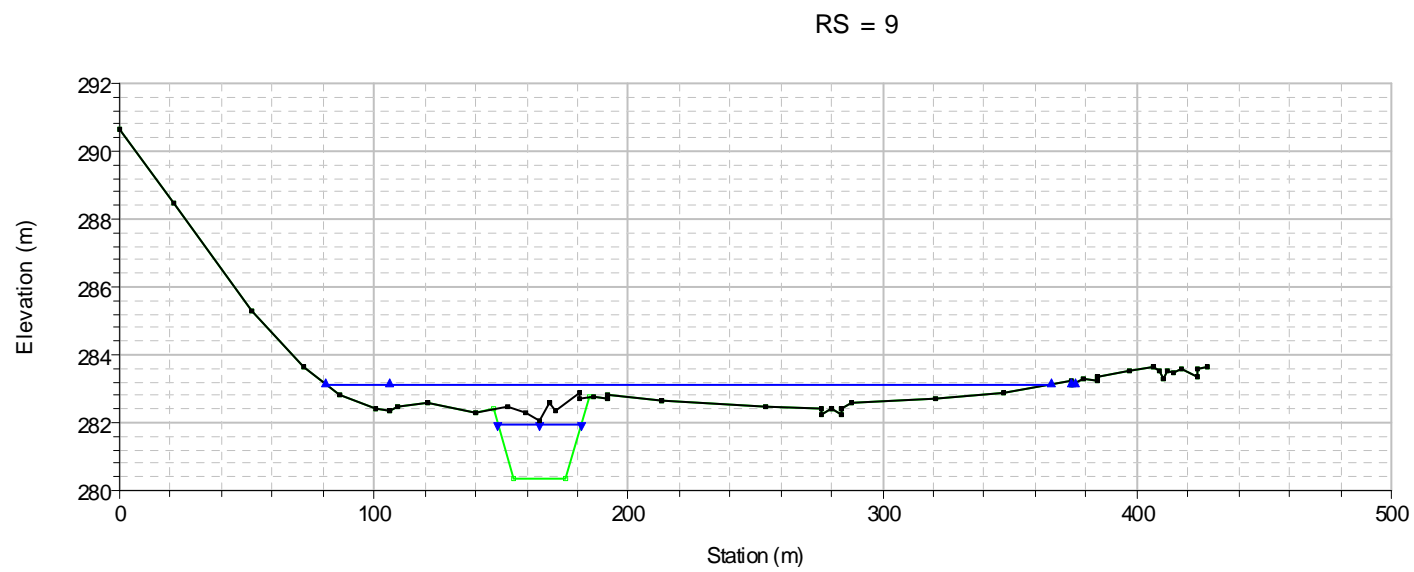
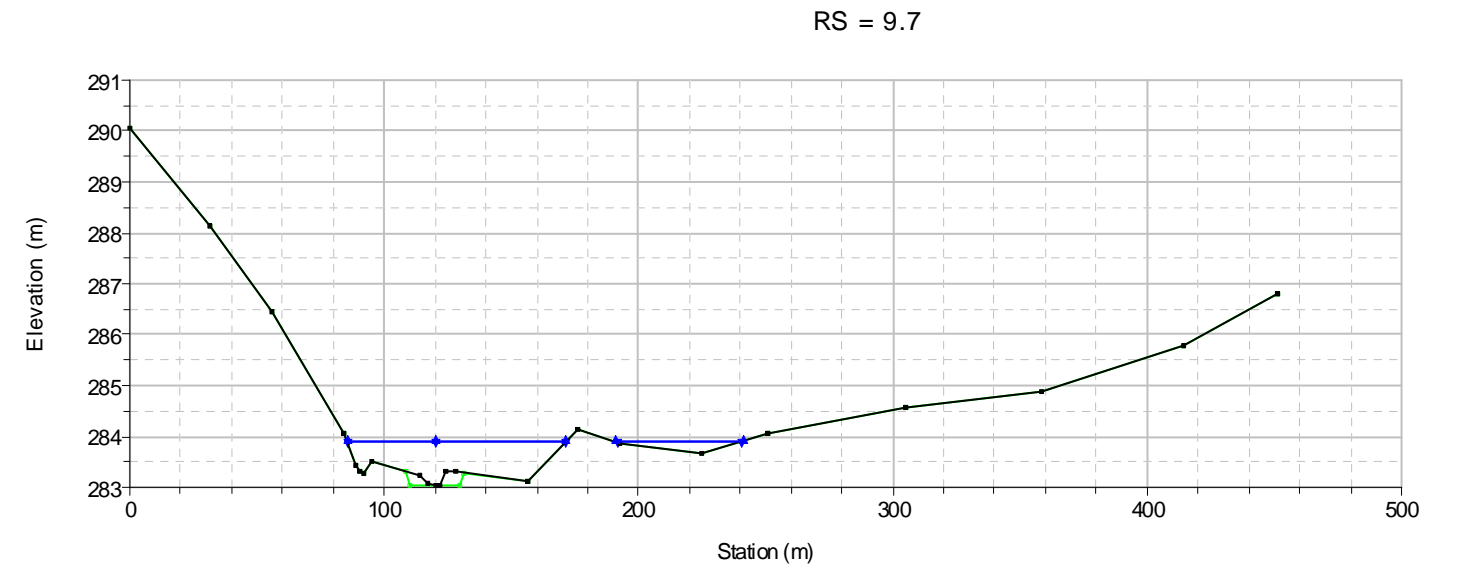
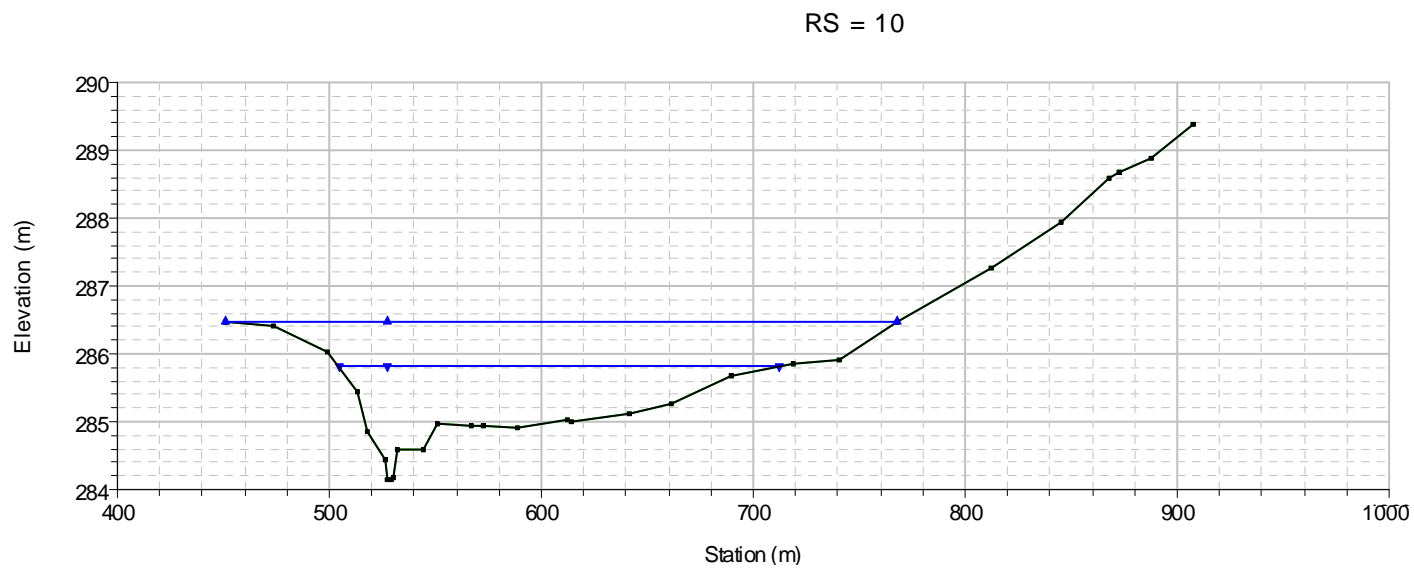


- Improvements to increase the conveyance capacity of the creek associated with the implementation of a riparian corridor are supported by the Community and are worth considering further by the Committee for inclusion in the draft *FRMP*.
- The construction of a flood protection levee along the right bank of the creek could be considered as an alternative to the riparian corridor in mitigating flooding. The principal constraints of a levee scheme, however, are the adverse environmental impact of the levee on residents the eastern side of the creek and the difficulties of disposing of local stormwater runoff from the protected areas. Further investigation with the benefit of additional survey information would be required to confirm its feasibility.
- Planning controls separately or in combination with the above measures are an essential component of the Floodplain Risk Management Plan. Modifications to Council's existing Gunnedah wide Flood Policy are suggested.
- Response modification measures which are supported comprise incorporation of flood improved flood awareness via the preparation of a Flood Information Brochure and incorporation of flood data included in this *FRMS* in SES's Local Flood Plan.
- Further consideration of a *Flash Flood Warning System* for Blackjack Creek catchment may be justified if the riparian corridor scheme or flood protection levee alternative does not proceed in a reasonable timeframe.

**TABLE 3.9**  
**REVIEW OF POTENTIAL FLOOD MANAGEMENT MEASURES**

Scheme	Comments
Riparian Corridor /Channel Improvement Scheme	This measure would be supported by DECCW and Namoi CMA. It would be a dual purpose project providing environmental and flood mitigation benefits. A riparian corridor on Blackjack Creek is considered worthy of further consideration for inclusion in the <i>FRMP</i> . A feasibility study is required to develop concept designs and prepare a case for Government funding.
Construct Levee	It is technically feasible to construct a levee to the 100 year ARI level plus freeboard. However, an excavated channel running along the "protected" side of the levee would be required to capture and dispose of runoff from the local stormwater system. This scheme is less attractive economically than the riparian corridor and will impact on the visual and physical connection between the creek and eastern floodplain. It is therefore environmentally less attractive and may not have the support of the community. It should only be included in the <i>FRMP</i> in the event that the riparian corridor/channel improvement does not proceed.
Construct Detention Basins	There are no natural storage areas of sufficient size in the middle reaches of Blackjack Creek to mitigate downstream flood peaks. Construction of an effective detention basin would require considerable land acquisition and excavation.  Detention basins are not considered to be a feasible flood management measure for inclusion in the <i>FRMP</i> .
Voluntary Purchase of Residential Property	This measure is sometimes employed to remove residential development from high risk areas of the floodplain. Implementation of a voluntary purchase scheme for the Blackjack Creek catchment is not economically justified. In view of the relatively shallow and short duration of flooding which would be experienced in these residences and the ready access to high ground from the flood affected areas, the scheme could not be justified on social grounds.
House Raising	This measure is sometimes employed to raise residential development in medium and low hazard areas of the floodplain. Implementation of a house raising scheme for Blackjack Creek is not economically warranted. In view of the relatively shallow and short duration of flooding which would be experienced in these residences, the scheme could not be justified on social grounds.
Planning Controls (Flood Policy)	This is a low cost and essential component of the Floodplain Risk Management Plan and will over time reduce damages. Council's existing Flood Policy recommends a graded set of controls for development, which depends on the nature of the development and its location within the floodplain. The Policy could be adopted for Blackjack Creek with some minor amendments and could be used for future development pending construction of the structural works outlined above.
Flood Warning and Forecasting	It is not technically feasible to provide extended warning times with a conventional flood warning system. A Flash Flood Warning System along the lines of the system outlined in <b>Section 3.9</b> would reduce the present day flood risk. However, if the riparian corridor scheme proceeds, the flood risk would be reduced and a formal Flash Flood Warning system may not be required.  SES and other emergency management authorities should use the flood information contained in this <i>FRMS</i> to update their procedures for flood response and evacuation, pending construction of the improved channel/riparian corridor.
Flood Awareness	Continuation of Council's policy of notifying flood affectation on S149 Certificates for properties impacted by floods up to 100 year ARI is supported. The affectation notices could be removed with the implementation of the riparian corridor or levee scheme. Flood awareness would be increased by the Council and SES collaborating to prepare a FloodSafe Brochure for Blackjack Creek.



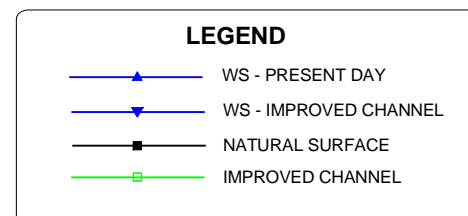
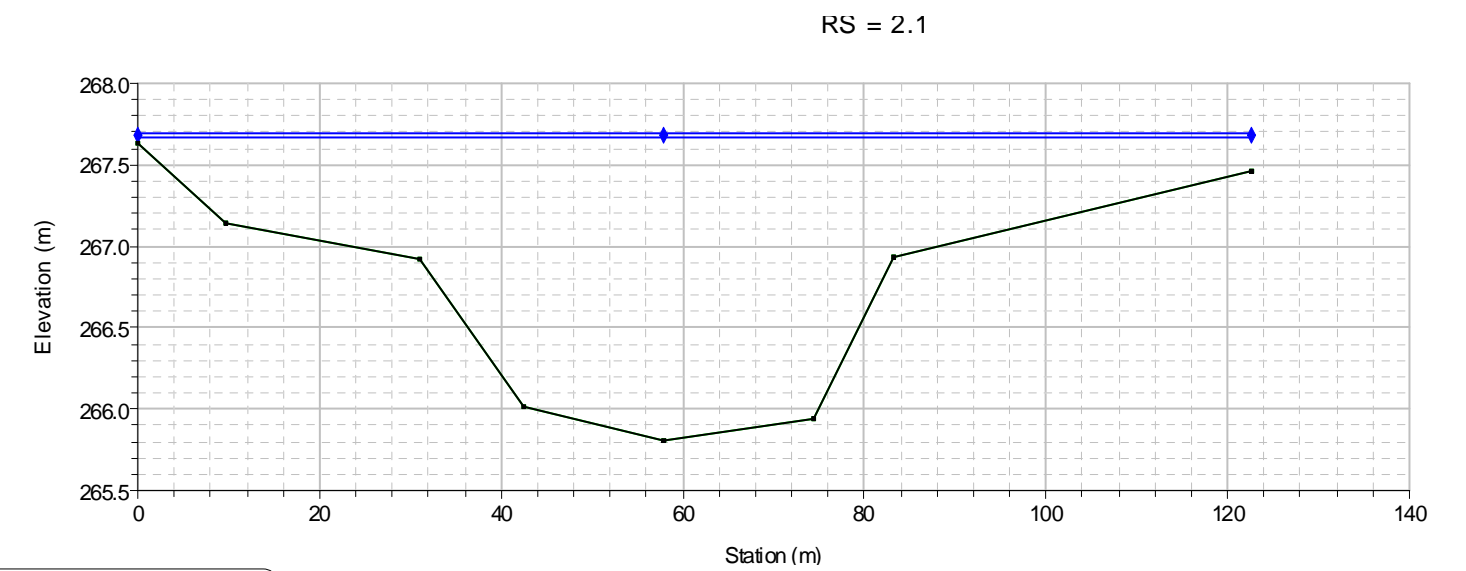
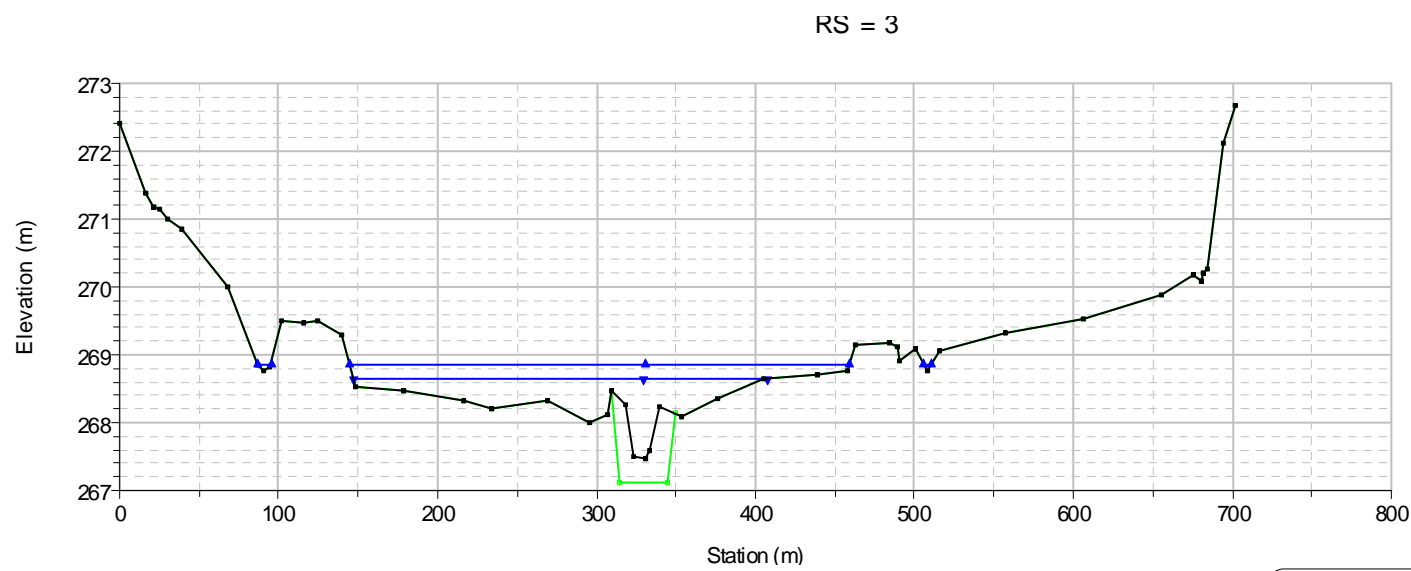
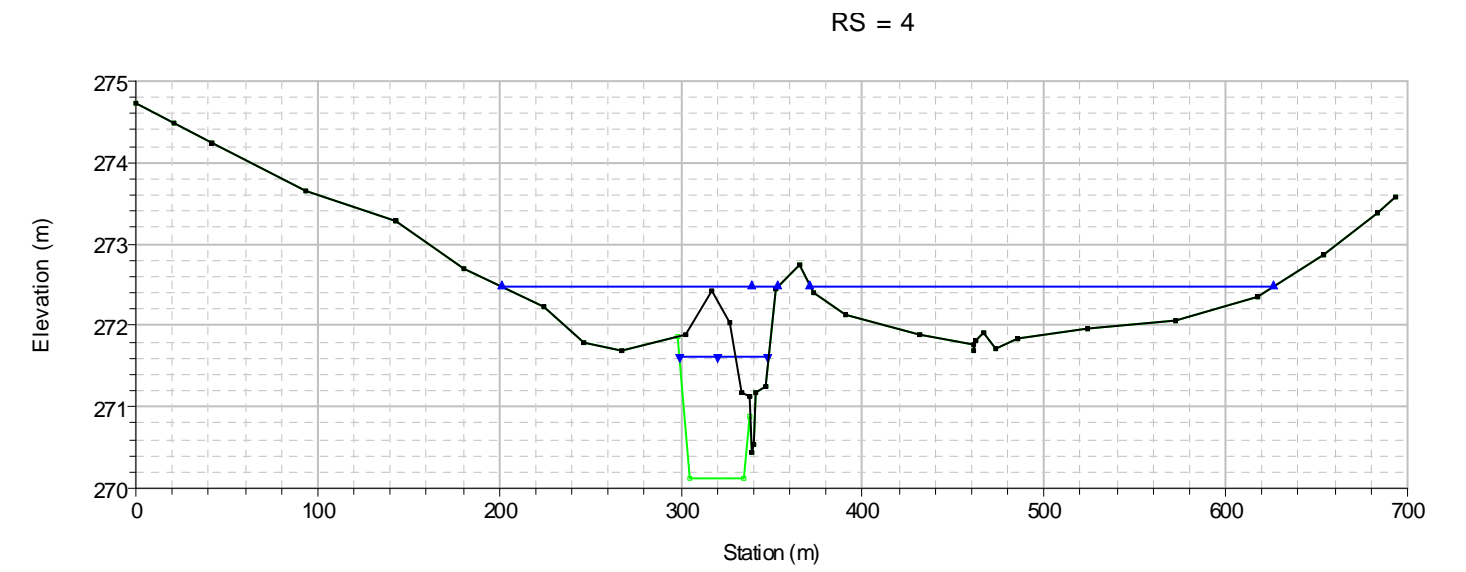
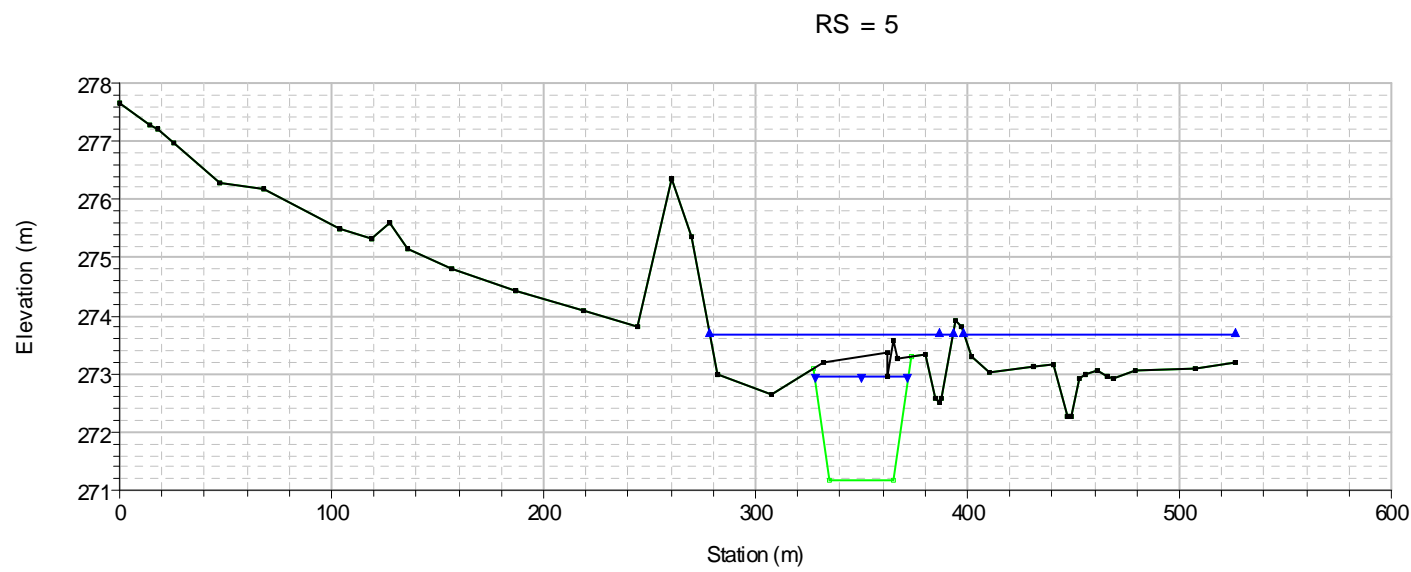
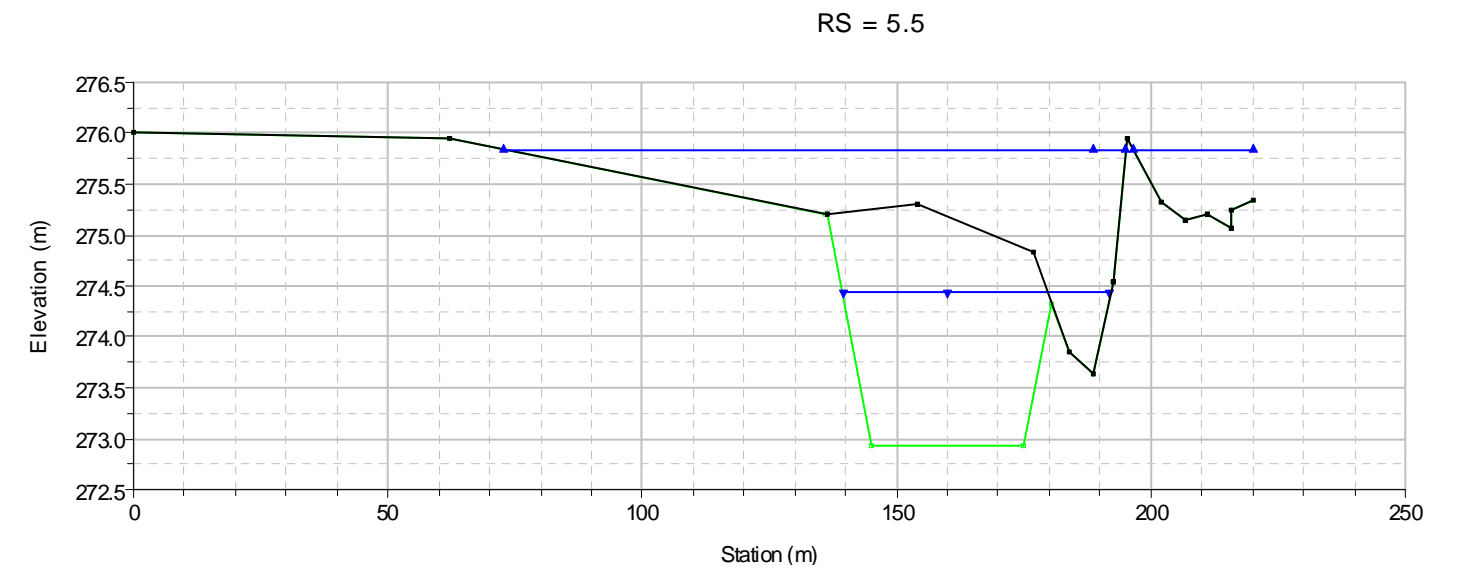
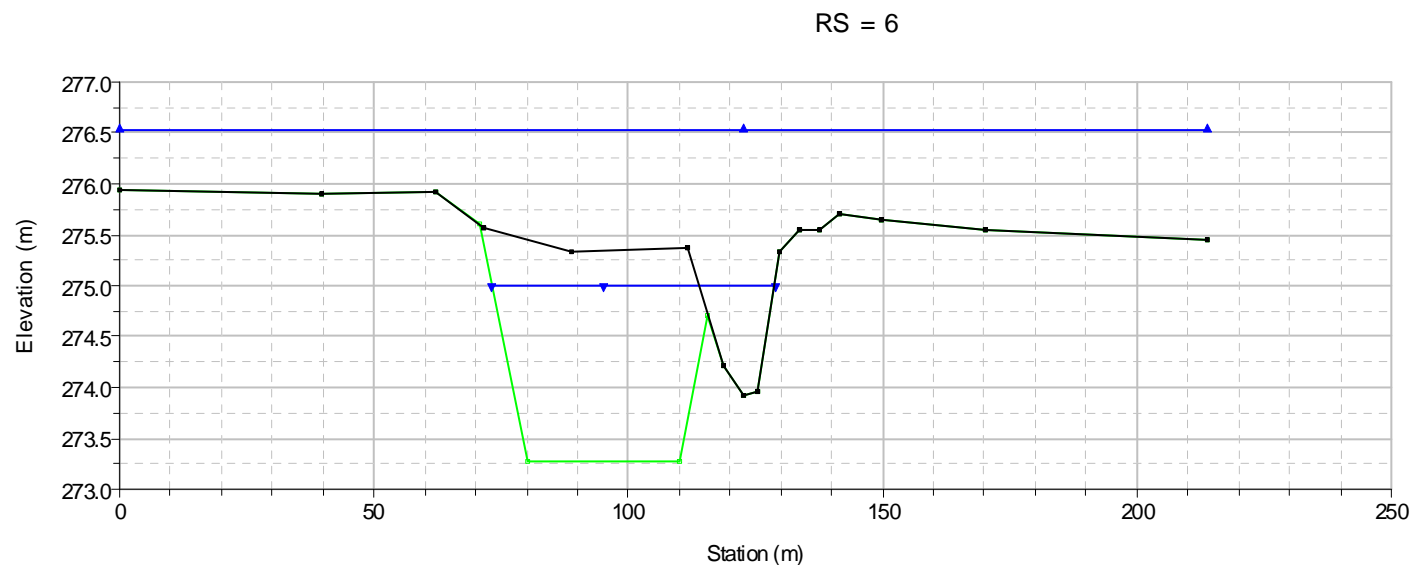


**BLACKJACK CREEK  
FLOODPLAIN RISK MANAGEMENT STUDY**

Figure 3.2 - Sheet 1 of 2

**CROSS SECTIONS  
IMPROVED CHANNEL**

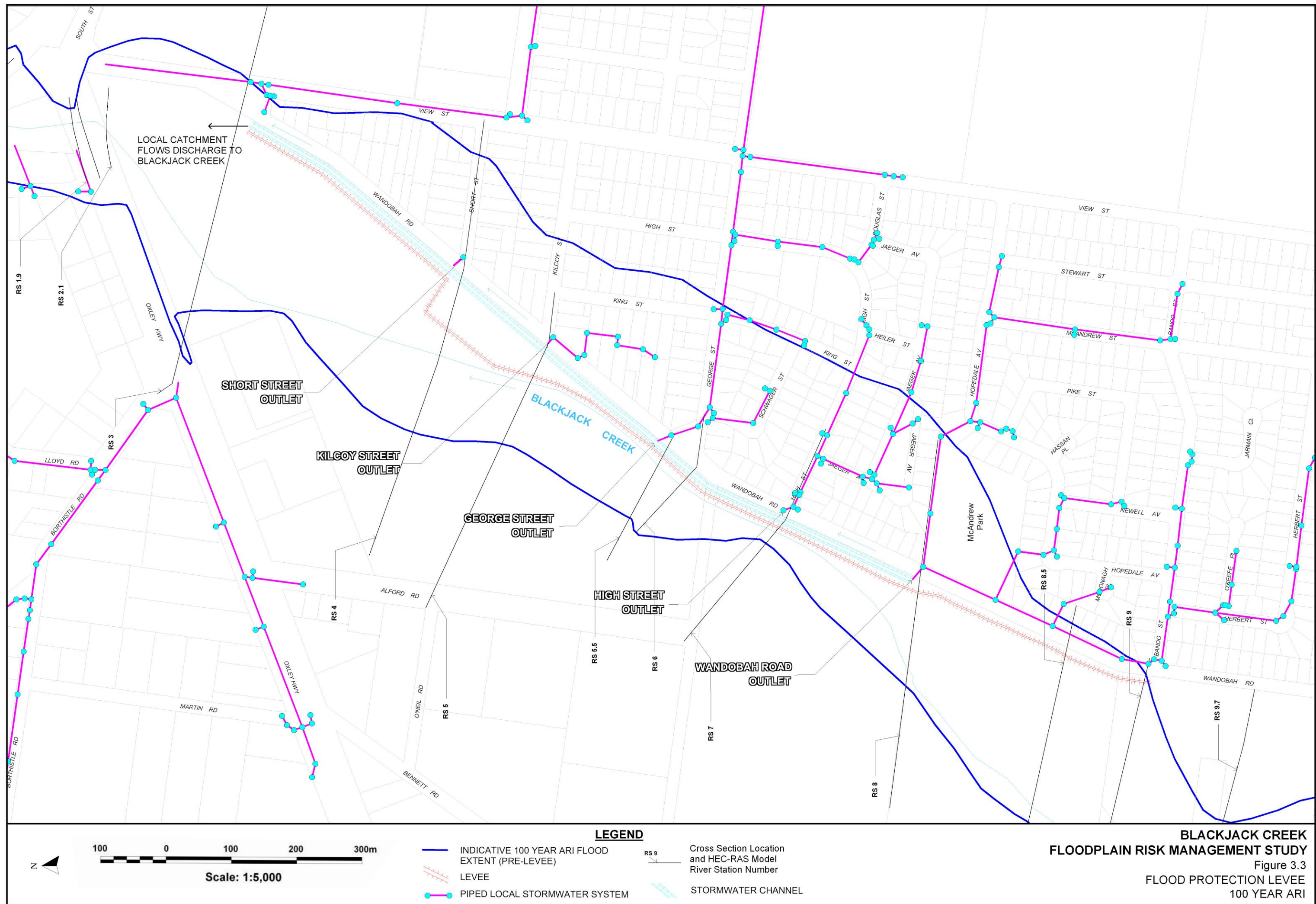


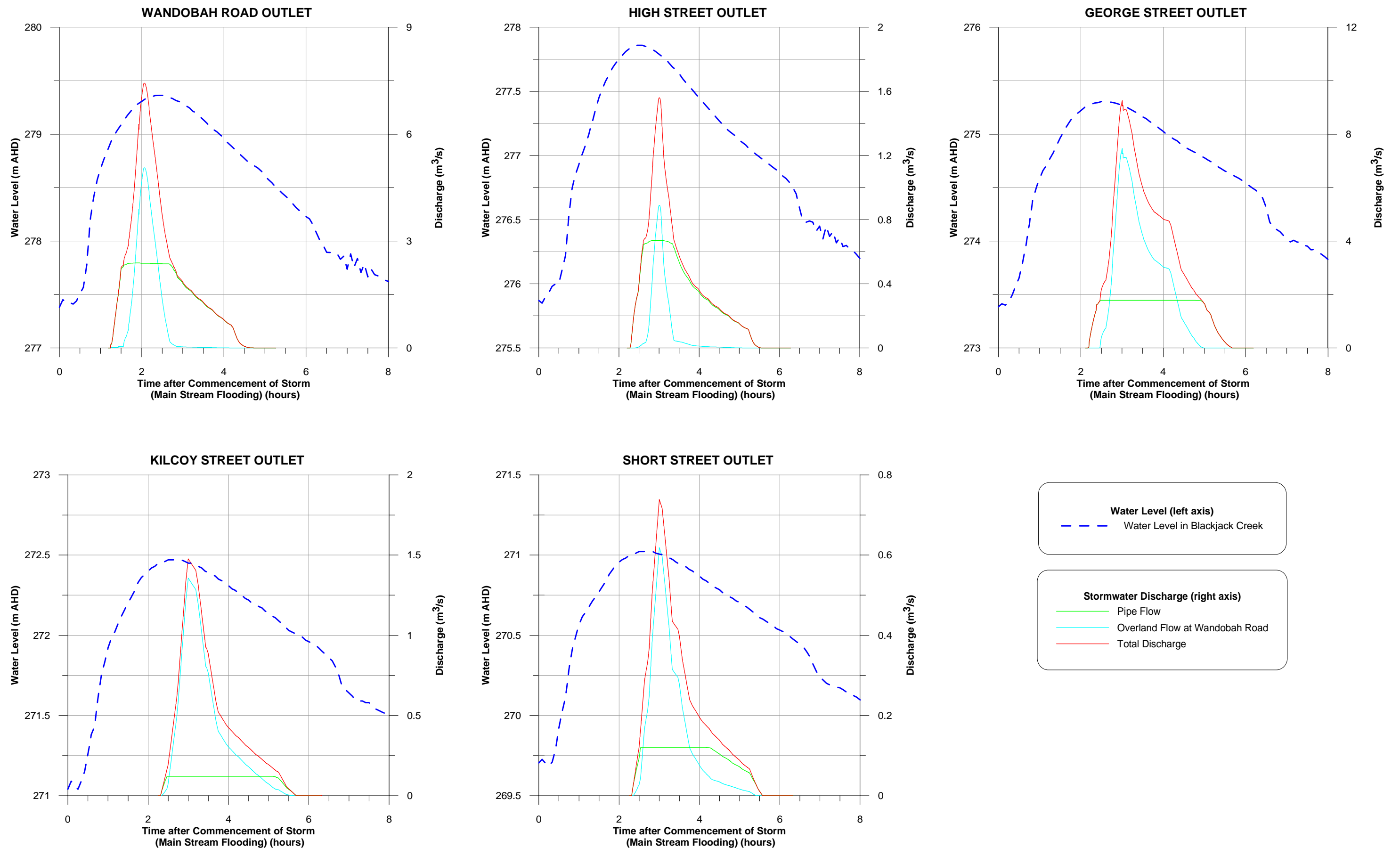


**BLACKJACK CREEK  
FLOODPLAIN RISK MANAGEMENT STUDY**

Figure 3.2 - Sheet 2 of 2

**CROSS SECTIONS  
IMPROVED CHANNEL**





**BLACKJACK CREEK  
FLOOD PLAIN RISK MANAGEMENT STUDY**

Figure 3.4

DISCHARGE HYDROGRAPHS AT LOCAL STORMWATER OUTLETS TO BLACKJACK CREEK  
100 YEAR STORM

## 4 SELECTION OF FLOODPLAIN MANAGEMENT MEASURES

### 4.1 Background

The *Floodplain Development Manual, 2005* requires a Council to develop a *Floodplain Risk Management Plan* based on balancing the merits of social, economic and environmental considerations which are relevant to the community. This chapter sets out a range of factors which need to be taken into consideration when selecting the mix of works and measures that should be included in the overall *Plan*.

The community will have different priorities and, therefore, each needs to establish its own set of considerations used to assess the merits of different options. The considerations adopted by a community must, however, recognise the State Government's requirements for floodplain management as set out in the *Floodplain Development Manual, 2005* and other relevant policies. A further consideration is that some elements of the *Plan* may be eligible for subsidy from State and Federal Government sources and the requirements for such funding must, therefore, be taken into account.

Typically, State and Federal Government funding is given on the basis of merit, as judged by a range of criteria:

- The magnitude of damage to property caused by flooding and the effectiveness of the option in mitigating damage and reducing the flood risk to the community.
- Community involvement in *Plan* preparation and acceptance of the option.
- The technical feasibility of the option (relevant to structural works).
- Conformance of the option with Council's planning objectives.
- Impacts of the option on the environment.
- The economic justification, as measured by the benefit/cost ratio of the option.
- The financial feasibility as gauged by Council's ability to meet its commitment to fund its part of the cost.
- The performance of the option in the event of a flood greater than the design event.
- Conformance of the option with Government Policies (eg *FDM, 2005*, Rivers and Estuaries Policy and Catchment Management objectives).

### 4.2 Ranking of Options

A suggested approach to assessing the merits of various options is to use a subjective scoring system. The chief merits of such a system are that it allows comparisons to be made between alternatives using a common "currency". In addition it makes the assessment of alternatives "transparent" (i.e. all important factors are included in the analysis). The system does not, however, provide an absolute "right" answer as to what should be included in the plan and what should be left out. Rather, it provides a method by which the Council can re-examine its options and if necessary, debate the relative scoring given to aspects of the plan.

Each option is given a score according to how well the option meets the criteria identified in **Section 4.1** above. In order to keep the scoring simple the following system is proposed:



- +2 Option rates very highly
- +1 Option rates well
- 0 Option is neutral
- 1 Option rates poorly
- 2 Option rates very poorly

The scores are added to get a total for each option.

Based on considerations outlined in this chapter, **Table 4.1** presents a scoring matrix for the options reviewed in **Chapter 3**. This scoring has been used as the basis for prioritising the components of the draft *Floodplain Risk Management Plan*. ***The proposed scoring and weighting shown in Table 4.1 was reviewed by the Committee as part of the process of preparing the draft Plan.***

### 4.3 Summary

**Table 4.1** indicates that there are good reasons to consider including the following elements into the draft *Floodplain Risk Management Plan*:

- Planning Controls via Council's existing Flood Policy for Gunnedah.
- Incorporation of the Catchment Specific information on flooding impacts contained in this Study in SES Emergency Management Procedures and Flood Awareness documentation for the study area.
- Riparian Corridor/Channel Improvement scheme on Blackjack Creek to provide flood mitigation and environmental benefits.
- Flood Protection Levee to protect residential area east of Wandobah Road (as an alternative mitigation measure to the above scheme).
- Flash Flood Warning System (in the event that the two structural mitigation measures do not proceed).

Property modification measures such as voluntary purchase of residential property or house raising schemes are not considered justified.

**TABLE 4.1  
BLACKJACK CREEK  
ASSESSMENT OF FLOODPLAIN MANAGEMENT OPTIONS**

Option	Impact on Flooding/ Reduction in Flood Risk	Community Acceptance	Technical Feasibility	Planning Objectives	Environ. Impacts	Economic Justification	Financial Feasibility	Extreme Flood	Government Policies and TCM Objectives	Score
<b>Flood Modification</b>										
Channel Improvement/Riparian Corridor	+2	+2	+1	+2	+2	0	-1	0	+2	+10
Flood protection Levee along east bank	+2	+1	0	0	-1	0	-1	0	+1	+2
<b>Property Modification</b>										
Flood Related Controls over future development (via Council Flood Policy)	+2	+2	0	+2	0	+2	0	0	+2	+10
House Raising in Low Hazard Areas	0	+1	0	+1	0	-2	-2	0	+1	-1
Voluntary Purchase of Residential Property	0	0	0	+1	0	-2	-2	+1	+1	-1
<b>Response Modification</b>										
Improvements in Flood Warning and Response	+2	+2	0	+1	0	+1	+1	+1	+1	+9
Community Education and Flood Awareness	+1	+2	0	+1	0	+1	0	+1	+2	+8
Certificate of Flood Affection of property	+2	+2	0	+2	0	+1	0	+1	+2	+10

## **5 DRAFT FLOODPLAIN RISK MANAGEMENT PLAN**

### **5.1 The Floodplain Risk Management Process**

A draft *Floodplain Risk Management Plan (FRMP)* has been prepared for the Blackjack Creek catchment as part of a Government program to mitigate the impacts of major floods and reduce the hazards in the floodplain. The *FRMP* has been prepared as part of the Floodplain Risk Management Process in accordance with NSW Government's Flood Prone Land Policy.

The first steps in the process of preparing the *FRMP* were the collection of Flood Data and the review of the Flood Study for Blackjack Creek prepared in 2005. That Flood Study was the formal starting process of defining management measures for flood liable land and represented a detailed technical investigation of flood behaviour in the catchment.

### **5.2 Purpose of the Plan**

The objectives of the *Floodplain Risk Management Study and Plan* were to assess the impacts of flooding, review policies and options for management of flood affected land and to develop an *FRMP* which:

- Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding and establishes a program and funding mechanism for the *FRMP*.
- Proposes amendments to Council's existing policies to ensure that the future development of flood affected land on Blackjack Creek is undertaken so as to be compatible with the flood hazard and risk.
- Ensures the *FRMP* is consistent with local emergency management planning.
- Ensures that the *FRMP* has the support of the community.

### **5.3 The Study Area**

This *FRMP* deals with the floodplain of the Blackjack Creek which has a total catchment area of 24 km<sup>2</sup> at its confluence with the Namoi River. For the purposes of this Plan the study focusses on the residential area in the 2 km long eastern floodplain of the creek between Lincoln Street and the Oxley Highway.

### **5.4 Community Consultation**

The Community Consultation process provided valuable direction over the course of the investigations, bringing together views from key Council staff, other departments and agencies, and importantly, the views of the community gained through:

- The delivery of a Community Newsletter and Questionnaire to property occupiers located in the floodplain, as well as inclusion of the documentation on Council's web site to allow the wider community to gain an understanding of the issues being addressed as part of the study.
- Meetings of the Floodplain Management Committee to discuss technical results of the study as they became available.
- Exhibition of the draft Study Report to give the community the opportunity to comment on the study findings and the draft *FRMP*.

- Additional meetings of the Committee following the public exhibition of the draft Study Report, which included a public meeting held at the Town Hall, to discuss community responses and concerns.
- The commitment by Council for the Feasibility Study and Concept Design of the Riparian Corridor/Improved Channel on Blackjack Creek, a measure recommended in the draft *FRMP* and aimed at providing a 100 year ARI level of security to residents against flooding from the creek.

## 5.5 Structure of Floodplain Risk Management Study and Plan

The *Blackjack Creek Floodplain Risk Management Study (FRMS)* and *draft FRMP* are supported by Appendices which provide additional details of the investigations undertaken during the investigation. A summary of the *draft FRMP* proposed for the study area is shown in **Table S.2** at the commencement of this report. The draft Plan includes five preferred measures which are given a Priority 1 ranking. They include:

- Planning and development controls for future development in flood prone areas (Measure 1),
- Improvements to existing flood preparedness and awareness in the Blackjack Creek community (Measures 2 and 3).
- Riparian corridor/channel improvement scheme on Blackjack Creek (Measures 4 and 5).

A priority list of alternative measures which could mitigate existing flooding conditions in the event that the riparian corridor/channel improvement scheme does not proceed is also presented in **Table S.2**. These measures could involve the investigation and construction of a flood protection levee along the eastern bank of Blackjack Creek (Measures 6 and 7), or investigation and implementation of a Flash Flood warning System (Measures 8 and 9).

## 5.6 Flooding Pattern and Impact

### 5.6.1 Flood Pattern

**Figure 2.1** shows the indicative extents of flooding for the 5, 20 and 100 year ARI and the Probable Maximum Flood. **Figure B8.3** of **Appendix B** shows residential and commercial properties which would be flooded above floor level in the event of a 100 year ARI flood. The extent of flooding and inundation of flood affected properties is indicative only, being based on available contour mapping and the cross sections of the creeks and floodplains comprising the hydraulic model developed in the Flood Study, 2005. It should not be used to identify the flood affectation of individual properties, for which a site specific survey would be required.

### 5.6.2 Impacts of Flooding

**Table 5.1** shows the number of properties which would be flooded to above floor level and the damages experienced for the various classes of property in the Blackjack Creek study area.

**TABLE 5.1**  
**ECONOMIC IMPACTS OF FLOODING**  
**BLACKJACK CREEK STUDY AREA**

Flood Event ARI	No. of Properties Flooded and Flood Damages						Total Flood Damages
	Residential		Commercial /Industrial		Public Buildings		
	No.	\$ x 10 <sup>6</sup>	No.	\$ x 10 <sup>6</sup>	No.	\$ x 10 <sup>6</sup>	\$ x 10 <sup>6</sup>
20	29	1.39	0	0	0	0	1.39
50	66	2.43	0	0	0	0	2.43
100	104	3.45	0	0	0	0	3.45
PMF	192	9.07	1	0.05	0	0	9.12

## 5.7 Flood Modification Measures

### 5.7.1 Riparian Corridor /Channel Improvement Scheme

Improvements to increase the conveyance capacity of the creek associated with the implementation of a riparian corridor are supported by the Community and are worth considering further by the Committee for inclusion in the draft *FRMP*. The riparian corridor would extend over about a 1.9 km reach between Lincoln Street and Oxley Highway. Preliminary hydraulic modelling and analysis of this scheme has been carried out using existing sources of survey data and indicative costs prepared.

Further hydrologic analysis with the benefit of additional survey information, the preparation of concept designs and refinement of the cost estimate is required to prepare a submission for Council/Government funding. A feasibility study has been included as a recommended measure in the draft *FRMP*, as the first step in the implementation of the project.

### 5.7.2 Flood Protection Levee

The construction of a 1.9 km flood protection levee along the right bank of the creek could be considered as an alternative to the riparian corridor/channel improvement in mitigating flooding in the event that the feasibility study and submission mentioned above is not successful in obtaining funding for that scheme. On the basis of the indicative costing prepared in the *FRMS*, the levee scheme is slightly less cost-effective and there are technical uncertainties with the channel scheme proposed for capturing and disposing of stormwater runoff from the areas on the protected side of the levee. Further investigation with the benefit of additional survey information would be required to confirm its feasibility. The principal constraint with the levee, however, is its adverse environmental impact on residents the eastern side of the creek. It would be up to 2 m in height and would obstruct the existing visual and physical linkage between the creek and Wandobah Road.

## 5.8 Property Modification Measures

The results of the *Floodplain Risk Management Study* indicate that an important measure for Gunnedah Shire Council to adopt in the floodplain would be strong floodplain management planning applied consistently by all branches of Council. A *Flood Policy* was prepared by Council following the recommendations of the Gunnedah and Carroll *FRMS* (SMEC, 1999). The

*Flood Policy* deals with flooding on the Namoi River, but could be adopted with minor amendments for Blackjack Creek.

The building and development controls set out in the *Flood Policy* involve the imposition of measures aimed at flood proofing future developments in flood affected areas. They include the specification of:

- Minimum habitable floor levels for residential and commercial and industrial developments (including appropriate freeboard provision);
- Appropriate flood compatible building materials.
- Egress routes from buildings.

The floodplain of Blackjack Creek has been divided into four zones according to the level of the flood risk. The approximate extents of the various **Flood Risk Zones** are shown in **Figure 2.5** and comprise:

- **Floodway.** This is the area within the envelope of land subject to a High Flood Hazard and Floodway categorisation in a 100 year ARI flood, defined in accordance with the criteria outlined in the *Flood Study, 2005* and the *Floodplain Risk Management Study, 2010*. In the **Floodway** high flood damages, potential risk to life and evacuation problems may be expected. The **Floodway** extends eastwards from the creek to Wandobah Road.
- **Intermediate Floodplain.** This is defined as the strip of land on the eastern side of Wandobah Road in which significant flow velocity and depth of inundation may be expected at the 100 year ARI level of flooding, although not sufficient to result in high hazard conditions. In this zone there would still be a significant risk of flood damages, but these damages may be minimised by the application of appropriate development controls.
- **Flood Fringe.** This is defined as all other land within the extent of the 100 year ARI flood. In this area flow velocities would not be significant and the depth of inundation would not be greater than 300 mm. In this zone the risk of damages is low and no flood related controls would apply to residential development, apart from the minimum floor level requirements.
- **Outer Floodplain.** This is the remaining portion of the floodplain to the extent of the Probable Maximum Flood. There would be no flood related development controls for residential and commercial and industrial development in this zone, although Council would check proposed floor levels to ensure they were above the Flood Planning Level.

The Policy requires the minimum floor level (**Flood Planning Level**) for new residential development equal to the 100 year ARI flood, plus an allowance of 500 mm for freeboard. The Policy considers that *new development* is an unsuitable use for land which is located in the **Floodway**.

Development in the **Intermediate Floodplain** could result in an adverse re-direction of flows towards existing developments, unless precautions were taken to prevent this occurrence. Accordingly, the Policy requires development to be designed to minimise obstructions to the passage of floodwaters by ensuring that the development does not restrict the passage of overland flow through the allotment. This requirement will reduce the potential for flood damages to adjacent development.

The Policy recommends that Flood Vulnerable Development such as housing for aged persons and people with disabilities be preferably excluded from the floodplain, or at least have minimum floor levels above the PMF level.

The **Flood Policy** is based on the recognition that individual developments should not be evaluated in isolation, but rather, should be considered in a strategic sense as if it were one of several developments in the area. Whilst individual developments in isolation may not have a measurable impact on flooding, the cumulative impacts of ongoing development could be significant.

New buildings or additions to existing buildings would be subjected to building controls with the long term objective of mitigating flood affectation to all buildings in the floodplain. The Policy recognises that controls need to be imposed on a merit basis, balancing restrictive development conditions with the impact of development on flood behaviour in the floodplain.

## **5.9 Indicative Flood Extents**

The plans showing the extents of flooding and flooded properties (**Figure 2.1**) are indicative only, being based on available 2 m contour mapping and limited cross sections of the creeks and their floodplains. This level of accuracy in the flood mapping is supported by DECCW, as the costs associated with undertaking detailed ground survey in each flood affected property presently lies outside the scope of the NSW Government's floodplain program.

Under the program, it is Council's responsibility to identify the flood risk within the floodplain and prepare maps showing indicative flood extents, with the onus being on the property owner to carry out sufficient survey to allow a more accurate picture of flood affection to be described in his allotment.

To allow Council to assess individual development proposals, a detailed site survey would be required to allow the extent of flooding and the flood hazard to be evaluated using the results of the Blackjack Creek Flood Study. For this reason, applicants will be required to submit a detailed survey plan of the site for which development is proposed.

## **5.10 Voluntary Purchase of Residential Property**

Removal of housing is a means of correcting previous decisions to allow buildings in high hazard areas in the floodplain. The voluntary purchase of residential property in hazardous areas has been part of subsidised floodplain management programs in NSW.

The review undertaken in the *FRMS* showed that implementation of a Government sponsored voluntary purchase scheme was not economically viable and could not be justified on social grounds.

## **5.11 Raising Floor Levels of Residential Property**

The analysis undertaken in the *Floodplain Risk Management Study* showed that the implementation of a voluntary house raising program was not economically viable and could not be justified on social grounds.

## 5.12 Response Modification Measures

### 5.12.1 Flood Warning and Response

The floor levels of properties potentially affected by flooding have been surveyed, or estimated from available topographic survey. Plans have been prepared as part of this present study, showing the indicative extent of flooding, high hazard areas and the locations of flooded properties. Plans showing the expected rate of rise of floodwaters have also been prepared. Consequently there is information available to identify areas at risk from flooding for the full range of flood events likely to trigger flood response procedures .

The Gunnedah Local Flood Plan, 2002 should be reviewed and further developed by SES so as to produce a graded response plan involving:

- Ranking the threatened houses according to their hazard situation, taking account of depth and velocity of floodwaters, and means of access, as a flood develops.
- Preparing a detailed response plan which focusses on initial evacuations from the most hazardous locations, followed by further evacuations in descending exposure to hazardous conditions.
- Preparing a plan for traffic management, which takes account of the sequence of road flooding as a flood develops. This plan would aim to:
  - maximise opportunities for the community to evacuate,
  - prevent unnecessary traffic through the affected area,
  - ensure access for SES operations.

### 5.12.2 Flood Awareness

A number of measures are recommended to maintain awareness in the community of the threat posed by floods:

- The proposed amendments to the Flood Policy should be considered, amended as required and adopted by Council.
- Council should continue to promote knowledge of the characteristics of flooding among the affected property owners. These characteristics should include information on the frequency of flooding and the depths at various locations. Council and SES should incorporate this information and the data derived from **Section 5.12.1** above in a FloodSafe Brochure to inform residents of the flood risk, which could be distributed with the rate notices. The community should also be made aware that a flood greater than historic levels or the planning level can, and will, occur at some time in the future. The need for a flood response and preparedness plan to address such an occurrence should be clearly explained.
- The *Floodplain Risk Management Plan* should be publicised and exhibited in Council offices and at community gathering places to make residents aware of the measures being proposed.

### 5.12.3 Flash Flood Warning System

In the event that neither of the two structural flood mitigation measures (riparian corridor/channel improvement or the flood protection levee) proceeds in a reasonable timeframe, a *Flash Flood*



*Warning* system as outlined in **Section 3.9** could be considered. A study would be required to confirm its feasibility prior to its implementation. Both the feasibility study and implementation of the system would qualify for Government funding assistance.

### 5.13 Recommended Measures and Funding

Broad funding requirements for the recommended measures to be included in the *draft FRMP* are given in **Table S.2**. These measures comprise a program of engineering investigations and capital works, preparation of planning documentation by Council, and community education on flooding by SES and Council to improve flood awareness and response. They will over time, achieve the objectives of reducing the flood risk to existing and future development for the full range of floods.

### 5.14 Implementation Program

The steps in progressing the floodplain management process are:

- Floodplain Management Committee to consider and adopt recommendations of this study. In particular, the Committee have reviewed the basis for ranking floodplain management measures (as set out in **Table 4.1** of the *FRMS* and the proposed works and measures to be included in the *draft FRMP* as set out in **Table S.2**).
- Exhibit the *draft FRMS* and *FRMP* and seek community comment.
- Consider public comment, modify the document if and as required, and submit the final document to Council.
- Council adopts the *FRMP* and submits an application for funding assistance from the Floodplain Management Program administered by DECCW and/or the Natural Disaster Mitigation Program administered by the State Emergency Management Committee and other agencies.
- As funds become available from DECCW, other Government agencies and/or Council's own resources, implement the measures in accordance with the established priorities.

The *FRMP* should be regarded as a dynamic instrument requiring review and modification over time. The catalysts for change could include new flood events and experiences, legislative change, alterations in the availability of funding, reviews of Council's planning strategies and importantly, the outcome of some of the studies proposed in this report as part of the *FRMP*. In any event, a thorough review every five years is warranted to ensure the ongoing relevance of the *FRMP*.

## 6 DEFINITIONS

Note: For expanded list of definitions, refer to Glossary contained within the NSW Government's *Floodplain Development Manual, 2005*.

TERM	DEFINITION
<b>Annual Exceedance Probability (AEP)</b>	The per cent probability of occurrence of a flood equal to or greater than a particular magnitude. For example, the 100 year ARI flood has a 1% chance (i.e a one-in-100 chance) of being equalled or exceeded in any one year.
<b>Australian Height Datum (AHD)</b>	A common national surface level datum corresponding approximately to mean sea level.
<b>Probable Maximum Flood</b>	The maximum possible flood that could reasonably be expected to occur at a particular location.
<b>Floodplain</b>	The area inundated by the <b>Probable Maximum Flood</b> .
<b>Flood Planning Level (FPL) – Blackjack Creek</b>	<p>Flood levels selected for planning purposes, as determined in the Blackjack Creek Flood Study, 2005 and referenced in the <i>Floodplain Risk Management Study, 2010</i> and associated <i>Floodplain Risk Management Plan</i>. For residential development in the floodplain, it is the flood level derived from the 100 year ARI flood event, plus the addition of a 500 mm Freeboard.</p> <p>Essential Community Facilities (eg. schools, hospitals), Critical Infrastructure and Flood Vulnerable Development (eg housing for Aged Persons and people with disabilities) should be excluded from the floodplain or at least have minimum floor levels equal to that of the PMF.</p>
<b>Flood Prone/Liable Land</b>	Land susceptible to flooding up to <b>Probable Maximum Flood</b> .
<b>Floodway</b>	Those areas of the floodplain where a significant discharge of water occurs during floods, they 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.
<b>Freeboard</b>	The factor of safety usually expressed as a height above the peak level of the Planning Level flood. Freeboard allows for factors such as wave action, localised hydraulic effects, greenhouse and climatic change, as well as accuracy of flood modelling data. The default value for freeboard is 500 mm unless a site specific freeboard to take account of localised effects is agreed to by Council.

TERM	DEFINITION
<b>Habitable Room</b>	<p>In a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.</p> <p>In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.</p>

## 7 REFERENCES

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## **GUNNEDAH SHIRE COUNCIL**

### **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN**

#### **APPENDIX A**

#### **DETAILS OF COSTS OF FLOOD MITIGATION SCHEMES**

**OCTOBER 2010**

**TABLE A1**  
**COST DETAILS IMPROVED CHANNEL/RIPARIAN CORRIDOR**

Item	Description	Unit	Rate	Quantity	Amount
1	Sediment Control over duration of project	Item	\$15,000.00	Item	\$15,000
2	Remove and dispose of vegetation	m <sup>2</sup>	\$1.05	162000	\$170,100
3	Excavate to remove topsoil (150 mm) and stockpile for later spreading over excavated surfaces	m <sup>2</sup>	\$0.85	162000	\$137,700
4	Excavate over 1900 m length to form trapezoidal channel, spread spoil on floodplain	m <sup>3</sup>	\$3.50	125000	\$437,500
5	Excavate from stockpile and spread topsoil over excavated surfaces	m <sup>2</sup>	\$0.92	162000	\$149,040
6	Sow and maintain native grasses over excavated channel batters (1900 m length)	m <sup>2</sup>	\$9.00	28000	\$252,000
7	Grass Seeding Channel Invert	m <sup>2</sup>	\$5.00	50000	\$250,000
8	Provide rock inverts to form isolated pools along length of channel	m <sup>3</sup>	\$50.00	1800	\$90,000
9	Riparian zone planting along channel overbanks ( 20 m strip each side)	m <sup>2</sup>	\$1.75	76000	\$133,000
10	Survey, Investigation and design (7.5%)				\$122,576
11	Unestimated items and contingencies (20%)				\$351,383
	<b>Total estimated Cost</b>				<b>\$2,108,299</b>

**TABLE A2**  
**COST DETAILS LEVEE SCHEME**

Item	Description	Unit	Rate	Quantity	Amount
1	Sediment Control over duration of project	Item	\$20,000.00	Item	\$15,000
2	Remove and dispose of vegetation	m <sup>2</sup>	\$1.05	51920	\$54,516
3	Excavate to remove topsoil (150 mm) over levee footprint and stockpile for later spreading over levee batters	m <sup>2</sup>	\$0.85	51920	\$44,132
4	Excavate over 300 m length to relocate existing channel near George Street (form trapezoidal channel, fill and compact existing channel)	m <sup>3</sup>	\$3.50	9000	\$31,500
5	Grass seed invert and batters of re-located channel Blackjack Creek	m <sup>2</sup>	\$5.00	7500	\$37,500
6	Roll and compact levee foundation	m <sup>2</sup>	\$5.00	21320	\$106,600
7	Supply and compact suitable impervious fill to form levee embankment	m <sup>3</sup>	\$40.00	22000	\$880,000
8	Excavate from stockpile and spread topsoil over all excavated surfaces	m <sup>2</sup>	\$0.92	58340	\$53,673
9	Grass seed levee batters	m <sup>2</sup>	\$5.00	22960	\$114,800
10	Excavate for storm water channel	m <sup>3</sup>	\$3.50	32800	\$114,800
11	Grass seed storm water channel surfaces	m <sup>2</sup>	\$5.00	24600	\$123,000
12	Survey, Investigation and design (10%)				\$157,552
13	Unestimated items and contingencies (35%)				\$606,576
	<b>Total estimated Cost</b>				<b>\$2,339,648</b>



## **GUNNEDAH SHIRE COUNCIL**

### **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN**

#### **APPENDIX B FLOOD DAMAGES**

**OCTOBER 2010**



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- B8.1 Residential Damage - Frequency Curve
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## SYNOPSIS

Estimation of flood damages to urban development in flood prone areas bordering Blackjack Creek was carried out to assess the impact of flooding on the community. The objectives were to assist the Floodplain Management Committee in confirming the Flood Planning Level and allow an economic assessment of various flood management measures to be carried out. Damages were assessed for floods ranging between the 20 Year ARI and PMF events.

There were no data available on historic flood damages on Blackjack Creek. The analysis was carried out using the flood damages model attached to *"Floodplain Risk Management Guideline No 4. Residential Flood Damages"*, which was prepared by DECCW to allow a consistent assessment across NSW for the comparison of flood management projects. For *Guideline No 4*, damage assessments which had been undertaken after major flooding in urban centres were adjusted and used to estimate damages likely to be experienced to typical residential development in NSW. Data for the flood damages model comprised the depths of inundation over the floodplain, as well as information on the unit values of damages to residential property. The depths of inundation was determined from the results of the hydraulic modelling described in the Main Report and from surveyed floor levels.

The estimated damages, which could occur for various floods, are summarised in **Table S1** below. Sub-division of urban flood damages is usually based on the three categories: "Residential", "Commercial" and "Public Buildings". Development on Blackjack Creek is almost entirely of a residential nature, with only one example of each of the other categories, which are therefore not significant in terms of damages experienced.

Residential damages versus flood frequency are shown graphically on **Figure B8.1**. Damages to contents were assumed to commence due to capillary and wave action once the flood level rose to an elevation 40 mm below the surveyed floor level. Under 20 year ARI conditions, 29 residences would be inundated to that level or greater. In the event of a 100 year ARI flood 104 properties would be similarly flooded. Under PMF conditions the number of flooded residences would increase to 192. The PMF is an extremely rare flood and for the purposes of assessing *average annual flood damages* was assumed to have a return period of 1 in 10<sup>5</sup> years. **Figure B8.2** shows the depths of inundation above surveyed floor level for the 100 year ARI flood in histogram format. Depths of inundation range between zero and 900 mm, with a median value of 250 mm. **Figure B8.3** shows the locations of flooded properties.

**TABLE S1**  
**FLOOD DAMAGES IN BLACKJACK CREEK STUDY AREA**

Average Recurrence Interval Year ARI	Flood Damages to Each Category (\$ x 10 <sup>6</sup> )			Total Damage (\$ x 10 <sup>6</sup> )
	Residential	Commercial	Public	
20	1.39	0	0	1.39
50	2.43	0	0	2.43
100	3.45	0	0	3.45
Extreme Flood	9.07	0.05	0	9.12

## **B1. INTRODUCTION AND SCOPE**

### **B1.1 Introduction**

Damages from flooding belong to two categories:

- **Tangible Damages**
- **Intangible Damages**

**Tangible damages** are defined as those to which monetary values may be assigned, and may be subdivided into direct and indirect damages. Direct damages are those caused by physical contact of floodwater with damageable property. They include damages to commercial and residential building structures and contents as well as damages to infrastructure services such as electricity and water supply. Indirect damages result from the interruption of community activities, including traffic flows, trade, industrial production, costs to relief agencies, evacuation of people and contents and clean up after the flood.

Generally, tangible damages are estimated in dollar values using survey procedures, interpretation of data from actual floods and research of government files.

The various factors included in the **intangible damage** category may be significant. However, these effects are difficult to quantify due to lack of data and the absence of an accepted method. Such factors may include:

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

### **B1.2 Scope of Investigation**

In the following sections, damages to residential, commercial and industrial properties and public buildings have been estimated on Blackjack Creek. Damages to community assets have also been assessed where data were available.

### **B1.3 Terminology**

Definitions of the terms used in this Appendix are presented in **Section 8** which also summarises the value of Tangible Flood Damages.

## B2. DESCRIPTION OF APPROACH

The damage caused by a flood to a particular property is a function of the depth of flooding above floor level and the value of the property and its contents. The warning time available for residents to take action to lift property above floor level also influences damages actually experienced. A spreadsheet model which had been developed for previous investigations of this nature was used to estimate damages on a property by property basis according to the type of development, the location of the property and the depth of inundation.

Using the results of the Flood Study (LACE, 2005), a peak flood elevation for each event was interpolated at each property. The interpolated property flood levels were input to the spreadsheet model which also contained property characteristics and depth-damage relationships. The depth of flooding was computed as the difference between the interpolated flood level and the surveyed floor elevation at each property.

The depth-damage curves for residential damages were determined using procedures described in *"Floodplain Management Guideline No 4. Residential Flood Damage Calculation"*, 2007 published by DECCW. Damage curves for commercial and industrial developments were derived from previous floodplain management investigations.

It should be understood that this approach is not intended to identify individual properties liable to flood damages and the values of damages in individual properties, even though it appears to be capable of doing so. The reason for this caveat lies in the various assumptions used in the procedure, the main ones being:

- the assumption that computed water levels and topographic data used to define flood extents are exact and without any error;
- the assumption that the water surfaces between hydraulic model cross sections are adequately represented by interpolation and are not subject to localised influences;
- the use of "average" stage-damage relationships, rather than a relationship for each property;
- the uncertainty associated with assessing an appropriate factor to convert potential damages to actual flood damages experienced for each property after residents have taken action to mitigate damages to contents.

The consequence of these assumptions is that some individual properties may be inappropriately classified as flood liable, while others may be excluded. Nevertheless, when applied over a broad area these effects would tend to cancel, and the resulting estimates of overall damages, would be expected to be reasonably accurate.

The information contained in the spreadsheets used to prepare the estimates of flood damages for the catchments should not therefore be used to provide information on the above-floor inundation of individual properties.

### B3. SOURCES OF DATA

#### B3.1 General

To estimate *Average Annual Flood Damages* for a specific area it is necessary to estimate the damages for several floods of different magnitudes, i.e. of different frequencies, and then to integrate the area beneath the damage – frequency curve over the whole range of frequencies. To do this it is necessary to have data on the damages sustained by all types of property over the likely range of inundation. There are several ways of doing this:

- The ideal way would be to conduct specific damage surveys in the aftermath of a range of floods, preferably immediately after each. An example approaching this ideal is the case of Nyngan where surveys were conducted in May 1990 following the disastrous flood of a month earlier (DWR, 1990). This approach would not be practicable in the present case due to the absence of recent major flooding on Blackjack Creek.
- The second best way is for experienced loss adjusters to conduct a survey to estimate likely losses that would arise due to various depths of inundation. This approach is used from time to time, but it can add significantly to the cost of a floodplain management study (LMJ, 1985). It was not used for the present investigation.
- The third way is to use generalised data such as that published by CRES (Centre for Resource & Economic Studies, Canberra) and used in the Floodplain Management Study for Forbes (SKM, 1994). These kinds of data are considered to be suitable for generalised studies, such as broad regional studies. They are not considered to be suitable for use in specific areas, unless none of the other approaches can be satisfactorily applied.
- The fourth way is to adapt or transpose, data from other flood liable areas. This was the approach used for Blackjack Creek. For the assessment of residential damages the *DECCW Guideline No 4, 2007* procedure was adopted, which was based on data collected following major flooding in Katherine in 1998, with adjustments to account for changes in values due to inflation, and after taking into account the nature of development and flooding patterns in the Blackjack Creek area. The data collected during site inspection in the flood liable areas of Blackjack Creek assisted in providing the necessary adjustments. Commercial and industrial damages were assessed via reference to recent floodplain management investigations (LACE, 2009).

#### B3.2 Property Data

The properties were divided into three categories: residential, commercial/industrial and public buildings.

For residential properties, the data used in the damages estimation included:

- the location/address of each property
- an estimate of the residence's value, age and size
- an assessment of the construction type and foundations

- a description of any external buildings/structures
- floor level of the residence

The residential descriptions were used to classify the properties into three categories which relate to the magnitude of likely flood damages (**Table B4.1**).

For commercial/industrial properties, the Property Survey obtained information regarding:

- the location of each property
- the nature of each enterprise
- an estimation of the floor area
- floor level

The property descriptions were used to classify the commercial developments into categories (i.e. high, medium or low value properties) which relate to the magnitude of likely flood damages.

Properties lying within the extent of the PMF were included in the database.



## **B4. RESIDENTIAL DAMAGES**

### **B4.1 Damage Functions**

The procedures identified in *DECCW Guideline No 4, 2007* allow for the preparation of a depth versus damage relationship which incorporates structural damage to the building, damage to internals and contents, external damages and clean up costs. In addition, there is the facility for including allowance for accommodation costs and loss of rent. Separate curves are computed for three residential categories:

- Single storey slab on ground construction
- Single storey elevated floor
- Two storey residence

The level of flood awareness and available warning time are taken into account by factors which are used to reduce “potential” damages to contents to “actual” damages. “Potential” damages represent losses likely to be experienced if no action were taken by residents to mitigate impacts. A reduction in the potential damages to “actual” damages is usually made to allow for property evacuation and raising valuables above floor level, which would reduce the damages actually experienced. The ability of residents to take action to reduce flood losses is mainly limited to reductions in damages to contents, as damages to the structure and clean up costs are not usually capable of significant mitigation.

The reduction in damages to contents is site specific, being dependent on a number of factors related to the time of rise of floodwaters, the recent flood history and flood awareness of residents and emergency planning by the various Government Agencies (Bureau of Meteorology and State Emergency Service).

Blackjack Creek is a “flash flooding” catchment with a time of rise of floodwaters limited to only one or two hours. There is no catchment specific flood warning system operated by the Bureau of Meteorology and no specific response procedures for Blackjack Creek are incorporated in the Namoi River Local Flood Plan developed by SES. Consequently, there would be limited time in advance of a flood event in which to warn residents and for them to take action to mitigate flood losses.

Provided warning were available, house contents may be raised above flood level to about 0.9 m, which corresponds with the height of a typical table/bench height. The spreadsheet provides two factors, one for above and one for below the typical bench height. The reduction in damages is also dependent on the likely duration of inundation of contents, which on Blackjack Creek would be limited to no more than an hour for most flooded properties. The “Total Contents Adjustment Factor” which converts potential damages to actual damages to contents was 0.9 for depths of inundation up to 0.9 m and 0.94 for greater depths.

**Table B4.1** below shows total flood damages estimated for the three classes of residential property using the procedures identified in *Guideline No 4*. A typical ground floor area of 135 m<sup>2</sup> was adopted, representative of house floor areas in the study area.

**TABLE B4.1**  
**DAMAGES TO RESIDENTIAL PROPERTIES**

Type of Residential Construction	0.5 m Depth of Inundation Above Floor Level	1m Depth of Inundation Above Floor Level
Single Storey Slab on Ground	\$38,800	\$46,000
Single Storey High Set	\$42,200	\$49,700
Two Storey Residence	\$29,600	\$34,700

Note: These damages include allowances for structural, contents, external and clean up costs.

#### **B4.2 Total Residential Damages**

**Table B4.2** summarises residential damages for a range of floods. The damage estimates were carried out for floods between the 20 Year ARI and the PMF, which were modelled hydraulically in the Main Report.

**TABLE B4.2**  
**RESIDENTIAL DAMAGES ON BLACKJACK CREEK**

Flood Event Year ARI	No. of Flooded Residences*	Flood Damages \$ x 10 <sup>6</sup>
20	29	1.39
50	66	2.43
100	104	3.45
PMF	192	9.07

Note: A residence is categorised as "flooded" when the flood level rises to within 40 mm of the surveyed floor level. Capillary and wave action is assumed to initiate damages to floors, carpets and fittings.

## **B5. COMMERCIAL AND INDUSTRIAL DAMAGES**

### **B5.1 Direct Commercial and Industrial Damages**

The method used to calculate damages requires each property to be categorised in terms of the following:

- damage category
- floor area
- floor elevation.

The damage category assigned to each enterprise may vary between "low", "medium" or "high", depending on the nature of the enterprise and the likely effects of flooding. Damages also depend on the floor area.

It has recently been recognised following the 1998 flood in Katherine that previous investigations using stage damage curves contained in proprietary software tends to seriously underestimate true damage costs (*DECCW Guideline No 4, 2007*). DECCW are currently researching appropriate damage functions which could be adopted in the estimation of commercial and industrial categories as they have already done with residential damages. However, these data were not available for the Blackjack Creek study.

On the basis of previous investigations (LACE, 2009) the following typical damage rates are considered appropriate for potential external and internal damages and clean up costs for both commercial and industrial properties. They are indexed to a depth of inundation of 2 metres. At floor level and 1.2 m inundation, zero and 70% of these values respectively were assumed to occur:

Low value enterprise	\$280/m <sup>2</sup>	(e.g. Commercial: small shops, cafes, joinery, public halls. Industrial: auto workshop with concrete floor and minimal goods at floor level, Council or Government Depots, storage areas.)
Medium value enterprise	\$420/m <sup>2</sup>	(e.g. Commercial: food shops, hardware, banks, professional offices, retail enterprises, with furniture/fixtures at floor level which would suffer damage if inundated. Industrial: warehouses, equipment hire. )
High value enterprise	\$650/m <sup>2</sup>	(e.g. Commercial : electrical shops, clothing stores, bookshops, newsagents, restaurants, schools, showrooms and retailers with goods and furniture, or other high value items at ground or lower floor level. Industrial: service stations, vehicle showrooms, smash repairs.)

The factor for converting potential to actual damages depends on a range of variables such as the available warning time, flood awareness and the depth of inundation. Given sufficient warning time a well prepared business will be able to temporarily lift property above floor level. However, unless property is actually moved to flood free areas, floods which result in a large depth of inundation, will cause considerable damage to stock and contents.

For the present study, the above potential damages were converted to actual damages using a multiplier which ranged between 0.3 and 0.7 depending on the depth of inundation above the floor. The factors also took into consideration the absence of recent floods in the catchment.

## B5.2 Indirect Commercial and Industrial Damages

Indirect commercial and industrial damages comprise costs of removal of goods and storage, loss of trading profit and loss of business confidence.

Disruption to trade takes the following forms:

- The loss through isolation at the time of the flood when water is in the business premises or separating clients and customers. The total loss of trade is influenced by the opportunity for trade to divert to an alternative source. There may be significant local loss but due to the trade transfer this may be considerably reduced at the regional or state level.
- In the case of major flooding, a downturn in business can occur within the flood affected region due to the cancellation of contracts and loss of business confidence. This is in addition to the actual loss of trading caused by closure of the business by flooding.

Loss of trading profit is a difficult value to assess and the magnitude of damages can vary depending on whether the assessment is made at the local, regional or national level. Differences between regional and national economic effects arise because of transfers between the sectors, such as taxes, and subsidies such as flood relief returned to the region. Some investigations have lumped this loss with indirect damages and have adopted total damage as a percentage of the direct damage. In other cases, loss of profit has been related to the gross margin of the business, i.e. turnover less average wages. The former approach has been adopted in this present study. Indirect damages have been taken as 50% of direct actual damages.

## B5.3 Total Commercial and Industrial Damages

**Table B5.1** summarises estimated commercial and industrial damages within the flood liable portion of Blackjack Creek.

**TABLE B5.1**  
**COMMERCIAL AND INDUSTRIAL DAMAGES ON BLACKJACK CREEK**

Flood Event Year ARI	Number of Properties with Floors Inundated	Damages \$ x 10 <sup>6</sup>
20	0	0
50	0	0
100	0	0
PMF	1	0.05

## **B6. DAMAGES TO PUBLIC BUILDINGS**

### **B6.1 Direct Damages – Public Buildings**

There are no public buildings located on Blackjack Creek within the extent of the PMF.

## **B7. DAMAGES TO INFRASTRUCTURE AND COMMUNITY ASSETS**

Infrastructure in the Blackjack Creek, such as electrical and telephone supply, sewerage and water supply systems, and road network, are potentially prone to damaging flooding. Community assets such as parks and other recreational amenities could also suffer damages. No data are available on damages experienced during historic flood events. However, a qualitative matrix of the effects of flooding on these categories is presented in **Table B7.1**.

**TABLE B7.1**  
**QUALITATIVE EFFECTS OF FLOODING ON**  
**INFRASTRUCTURE AND COMMUNITY ASSETS**  
**ON BLACKJACK CREEK**

Damage Sector	Flood Event ARI				
	5	20	50	100	PMF
Electricity	0	0	0	X	X
Telephone	0	0	0	X	X
Roads	0	X	X	X	X
Bridges	0	0	0	X	X
Sewerage	0	0	0	0	0
Water Supply	0	0	X	X	X
Parks and Gardens	0	X	X	X	X

**Notes:** 0 = No significant damages likely to be incurred.  
X = Some damages likely to be incurred.

## B8 SUMMARY OF TANGIBLE DAMAGES

### B8.1 Tangible Damages

Flood damages under existing conditions have been computed for a range of flood frequencies from 20 year ARI to the PMF. Flows up to the 5 year ARI are conveyed within the channel. Larger flows would result in surcharges of Wandobah Road into the residential areas, with inundation extending eastwards with increasing flood magnitude. The 20 year ARI is the “threshold” flood magnitude at which significant damages are experienced in Blackjack Creek.

The total damages for each flood event are shown on **Table B8.1**. Cumulative average annual damages were assessed and are also shown. A 1 in 100,000 year return period was assigned to the PMF. **Figure B8.1** shows the damage - frequency curve. **Figure B8.2** is a histogram of the depths of residential above floor inundation for the 100 year ARI flood. **Figure B8.3** shows properties flooded by the 100 year ARI event.

**TABLE B8.1**  
**TOTAL DAMAGES ON BLACKJACK CREEK**

Flood Event Year ARI	No. of Properties with Floors Inundated			Total Damages \$ x 10 <sup>6</sup>	Cumulative AAD \$
	Residential	Commercial/ Industrial	Public		
5	0	0	0	0	0
20	29	0	0	1.39	104,250
50	66	0	0	2.43	161,550
100	104	0	0	3.45	190,950
PMF	192	1	0	9.12	253,500

### B8.2 Definition of Terms

*Average Annual Damages* (also termed “expected damages”) are determined by integrating the area under the damage-frequency curve. They represent the time stream of annual damages, which would be expected to occur on a year by year basis over a long duration.

Using an appropriate discount rate, average annual damages may be expressed as an equivalent “*Present Worth Value*” of damages and used in the economic analysis of potential flood management measures.

*Cumulative Annual Average Damages* may be referenced to a particular flood frequency. They represent the average damages which would be expected on an annual basis for all flood events up to and including that nominated frequency.

For example, the cumulative average annual value of damages on Blackjack Creek for all floods up to the 100 year ARI level is \$190,950 (**Table B8.1**). A flood management scheme which has a design 100 year ARI level of protection, by definition, will eliminate damages up to this level of flooding. If the scheme has no mitigating effect on larger floods, then these damages represent the benefits of the scheme expressed on an average annual basis.

Under current NSW Treasury guidelines, economic analyses are carried out assuming a 20 year economic life for projects and discount rates of 7% pa. (best estimate) and 10% and 4% pa. (sensitivity analyses).

### B8.3 Present Worth of Damages in Blackjack Creek

The *Present Worth Values* of damages likely to be experienced in the study area for all flood events up to the 100 year ARI, a 20 year economic life and discount rates of 4, 7 and 10 per cent are shown on **Table B8.2**. Corresponding values for all floods up to the Extreme Flood are shown on **Table B8.3**.

For a discount rate of 7% pa, the *Present Worth Value* of damages for all flood events up to the PMF is about \$2.68 Million for a 20 year economic life. Therefore a scheme costing up to \$2.68 Million could be economically justified if it eliminated damages for all flood events up to this level. Similarly, a scheme providing a 100 year ARI level of protection could be economically justified if it cost up to \$2.02 Million.

More expensive schemes would have a benefit/cost ratio less than 1, but may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility. Flood management measures are considered on a multi-objective basis in the Main Report.

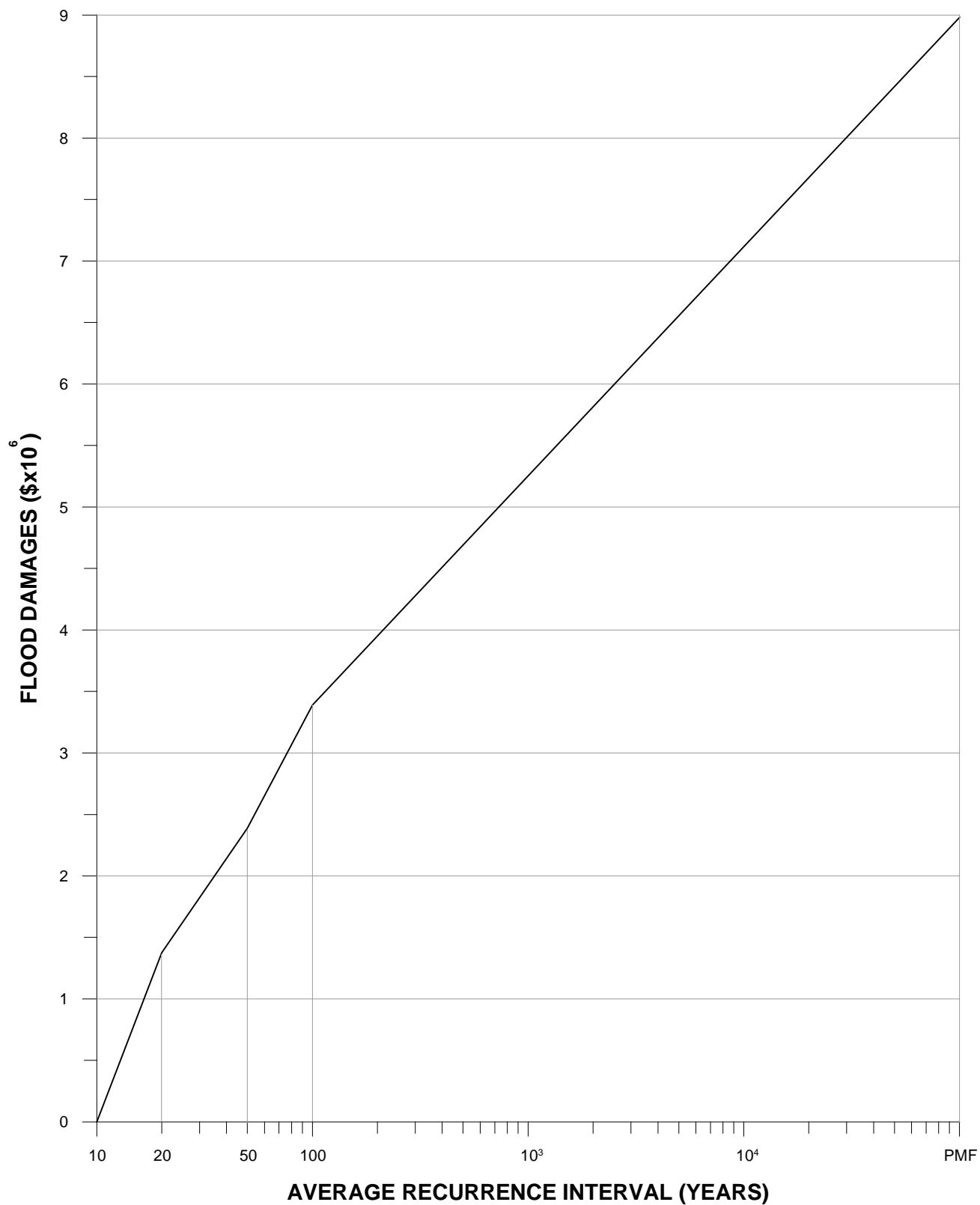
**TABLE B8.2**  
**PRESENT WORTH OF DAMAGES ON BLACKJACK CREEK**  
**ALL FLOODS UP TO 100 YEAR**  
**ECONOMIC LIFE OF 20 YEARS**  
**\$ X 10<sup>6</sup>**

Discount Rate – per cent		
4	7	10
2.60	2.02	1.62

**TABLE B8.3**  
**PRESENT WORTH OF DAMAGES ON BLACKJACK CREEK**  
**ALL FLOODS UP TO PMF**  
**ECONOMIC LIFE OF 20 YEARS**  
**\$ X 10<sup>6</sup>**

Discount Rate – per cent		
4	7	10
3.44	2.68	2.16

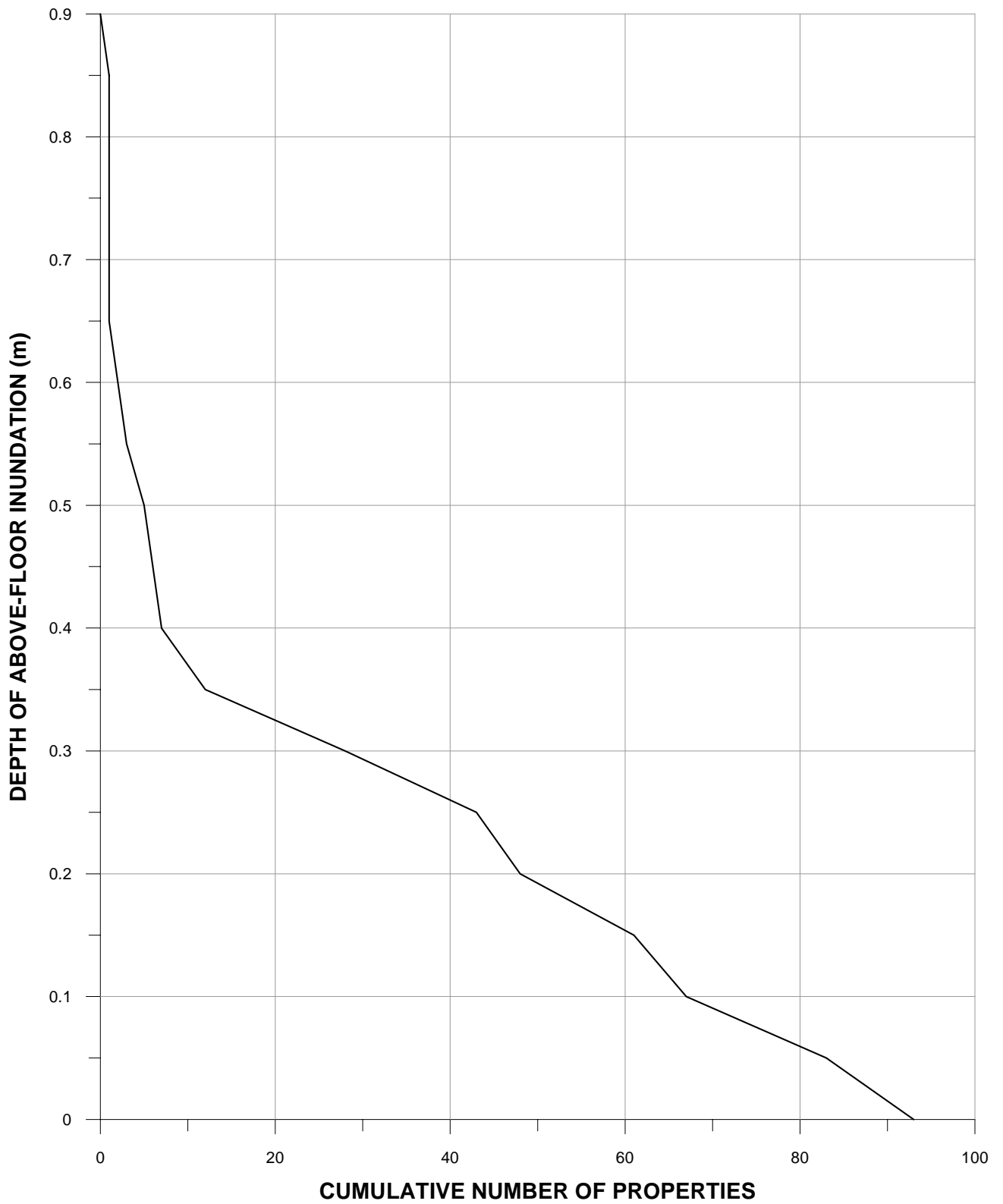




**BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY**

Figure B8.1

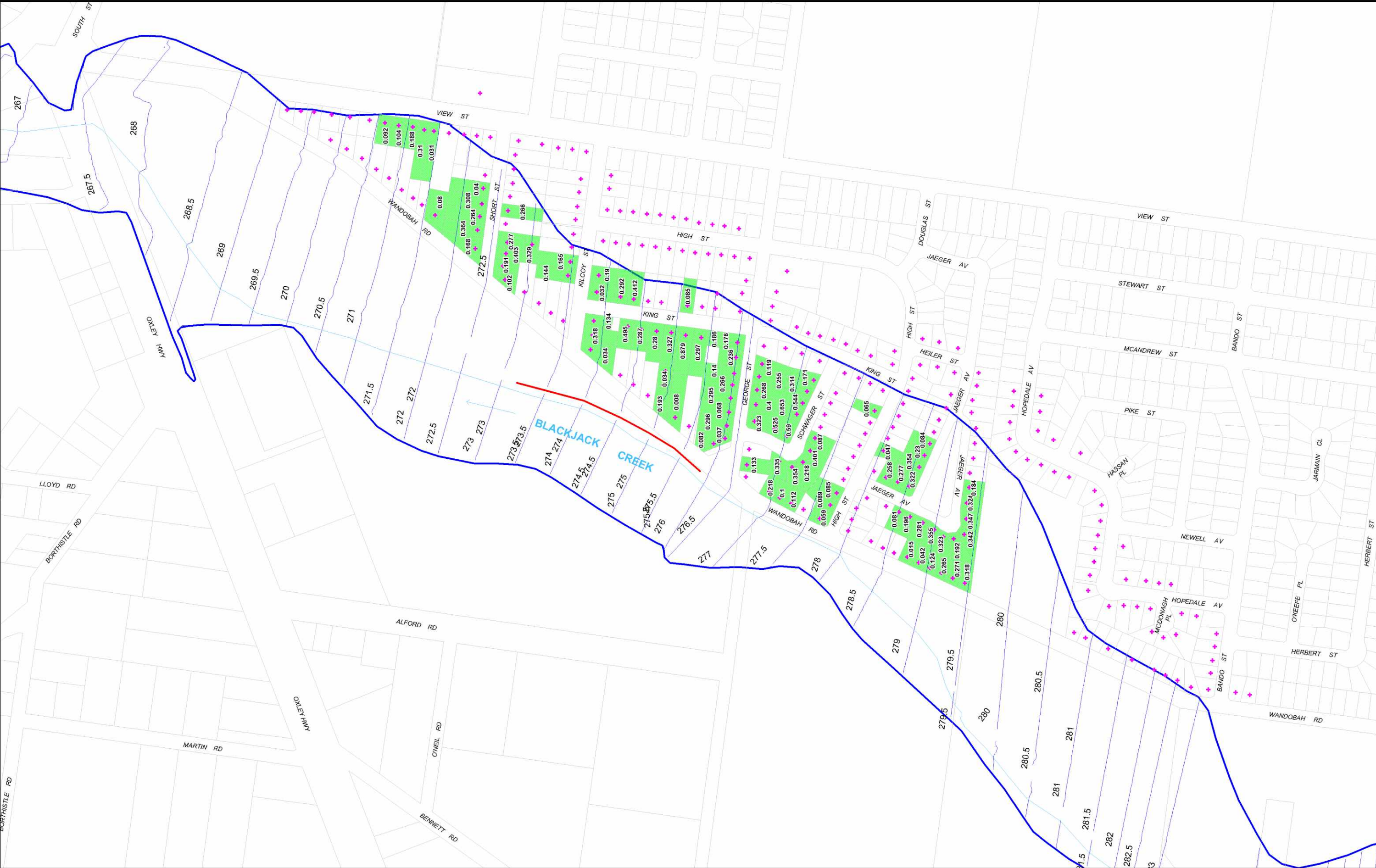
RESIDENTIAL DAMAGE - FREQUENCY CURVE



**BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY**

Figure B8.2

HISTOGRAM OF FLOODED RESIDENTIAL PROPERTIES - 100YR ARI



LEGEND	
0.192	DEPTH OF ABOVE-FLOOR INUNDATION (m)
278.5	WATER SURFACE CONTOURS (m)
—	EXISTING LEVEE
+	SURVEYED RESIDENTIAL PROPERTIES
■	RESIDENTIAL PROPERTIES FLOODED
	ABOVE FLOOR LEVEL

**BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY**

Figure B8.3

FLOODED PROPERTIES

100 YEAR ARI

## **B9. REFERENCES AND BIBLIOGRAPHY**

Lyall and Associates Consulting Water Engineers (2009) *"Conargo Floodplain Risk Management Study and Plan"*. Report prepared for Conargo Shire Council and DECCW.

Department of Environment and Climate Change, NSW (2007) *"Floodplain Management Guideline No 4. Residential Flood Damages"*.

Department of Water Resources, NSW (1990) *"Nyngan April 1990 Flood Investigation"*.

Lyall, Macoun and Joy, Willing and Partners Pty Ltd (1985) *"Camden Floodplain Management Study"*. Report for Water Resources Commission and Camden Municipal Council.

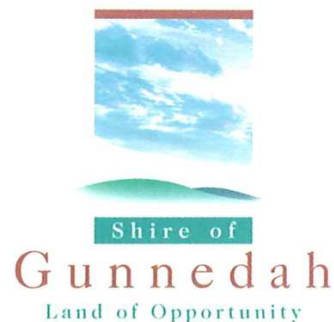
Sinclair Knight Merz (1994) *"Forbes Floodplain Management Report and Draft Floodplain Management Plan, Volume 1"*. Report prepared for Department of Land and Water Conservation.

Water Studies (1986) *"The Sydney Floods of August 1986"*, Volume I Residential Flood Damage Survey, Report prepared for CRCE Water Studies Pty Ltd for the NSW PWD.

Water Studies (1992) *"Forbes Flood Damage Survey, August 1990 Flood"*. Report prepared for Department of Water Resources.



Environment,  
Climate Change  
& Water



## **GUNNEDAH COUNCIL**

### **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY**

#### **APPENDIX C**

#### **COMMUNITY NEWSLETTER AND RESPONSES TO QUESTIONNAIRE**

**JUNE 2010**

**DRAFT**



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## **ATTACHMENTS**

- 1. Newsletter and Community Questionnaire**
- 2. Responses to Community Questionnaire**

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## **C1. INTRODUCTION**

At the commencement of the *Blackjack Creek Floodplain Risk Management Study and Plan*, the Consultants prepared a combined Newsletter/Questionnaire which was distributed by Council to residents located on the floodplain of Blackjack Creek. (refer to **Attachment 1**)

The purpose of the Newsletter was to introduce the objectives of the Study and provide information on flooding conditions so that the community would be better able to respond to the Questionnaire and contribute to the Study process.

The Newsletter contained the following information:

- A Plan of the study area showing the indicative extents of flooding for the 100 year and Probable Maximum Floods.
- The objectives of the Study, namely the assessment of options for reducing the impacts of flooding on existing development and the preparation of guidelines for future development in accordance with best floodplain management principles.
- The objectives of the Plan, namely the reduction of flood risk and minimising the long-term impact of flooding on the community and the recommendation of appropriate flood management measures.

The Questionnaire was structured with the objectives of:

- Obtaining local information on flood experience and behaviour at residents' properties.
- Determining residents attitudes to controls over development in flood liable areas in the Blackjack Creek catchment.
- Inviting community views on possible flood management options which could be considered for inclusion in the *Floodplain Risk Management Plan*.
- Obtaining feedback on any other flood related issues and concerns which the residents cared to raise.

This **Appendix** discusses the responses to the 12 questions included in the Questionnaire and comments made by respondents. **Section C2** deals with the residents' experience with historic flooding; determining residents' views on the relative importance of classes of development over which flood-related controls should be imposed by Council; and whether residents are aware of the advice Council currently provides regarding the potential flood affectation of existing properties. **Section C3** nominates and seeks residents' opinions on potential measures which could be incorporated in the *Floodplain Risk Management Plan* for Blackjack Creek.

**Section C4** summarises the attitude of the respondents to flooding issues, existing flood policy and potential floodplain management measures which could be incorporated in the *Floodplain Risk Management Plan* for Blackjack Creek which will be developed during this Study.

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## **C2 RESIDENT RESPONSES**

### **C2.1 General**

The Consultants received 57 responses to the Questionnaire as of the requested date (end of April 2010). About 40 respondents (optionally) provided their addresses, which allowed the Consultants to cross reference information they provided about flooding on their properties to the property survey which the Consultants used to assess the economic impacts of flooding. To provide basic data for the property survey, the Consultants had a surveyor provide natural surface and floor levels of residences.

The Consultants have collated the responses, which are shown in graphical format (**Attachment 2**). About 30 respondents had lived in the study area for more than 20 years (Question 2) and some were able to provide useful information on the flooding conditions experienced in both the January 1984 and November 2008 floods. These floods are the highest to have occurred in the past 30 years on Blackjack Creek. Both floods are classified as major flood events and resulted in damaging flooding to residential property. Rainfalls experienced during the January 1984 storm approached the 100 year intensity for the 2 to 3 hour period likely to maximise flows on Blackjack Creek. The November 2008 storm rainfalls had a return period between 20 and 50 years.

Where respondents provided information on the depths of flooding reached on their properties, as well as their addresses, this information was used to cross check with flood level data included in the Blackjack Creek Flood Study, prepared by LACE in 2005. In general the information provided by the respondents confirms modelled and historic flood information (mainly on the January 1984 event) contained in the LACE, 2005 study.

### **C2.2 Experiences of Flooding**

The first seven questions assessed resident information such as; property ownership, length of time in the study area, whether the respondent had any experience of flooding and if so, which particular flood and whether they had experienced above-floor inundation.

Twenty two respondents reported that they had experienced flooding on their property, with 12 nominating the January 1984 flood and 9 the November 2008 event. One resident advised that he had experienced above-floor inundation in a flood in 1974.

As far as the source of flood warnings to the Blackjack Creek population is concerned (**Question 8**), 26 respondents advised that they had received no warnings of impending flooding. Two respondents advised that they been warned by neighbours, friends or relatives and 6 by their own observations. None reported that they had received warnings from Police or SES. Some respondents received warnings from multiple sources.

### **C2.3 Controls over Development in Flood Prone Areas**

The residents were also asked to rank from 1 to 6 the classes of development likely to occur on the Blackjack Creek floodplain which they consider should receive protection from flooding (**Question 9**). These rankings were added for each response to achieve a total score for the survey. The lowest score identified the most important class overall for the residents.

The six classes, in decreasing order of importance, ranged from residential (which was considered the most important category to protect), to flood-vulnerable residential development such as aged persons' accommodation, minor extensions to existing houses, existing outbuildings, new residential sub-divisions and lastly and least important, new outbuildings such as garages.

#### **C2.4 Awareness of Advice Council Provides about Potential Flood Affection of Properties**

**Question 10** asked about residential awareness of the advice Council provides about the potential flood affection of individual properties (in practice this is achieved by providing flood related wording on Section 149 Certificates) and advice available from Council regarding measures to mitigate impacts of flooding. The response was evenly divided, with 23 respondents advising they were aware of Council's advice, versus 22 who were unaware.

### **C3 POTENTIAL FLOOD MANAGEMENT MEASURES**

The respondents were also asked for their opinion on potential flood management measures which could be included in the Floodplain Risk Management Plan, by ticking a “yes” or “no” to the 12 options provided in **Question 11**.

The options comprised a range of structural measures (e.g. management of vegetation in Blackjack Creek to maximise the hydraulic capacity of the floodplain, channel enlargement, detention basins to reduce downstream flood peaks, levees to contain floodwaters) and non-structural measures (e.g. voluntary purchase of residential properties, house raising, planning controls, improvements to flood warning and response procedures, community education on flooding, etc). The options were not mutually exclusive, as the *Floodplain Risk Management Plan* adopted could, in theory, include all of the options set out in the Questionnaire, or indeed, other measures to be nominated by the respondents.

The most popular measure was the continuation by Council of the management of vegetation in Blackjack Creek and cleaning debris from the channel after flooding. In comments attached to their Questionnaires, residents commented on the need for creek maintenance to maintain the capacity of the waterway and hence minimise flood levels. Several respondents reported instances of blockage of the creek channel by cars, vegetation and other debris conveyed by the flow. Another popular structural flood mitigation measure was the enlargement of the creek channel to increase hydraulic capacity. The construction of permanent levees to contain floodwaters was also favoured.

Development controls, improved flood warning procedures, evacuation and emergency plans, community education, Council's provision of advice regarding flood affectation (e.g. via Section 149 certificates) and the use of flood markers to show the extents of inundation were also favoured by the respondents.

Respondents were evenly divided on the implementation of a residential Voluntary Purchase scheme (to be administered by Council and designed by Government to allow residents on a wholly voluntary basis to vacate high hazard areas in the floodplain). A similar lukewarm response was given to the provision of subsidies for raising the floor levels of existing residential properties located in less hazardous zones of the floodplain.

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#### **C4 LOCAL FLOODING ISSUES**

A number of respondents complained about surcharges of the piped local stormwater system in the residential areas on the eastern part of the catchment, particularly in the View Street area.

Residents reported that during several recent storms the stormwater system had surcharged. The problem appears to be caused by a lack of capacity in the drainage system possibly aggravated by recent sub-division development. Residents also reported overland flows from the direction of the golf course due to surcharges of the dams.

The *Blackjack Creek Floodplain Risk Management Study and Plan* covers main stream flooding issues resulting from surcharges of the creek channel when catchment-wide major storms occur. Issues resulting from overflows of the piped stormwater system due to localised storms are, strictly speaking, outside the scope of the present investigation. Main stream flooding and surcharges of the piped stormwater system both occur as a result of intense rainfalls on the respective catchments and are therefore, likely to be closely correlated. Gunnedah Council has recently developed a computer based hydrologic model of the piped system to assist with planning of improvements. It is intended that the results of Council's work will be taken into account in the present investigation when planning measures to mitigate the effects of main stream flooding.

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## **C5 SUMMARY**

A large number of responses were received relative to the number of Newsletter/Questionnaires distributed by Council. The responses amounted to about 30 per cent of the total distributed, which is well in excess of the typical 10 per cent return. This fact demonstrated the considerable interest by the Blackjack Creek community in the study. The information on residents' experiences of historic flooding provided useful data to the Consultants and demonstrated that there is a real flood problem in the residential area with several properties experiencing above-floor inundation and numerous allotments flooded below floor level.

### **C5.1 Issues**

The issues identified by respondents in their responses to the Questionnaire support the proposed objectives of the Study, as nominated in the Newsletter and the activities nominated in the Study Brief. No new issues were identified in regard to main stream flooding which is the primary subject of the Study. Several residents did however provide information on surcharges of the piped stormwater system due to local storm events which will be of assistance to Council in planning improvements to the system.

### **C5.2 Flood Management Measures**

The non-structural flood management measures such as planing controls over new development in flood liable areas, as well as improvements to flood warning and emergency management measures appear to be the most popular of the potential measures set out in the Questionnaire. Of the structural measures, management of vegetation and clearing the creek of debris following flood events and enlargement of the channel to increase hydraulic capacity were the most popular. There do not appear to be any new measures raised by the respondents in their responses to **Question 11**.

### **C5.3 November 2008 Storm**

In view of the awareness of this flood event by the respondents, the Consultants will carry out an investigation of the November 2008 storm and resulting flood flows on Blackjack Creek. This investigation will involve collection and analysis of rainfall data, assessment of likely flows and levels and the return period of this event.

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**ATTACHMENT 1**

**NEWSLETTER AND COMMUNITY QUESTIONNAIRE**



# Blackjack Creek Floodplain Risk Management Study and Plan



## To Residents bordering Blackjack Creek

Gunnedah Shire Council has engaged Lyall & Associates Consulting Water Engineers to prepare a Floodplain Risk Management Study and Plan for Blackjack Creek, located on the western fringes of the catchment in the Wandobah Road area. Council and the Department of Environment, Climate Change and Water are jointly funding the study.

The primary objectives of the Study will be to assess options for reducing the impacts of flooding on existing development and to prepare guidelines for future development in accordance with best floodplain management principles. The Plan has the objective of reducing the flood risk and minimising the long-term impact of flooding on the community, through assessment and recommendation of appropriate flood management measures.

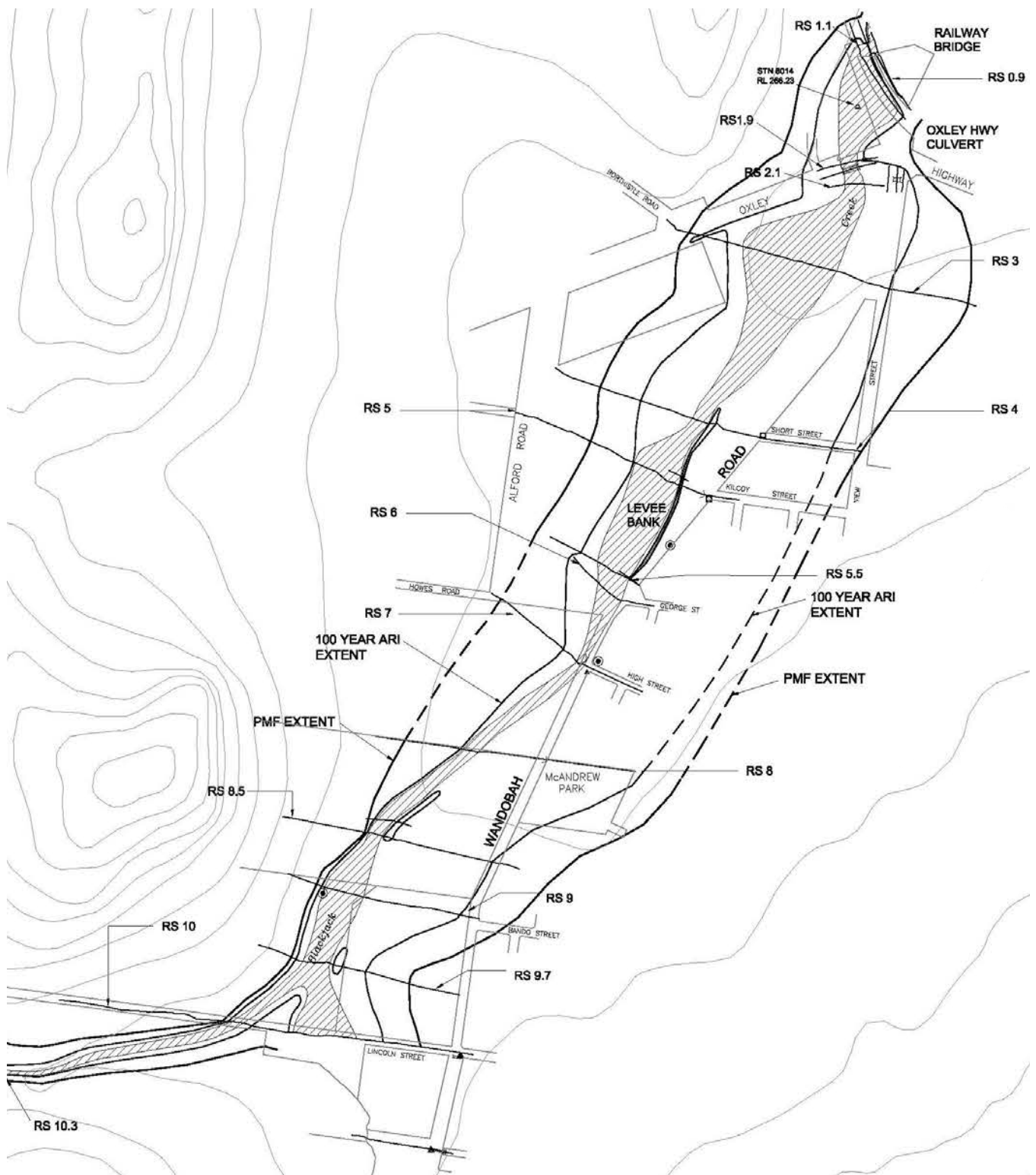
## Have Your Say on Floodplain Management

The Study and Plan are set to run to mid-2010. An important step in the preparation of the Study is the compilation of a database of community expectations and preferences on ways of reducing the flood risk within the Study area. The attached questionnaire will be provided to selected residents and businesses, but any interested person is invited to complete it. All information provided will remain confidential and for use in this study only.

**Please return the completed questionnaire in the reply paid envelope provided by the end of April 2010.**



Blackjack Creek Upstream of Oxley Highway



PLAN OF STUDY AREA

# Blackjack Creek Floodplain Risk Management Study and Plan

## Community Questionnaire

### TO RESIDENTS BORDERING BLACKJACK CREEK

This questionnaire is part of the Blackjack Creek Floodplain Risk Management Study, currently being undertaken by Consultants on behalf of Gunnedah Shire Council. It will help us determine the flood issues that are important to you.

Please return your completed questionnaire in the reply paid envelope provided by the end of **April 2010**. No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers  
Reply Paid 78855  
NORTH SYDNEY NSW 2060

Your name and address (optional): \_\_\_\_\_

#### About your property

**1. Please tick as appropriate:**

- a. I am a resident ☐
- b. I own the property ☐
- c. I rent the property ☐
- d. Other (please specify \_\_\_\_\_) ☐

**2. How long have you owned or lived at this address?**

- a. Less than 1 year ☐
- b. 1 year to 5 years ☐
- c. 5 years to 20 years ☐
- d. More than 20 years (... years) ☐

**3. What is your property?**

- a. House ☐
- b. Villa/Townhouse ☐
- c. Unit/Flat/Apartment ☐
- d. Vacant land ☐
- e. Other (\_\_\_\_\_ ) ☐

#### Your flood experience

*(If you have experienced a flood, please answer Questions 4 to 7, otherwise go to Question 8)*

**4. Do you have any information about flooding at the property?**

- a. Yes ☐
- b. No ☐
- If yes, what information do you have?
- c. Own experience ☐
- d. Flood levels from Council ☐
- e. Council planning certificate ☐
- f. Information from State Emergency Service (SES). ☐
- g. Photographs ☐
- h. Other (\_\_\_\_\_ ) ☐

**5. Have you ever experienced flooding at the property?**

- a. Yes ☐
- b. No ☐
- If yes, which floods?
- c. November 2008 ☐
- d. January 1984 ☐
- e. Other (\_\_\_\_\_ ) ☐

**6. In the biggest flood you have experienced, was the property flooded above floor level of the main residence?**

- a. No ☐
- b. Yes ☐

If yes, what was the depth of water over the floor?

What year? \_\_\_\_\_

**7. In this biggest flood, did you receive any warning, and if so, from where?**

(Tick one or more boxes)

- a. No warning whatsoever ☐
- b. TV ☐
- c. Radio ☐
- d. Own observations ☐
- e. Police ☐
- f. State Emergency Service (SES) ☐
- g. Neighbours, relatives or friends ☐
- h. Other (\_\_\_\_\_) ☐

***Your attitudes to Council's development controls***

**8. Please rank the following development types according to which you think are the most important to protect from floods (1=highest priority to 8=least priority)**

- a. Residential ☐
- b. Essential community facilities (eg. Hospital) ☐
- c. Critical utilities (eg. Telephone Exchange) ☐
- d. Minor development and additions (eg. house extension) ☐
- e. New residential subdivisions ☐

**9. Are you aware of the controls Gunnedah Council currently places on development in flood prone areas?**

- a. Yes ☐ b. No ☐

Comment: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**10. Are you aware of the advice Gunnedah Council currently provides about the potential flood affectation of individual properties?**

- a. Yes ☐ b. No ☐

Comment: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

***Your opinions on floodplain risk management measures***

**11. Below is a list of possible options that may be looked at to try to minimise the effects of flooding on Blackjack Creek.**

This list is not in any order of importance and there may be other options that you think should be considered. For each of the options listed, please indicate "yes" or "no" to indicate if you favour the option. Please leave blank if undecided.

- |  | <u>Yes</u>               | <u>No</u>                |
|--|--------------------------|--------------------------|
| a. Maintenance programs to clear creek of vegetation and debris impeding flows.  | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Enlarge the creek channel.  | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Construct detention basins.   | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Construct permanent levees to contain floodwaters.  | <input type="checkbox"/> | <input type="checkbox"/> |
| e. Voluntary scheme to purchase residential property in high hazard areas.   | <input type="checkbox"/> | <input type="checkbox"/> |
| f. Provide funding or subsidies to raise houses above major flood level in low hazard areas.   | <input type="checkbox"/> | <input type="checkbox"/> |
| g. Specify controls over future development in flood-labile area (eg. controls on extent of filling, on site detention policies, controls on site imperviousness, floor level requirements, etc) | <input type="checkbox"/> | <input type="checkbox"/> |
| h. Improve flood warning procedures both before and during a flood.  | <input type="checkbox"/> | <input type="checkbox"/> |
| i. Improve evacuation and emergency assistance plans.  | <input type="checkbox"/> | <input type="checkbox"/> |
| j. Community education, participation and flood awareness programs.  | <input type="checkbox"/> | <input type="checkbox"/> |
| k. Provide a certificate to purchasers in flood prone areas stating that the property is flood affected and to what extent.  | <input type="checkbox"/> | <input type="checkbox"/> |
| l. Install flood markers (eg. on power poles) to act as reminders of heights of previous floods.   | <input type="checkbox"/> | <input type="checkbox"/> |



### ***Other Information***

**12. What do you think is the best way for us to get input and feedback from the local community about the results and proposals from this study? (Tick one or more boxes)**

- a. Council's website ☐
- b. Articles in local newspaper ☐
- c. Open days or drop-in days ☐
- d. Through Council's Floodplain Risk Management Committee ☐
- e. Other (please specify \_\_\_\_\_) ☐

**13. If you wish us to contact you so you can provide further information, or you have ticked items a) or b) of Question 12, please provide your details below:**

Name: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Phone (Home) \_\_\_\_\_

Best time to call is \_\_\_\_\_

Fax No. \_\_\_\_\_

Email: \_\_\_\_\_

### ***Who can I contact for further information?***

#### **Gunnedah Shire Council**

Lachlan Johnson

Phone: 6740 2126

#### **Lyall & Associates**

#### **Consulting Water Engineers**

Scott Button

Phone: 9929 4466

Copies of this questionnaire can be obtained from:

[www.infogunnedah.com.au](http://www.infogunnedah.com.au)

*Please write your comments on the next page*

## COMMENTS

Please write your comments here:

[illegible]

Thank you for your participation in this study

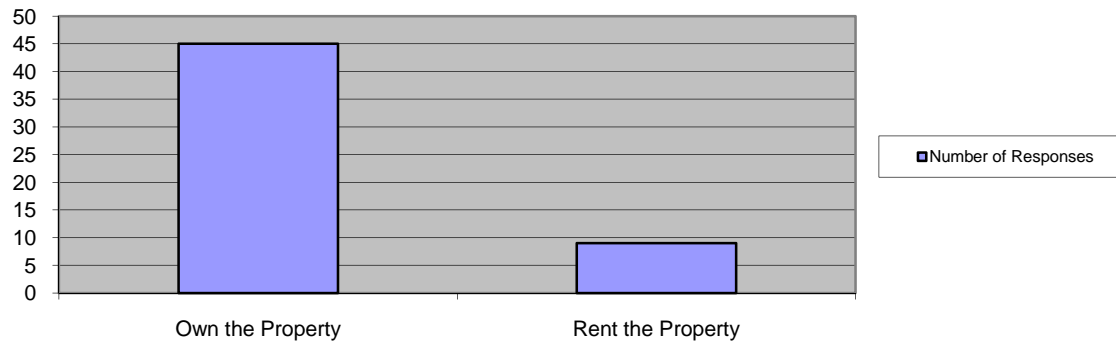
**ATTACHMENT 2**

**RESPONSES TO COMMUNITY QUESTIONNAIRE**

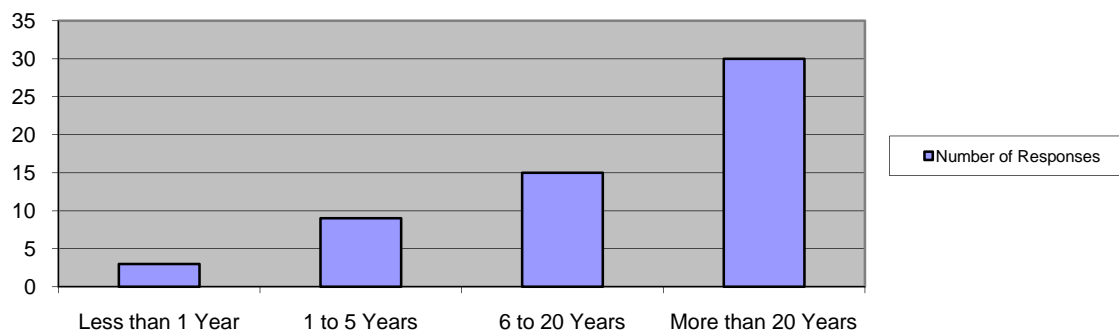


## **ABOUT YOUR PROPERTY**

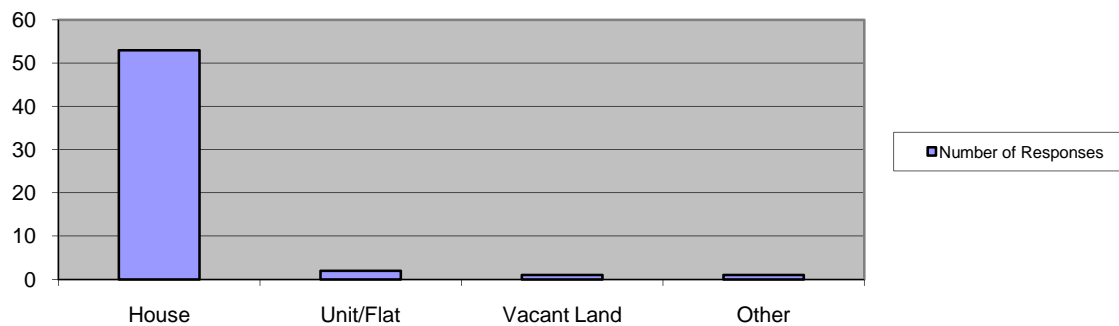
**Question 1 - Residential Status?**



**Question 2 - Time at this Address?**

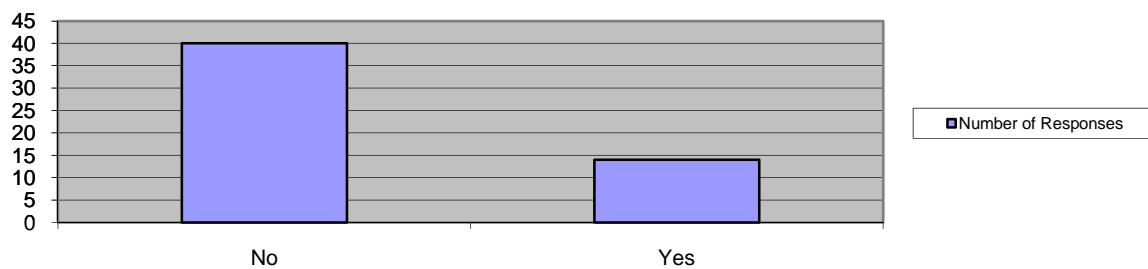


**Question 3 - Type of Property?**

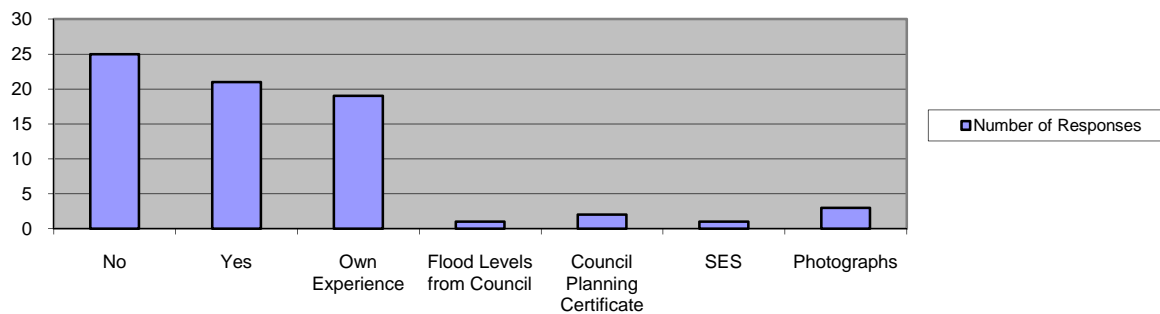


## YOUR FLOOD EXPERIENCE

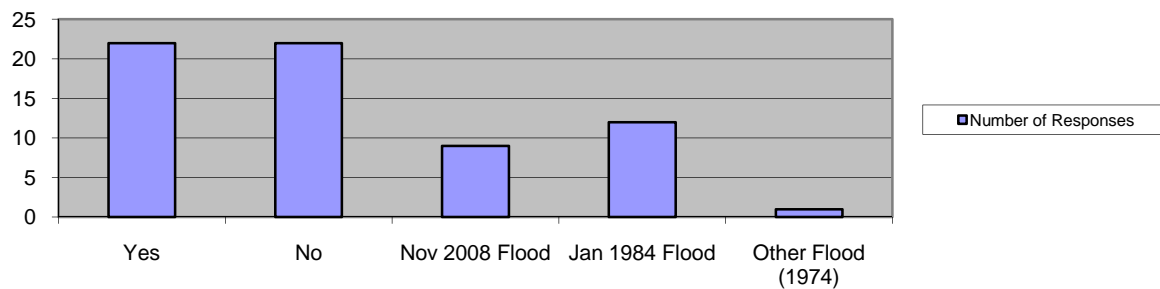
**Question 4 - Aware that the Property may be Flooded?**



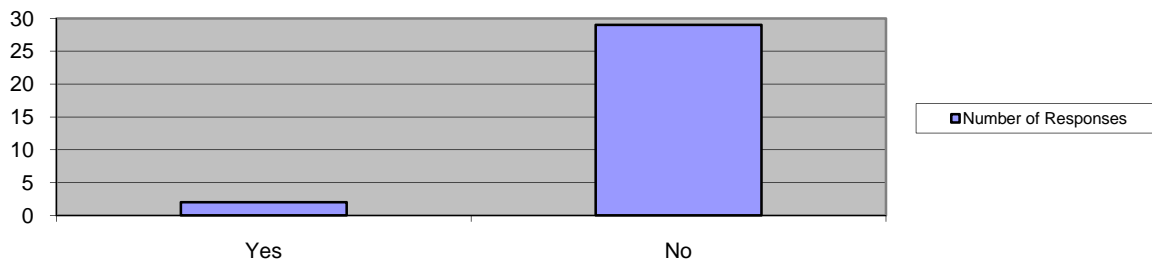
**Question 5 - Any information about Flooding at the Property?**



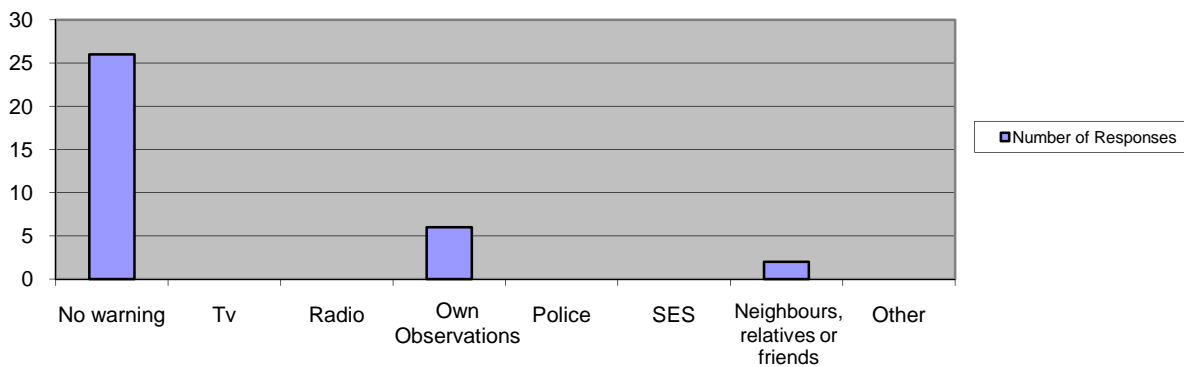
**Question 6 - Flood Experienced on Property?**



**Question 7 - Flooding Above Floor Level?**

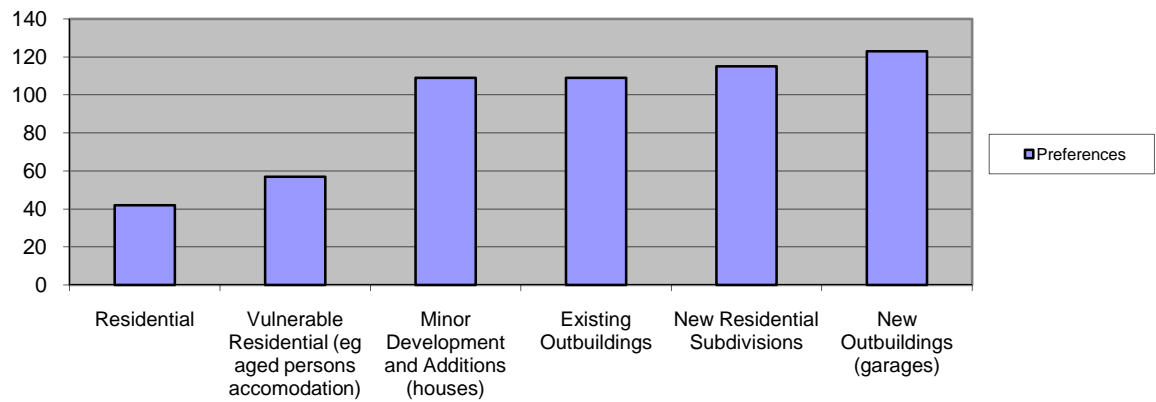


**Question 8 - Where did the Flood Warning Come From?**

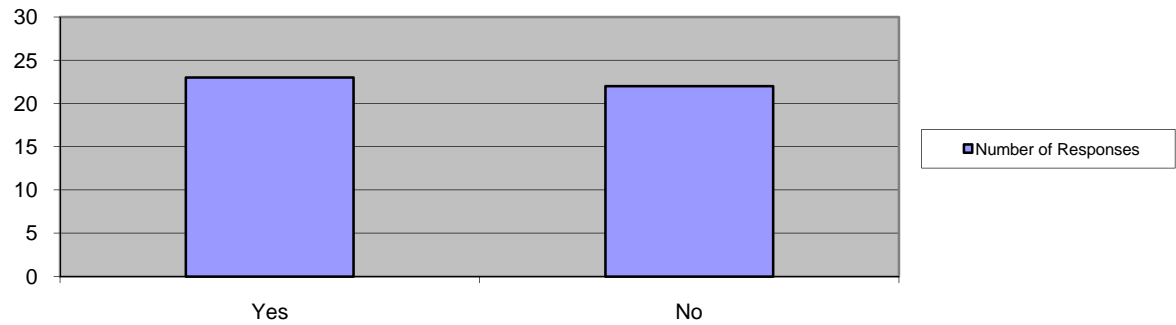


**YOUR ATTITUDE TO COUNCIL'S DEVELOPMENT CONTROLS**

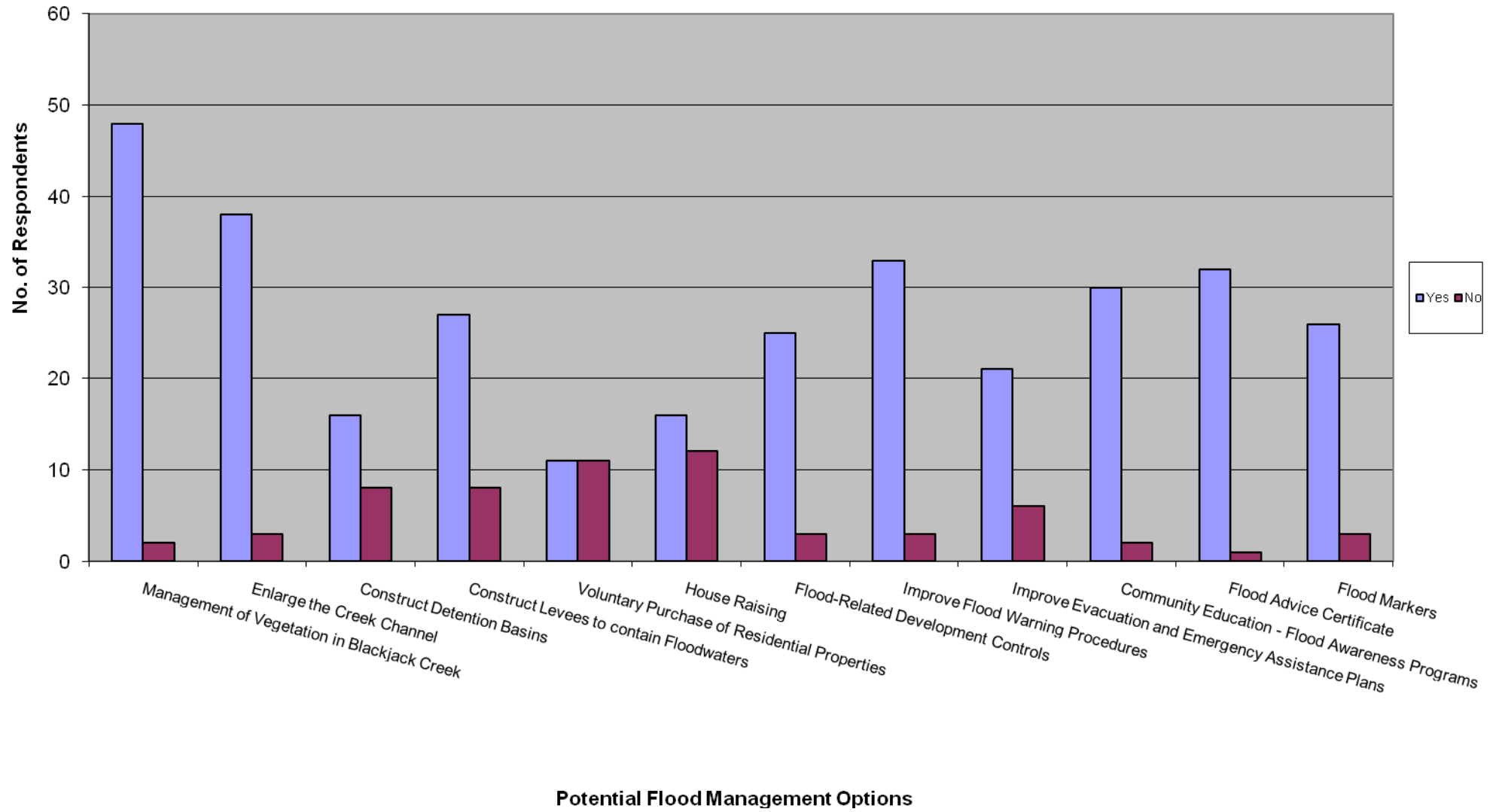
**Question 9 - Ranking Development for Protection**  
**(Note: lowest score = most important)**



**Question 10 - Aware of Advice Currently Provided by Council Regarding Flooding?**

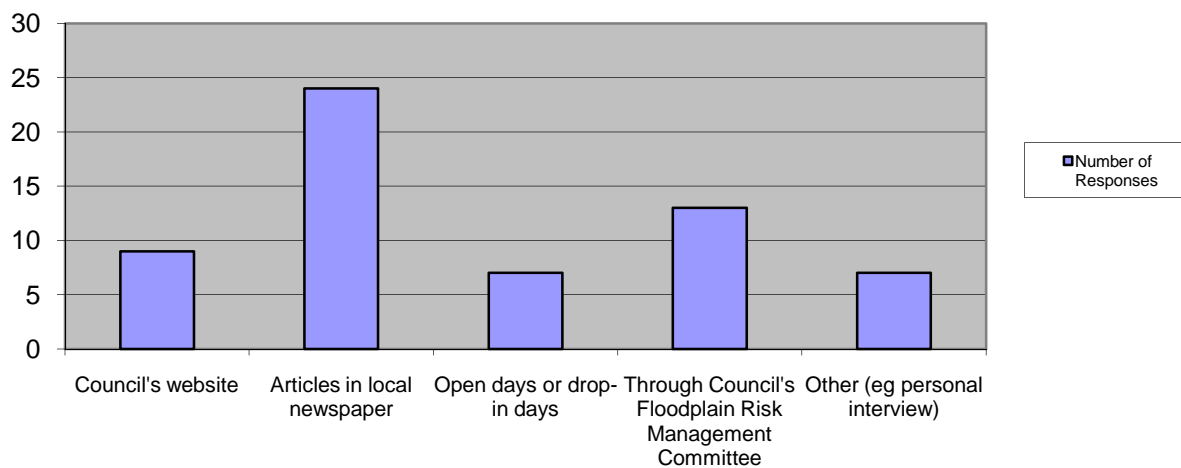


## Question 11 - Flood Management Options





**Question 12 - Best Methods to get Input and Feedback from the Local Community**





## **GUNNEDAH SHIRE COUNCIL**

### **BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN**

#### **APPENDIX D**

#### **FLOODPLAIN MANAGEMENT COMMITTEE REPORT TO ORDINARY MEETING OF GUNNEDAH SHIRE COUNCIL 15 JUNE 2011**

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT**

1. **REPORT** of the Floodplain Management Meeting held on Tuesday 19 April 2011 in the Town Hall, Conadilly Street, Gunnedah, commencing at 6.00 pm.
2. **PRESENT:** Councillor S Benham (in the Chair), Mr George Ruttley, Mr J Sutherland (Design Engineer), Mr W Kerr (Director Infrastructure Services), Mr M Silver (Director Planning & Environmental Services), Mr L Johnson (Environmental & Natural Resources Planner), Mr Ted Bernays, Cllr S Smith, Ms Sharon Howett (Gunnedah SES), Mr Doug Brown, Mr Scott Button (Lyall & Associates) and Mr Lindsay Finlay.
3. **WELCOME**  
  
The Chairman, Cllr S Benham welcomed members of the gallery and committee members and thanked them for their attendance. He introduced each Committee member individually.
4. **APOLOGIES**  
Apologies were tendered on behalf of Mr Ken Lloyd, Mr Andrew Galvin, Mr Andrew Falkenmire and Councillors C Fuller, A Marshall, L Mills and T Duddy.

*Committee Recommendation  
Moved Mr T Bernays, seconded Mr G Ruttley*

5. **DECLARATION OF INTEREST**

Nil.

6. **CONFIRMATION OF PREVIOUS MINUTES**

It was **RESOLVED** that the Minutes of the previous meeting held on Wednesday 20 October 2010 were a true and correct record.

*Committee Recommendation  
Moved Mr D Brown, seconded Councillor S Smith*

7. **BUSINESS ARISING**

The Director Planning & Environmental Services advised that all issues in the previous minutes had been attended to or would be dealt with tonight as circulated in the agenda

8. **GUNNEDAH SHIRE FLOODPLAIN MANAGEMENT COMMITTEE - CONSTITUTION**

**Environmental & Natural Resource Planner's Report**

<b>POLICY</b>	Constitution of Gunnedah Shire Floodplain Management Committee
<b>LEGAL</b>	Local Government Act 1993
<b>FINANCIAL</b>	Nil

- 8.1 **INTRODUCTION**

This report outlines the changes to the Constitution of Gunnedah Shire Floodplain Management Committee adopted by Council to include two additional community members on the Committee.

- 8.2 **COMMENTARY**

The changes to the constitution permitted two additional community members from the Blackjack Creek catchment to be appointed to the Gunnedah Floodplain Management Committee.

Subsequently, Council invited nominations for the two positions. Four nominations were received. Council at its March meeting appointed Mr George Ruttley and Mr Lindsay Finlay to the Committee.

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 2****Committee Deliberations**

The Director Planning & Environmental Services referred the first two items on the Agenda to Mr Lachlan Johnson who went on to explain that the Constitution of the Committee required amendment to include two additional Committee members: Mr George Ruttley and Mr Lindsay Finlay.

RECOMMENDATION: That the information be received and noted.

*Committee Recommendation  
Moved Mr T Bernays, seconded Mr D Brown*

**9. VOLUNTARY HOUSE RAISING GUNNEDAH & CARROLL****Environmental & Natural Resource Planner's Report**

<b>POLICY</b>	House Raising Operations & Tendering and Procurement Policy
<b>LEGAL</b>	Local Government Act 1993
<b>FINANCIAL</b>	Flood Housing – Restricted Asset

**9.1 INTRODUCTION**

This report outlines the progress of the Gunnedah – Carroll Voluntary House Raising Program.

**9.2 BACKGROUND**

The Voluntary House Raising Program has operated since the adoption of the Gunnedah – Carroll Floodplain Management Plan in 1999. Council continues to receive support through the State Floodplain Management Program – Voluntary House Raising and Voluntary Purchase. Voluntary House Raising has been a very successful and important flood mitigation measure in the floodplain of Gunnedah and Carroll.

**9.3 COMMENTARY**

The Gunnedah – Carroll Floodplain Management Plan has identified a number of residences in the Gunnedah and Carroll Floodplain for Voluntary House Raising. The owners of two (2) properties within Gunnedah have taken up the opportunity for house raising under the 2010/2011 program.

Council's contribution to support the 'local' funding component of the two projects, in accordance with the House Raising Operations Policy, will total \$35,000. Council at its March 2011 meeting authorised the transfer of the funds from the Flood Housing restricted asset.

Architectural plans and engineers details have been prepared by suitably qualified consultants. The raising of the two dwellings has been put out to Quotation closing on 18 April 2011.

An assessment of the quotation will be carried for consideration by the Floodplain Management Committee and the recommendation to Council. It is proposed that a recommendation on the Quotations will be considered by Council at its May meeting. As a consequence an additional meeting of the Committee will need to be scheduled prior to 11 May 2011.

**OFFICER'S RECOMMENDATIONS:**

1. That the information be received and noted.
2. That a meeting of the floodplain Management Committee be scheduled for ..... to consider the Quotations and to determine a recommendation to Council.

**Committee Deliberations**

Mr Johnson advised that two houses had been identified and taken up the opportunity for house raising and Council at its meeting on 20 March 2011 had endorsed the transfer of \$35,000 from the Flood Housing restricted asset to fund Council's portion of the total cost.

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 3**

Mr Johnson reported that quotations for the raising of the dwellings closed on 18 April 2011. An assessment of the quotations will be carried out by Council staff and will also be considered by the Floodplain Management Committee. Accordingly, a subsequent meeting of the Floodplain Management Committee will need to be scheduled in the near future.

The Director Planning & Environmental Services indicated that as only one quotation has been received for each house the Committee may choose to forego a meeting after determining the quotations are acceptable. Mr Silver said he would circulate the assessments to Committee members for consideration.

**COMMITTEE RECOMMENDATIONS:**

1. That the information be received and noted.
2. That a meeting of the Floodplain Management Committee be scheduled for 5 May 2011 to consider the quotations and to determine a recommendation to Council.

*Committee Recommendation  
Moved Ms S Howett, seconded Cllr S Smith*

**10. BLACKJACK CREEK FLOODPLAIN RISK MANAGEMENT STUDY & DRAFT PLAN****Environmental & Natural Resource Planner's Report**

<b>POLICY</b>	Blackjack Creek Floodplain Risk Management Study & Draft Plan
<b>LEGAL</b>	Nil
<b>FINANCIAL</b>	Nil

**10.1 INTRODUCTION**

This report presents the Blackjack Creek Floodplain Risk Management Study & Draft Plan to be endorsed by the Gunnedah Floodplain Management Committee for recommendation to Council for adoption.

**10.2 BACKGROUND**

In November 2009 Council engaged Lyall & Associates consulting Water Engineers to prepare a Floodplain Risk Management Study and Plan for Blackjack Creek. The Draft Plan was initially placed on public exhibition following endorsement by Council at the December Ordinary Meeting for a period of 28 days with submissions to be received no later than the 4 February 2011. The public exhibition period was extended until 18 February in light of community concerns and submissions that the period be extended.

The NSW Government Floodplain Development Manual outlines the floodplain risk management process. This process is detailed below and must be adhered to ensure compliance with NSW State Government Policy.

- Data Collection (carried out by Lyall & Associates Consulting Water Engineers) – 2005 and 2010
- Flood Study (undertaken by Lyall & Associates Consulting Water Engineers) - 2005
- Floodplain Risk Management Study (prepared by Lyall & Associates consulting Water Engineers) - 2010
- Floodplain Risk Management Plan (Draft Plan prepared by Lyall & Associates Consulting Water Engineers) - 2010
- Plan Implementation
- Funding for Management Measures
- Review of adopted management plan

**10.2.1 Data Collection**

A variety of data are required to assess flood behaviour and the effectiveness, costs and benefits of management measures. Data collection should not be seen as an end in itself, but

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 4**

as input to enable preparation of properly informed studies, management plans, and floodplain management decisions.

**10.2.2 Flood Study**

The Flood Study is a comprehensive technical investigation of flood behaviour. It defines the nature of flood risk by providing information on the extent, level and velocity of floodwaters and on the distribution of flood flows across various sections of the floodplain for the full range of flood events up to and including the Probable Maximum Flood (PMF).

Major components of a flood study involve determining discharge, water levels, velocities, etc for floods of varying intensity.

The flood study determines hydraulic and hazard categories within the floodplain for the potential range of floods and land use scenarios in order to consider the cumulative affects. The manual recognises three hydraulic categories:

- Floodway
- Flood storage
- Flood Fringe

These hydraulic categories are broken into two hazard categories:

- High
- Low

Investigating the full range of flood events up to and including the PMF enables changes in the nature and consequences of flooding to be assessed as flood severity increases.

Determining the appropriate areas for and types of development generally depend upon flood exposure of the land, as defined by hydraulic and hazard categorisation in consideration of isolation.

This information is also weighed objectively in selecting Flood Planning Levels.

The Floodplain Risk Management Study & Plan follow on from the Blackjack Creek Flood Study which was prepared by Lyall & Associates Consulting Water Engineers in 2005 and subsequently adopted by Council at the December 2005 Ordinary Council.

**10.2.3 Floodplain Risk Management Study**

A floodplain risk management study is a multidisciplinary process that is lengthy and detailed. The management study balances a number of differing factors to generate recommendations for an appropriate mix of management measures to deal with the different types of flood risk. The factors considered in the management study include:

- Flood behaviour, danger and damage
- The community costs of flooding
- Future land use
- Comprehensive range of flood risks and management measures
- Environmental needs of watercourse and floodplain
- Environmental & cultural impacts of management measures.

A management study aims to identify all relevant issues, quantify them and weigh them appropriately into an overall management plan by which the community as a whole is better off, though some groups may perceive themselves as disadvantaged.

The purpose of a management study is to identify, assess and compare various risk management options and consider options for environmental enhancement as part of mitigation works.

The management study draws together the results of the flood study and data collection exercises. It provides information and tools to allow the strategic assessment of the impacts of management options for existing, future and continuing flood risk on flood behaviour and

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 5**

hazard the social economic, ecological and cultural costs and benefits of the options, it also provides the basis for robust decision making in management plan.

A management plan generally involves a mix of options as it is unusual for a single management option to manage the full range of flood risk. Determining the optimum mix of measures can require complex studies, exercise of professional judgement and extensive community consultation. Typical options considered are categorised into three categories.

- Property modification measures – (zoning, voluntary purchase, voluntary house raising, building & development controls, flood proofing buildings, flood access)
- Response modification measures – (Community awareness, community readiness, flood prediction and warning, local flood plans, evacuation arrangements, recovery plans)
- Flood modification measures – (Flood control dams, retarding basins, levees, by pass floodway's, channel improvement, flood gates)

The impact of the management works or proposed developments on flooding behaviour elsewhere should be assessed on a cumulative rather individual or ad hoc basis within the context of the management plan. This includes both the effect of development on flood behaviour and the number of people who may require evacuation, particularly in rare flood events. Where mitigation work is considered, they should be designed to produce net positive ecological outcomes, where practical and feasible.

Flood planning levels (FPL's) are an important tool in the management of flood risk. They are derived from a combination of a flood risk. They are derived from a combination of a flood event, an historic flood or certain AEP and a freeboard.

FPL's do not, however, ensure that development is located in areas where it will not have significant adverse impacts on flooding nor do they address personal danger issues. These issues need to be considered strategically in the risk management study and managed through appropriate land use restrictions in EPI's and emergency response planning.

FPL's can indicate the level of the protection provided by flood or property modification measures. As noted previously, it is generally not feasible not socially or economically justifiable to adopt the PMF as the basis for such FPL's. The FPL for residential dwellings would generally be based around the 1% AEP flood event plus an appropriate freeboard (typically 0.5m) unless there are clearly identified benefits from a higher FPL which outweigh the associated costs. The FPL for protection works, such as channel reconstruction/riparian corridor, may be different due to the economics of the situation, ecological impacts, and the physical limitations of the site, community concerns, and the height floods can rise above ground level in the area.

Unless, the PMF is used as the basis for any FPL, a larger flood than the one used to determine the FPL, can always occur. The difference in flood levels, damages, and the area of inundation and the number of dwellings to be evacuated in the PMF event relative to the event, upon which the FPL is based, serves to alert Council to the upper limit of the costs and consequences of flooding.

**10.2.4 Floodplain Risk Management Plan**

A floodplain risk management plan is the formalisation of an effective floodplain management process. It is based on a comprehensive and detailed evaluation of all factors that affect and are affected by the use of flood prone land.

The floodplain risk management study & plan are integrally linked. The study provides the assessment of options that form the basis of considerations and decisions in the management plan.

The purpose of a management plan is to provide input into the strategic and statutory planning roles of Council. It does not, by intent, purport to be the only document relevant to development of flood prone land. The management plan provides the type of information necessary for adequate forward planning for flood prone flood.

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The advantage to both Council and the community in general of having a properly considered management plan in place include:

- Having proper basis for managing and using land to provide a balance between danger to personal safety and economic losses due to flooding, and social, ecological and cultural interests. This provides the current and future community best value from managing and using its floodplains;
- Optimising use of community infrastructure, such as roads, water supply & sewerage;
- Minimising personal danger to residents, visitors and emergency response personnel and community flood damage;
- Strategically assessing future developable land so its impacts of its development on flooding and the affects of flooding on the development can be effectively considered. This provides a sound basis for cooperating floodplain risk management outcomes in revising Council's EPI and development controls. It allows the community to grow in a responsible and socially cohesive fashion in consideration of flood issues. It also provides for increased certainty, from a flood perspective, for development applicant in line with the Gunnedah LEP requirements; and
- Having a basis for more timely assessment of development applications for flood prone land, especially were the Gunnedah LEP and DCP plans and policies have been altered, in light of the management plan, to incorporate appropriate zonings, and flood related development controls. Individual development applications

**10.2.5 Plan Implementation**

Management studies and plans provide an informed basis for decision making by Council to enable flood risk to be effectively managed to an acceptable and understood level.

The completion and adoption of a management plan does not manage flood risk. This relies on the implementation; this is a critical step in the management process.

Implementation is undertaken in accordance with a priority for management measures developed in the plan.

**10.2.6 Funding for Management Measures**

If Council seeks State Government Financial Assistance for implementation measures, it is required to provide the following advice which may be derived for the management study, as a minimum;

- Methods used to seek public comment and take account of submissions received
- Methods used to formulate a balanced, community acceptable management plan; and
- Details of environmental & cultural assessment of mitigation works and safeguards proposed to minimise any adverse impacts and maximise positive ecological opportunities. All proposed works are subject to environmental assessment under the Environmental Protection & Assessment Act.

**10.2.7 Review of Adopted Management Plan**

Review of the management plan should be triggered by the following instances:

- Time, review regularly, around every 5 years;
- After significant flood events which provide additional data on flood behaviour;
- Where significant changes occur to the factors influencing the decisions in the plan, including changes to local flood plans;
- Where impediments to implementation exist that warrant a review; and
- Where changes in future land use trends outside those considered in the management plan are proposed

This review should account for changes across the full range of issues originally addressed and consider any associated emergent issues.



**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 7****10.3 COMMENTARY****10.3.1 Exhibition and Submissions**

The Blackjack Creek Floodplain Risk Management Study & Draft Plan was placed on public exhibition from 6 January 2011 to 4 February 2011. The document generated considerable public interest with 8 submissions received.

Prior to the expiry of the public exhibition period a discussion session was held with 60 residents of the area covered by the Study and Draft Plan. Various issues and concerns were raised having regard to insurance, property values, planning certificates, flood data, location of mitigation works and structures as well as general maintenance issues.

A request was subsequently received for more time to make submissions to the Study and Draft Plan. Consequently an extension to Friday 18 February 2011 was granted.

The extension of the public exhibition period was reported to the February Ordinary Meeting where Council resolved to endorse the extension. The extension of the exhibition period saw a further 95 submissions received.

The submissions received outlined a number of issues and concerns with the Study and Draft Plan. Key issues raised include:

- Opposition to classification as Flood Liable Land
- Flood related development controls and the impact on existing and future development within the area
- Notations on S149 Planning Certificates
- Impacts upon land values
- Cleaning out of creek similar to that of Ashford's Watercourse
- Impact on Insurance Premiums
- Impact of the golf course dams during flood events
- Car bodies buried within the creek and their influence during the 1984 flood event
- Location of channel/riparian corridor
- Subdivision and development of Mornington Estate and rural residential areas within the Blackjack creek Catchment and the influence on flooding
- Discrepancies in baseline data and floor levels.
- Ecological impact of the proposed mitigation option
- No notification that properties may be located in flood liable land prior to the preparation and exhibition of the Study & Draft Plan
- The impact of proposed mitigation option/s upon Gunnedah Lawn Cemetery, Funeral Home & Crematorium and the Namoi Valley Brick Works.

A copy of the submissions was sent to Councillors for their information and review.

Further correspondence took place following the public exhibition period between Council, members of the community and the Residents Against Blackjack Creek Floodplain Management Plan Lobby Group. The issues raised and information sought has been responded to by Council.

As a consequence of the number of submissions received during the public exhibition period and subsequent correspondence with community members a second discussion session was held at Council's Administration building on 28 March 2011. The discussion session was attended by Mr. Scott Button of Lyall & Associates Consulting Water Engineers, Councillors, DECCW Staff, SES, Floodplain Management Committee, Gunnedah Shire Council technical staff, members of the Lobby Group – Residents Against Blackjack Creek Floodplain Management Plan and the Floodplain Management Committee nominees.

The meeting addressed a number of community concerns and gave the opportunity to discuss the Draft Plan with the consultant, DECCW Officers and Council Officers.

**FLOODPLAIN MANAGEMENT COMMITTEE REPORT – Page 8****10.3.2 Consultant's Response**

Lyall & Associates Consulting Water Engineers reviewed the submissions and have provided the following response:

**10.3.2.1 Preamble**

*Our comments on the various submissions by the public are set out below. In general we have restricted our responses to addressing technical issues associated with the Flood Study, 2005 and the draft Floodplain Risk Management Study, 2011.*

*These studies were jointly sponsored by Council and Department of Environment, Climate Change and Water and were undertaken in accordance with the State Government's Flood Prone Land Policy, following procedures set out in the Floodplain Development Manual, 2005. The studies were undertaken under the direction of the Floodplain Management Committee which comprised Government, Council and local representatives and involved Community Consultation.*

*The objective was to prepare a Management Plan for the Blackjack Creek floodplain so that future development may be undertaken in recognition of the flood risk.*

*The study focussed on mainstream flooding from Blackjack Creek. The creek is fed by a catchment of 24 km<sup>2</sup> which extends into the rural areas about 3.5 km to the south of Lincoln Street.*

*Contributions to flow from the residential area to the east of Wandobah Road were included in our assessment of total flows on Blackjack Creek. However, the solution of problems arising from surcharges of the local piped stormwater drainage system in that area was outside the scope of this study. Accordingly, we have not addressed issues relating to the conditions imposed by Council on recent sub-division developments in the residential area on the eastern side of Wandobah Road. We understand that Council has provided separate advice to respondents on that issue.*

**10.3.2.2 Response to Letter of 14 February 2011  
(Received From 57 Respondents)**

*This letter expresses the concern that there will be a re-zoning of the residential land on the eastern floodplain resulting from the study. There is no intention to re-zone the land. In accordance with the Government's Flood Prone Land Policy it is intended that land subject to inundation from mainstream flooding from Blackjack Creek up to the 1 in 100 year magnitude will be identified as such and will be subject to flood related development controls.*

*The controls are not onerous and will not preclude future development in the area to the east of Wandobah Road. They require a minimum floor level for future developments equal to the 100 year flood level plus an allowance of 500 mm freeboard. In addition properties lying within the extent of the Flood Planning Area (the area inundated by 1 in 100 year flood plus the 500 mm freeboard allowance) will be identified as subject to flood related development controls on S149 Certificates. This will allow the existing flood risk to be identified to both existing and future occupiers of the floodplain and is in accordance with the merits-based approach to floodplain management set out in the Floodplain Development Manual, 2005. Council is obliged to conform with this approach.*

*Under the Government's policy it is not possible for Council to remove flood affectation notices from S149 Certificates, once the land is identified as flood prone at the 1 in 100 year level, unless the lands are subsequently rendered flood-free by future flood mitigation measures.*

*The draft Floodplain Management Study identifies two alternative measures which could achieve this objective. Future studies aimed at determining their feasibility so that they may qualify for Government funding assistance are included in the draft Management Plan.*

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*The alternative schemes are:*

- *A Riparian Corridor/Channel Improvement Scheme running along the length of Blackjack Creek from downstream of Lincoln Street to the Oxley Highway, or*
- *A flood protection levee running along the eastern bank of Blackjack Creek.*

*A preliminary design concept for each alternative scheme has been included in the Floodplain Risk Management Study report, which could be developed in the feasibility studies. Once the draft Floodplain Risk Management Study and Plan have been adopted, Council will be in a position to apply for government funding assistance to advance these measures.*

*10.3.2.3 Letter from Slater and Gordon Solicitors on Behalf of Margaret Doreen Smith of Balmoral, Gunnedah*

*The route of the Riparian Corridor/Improved Channel and the channel dimensions shown on Figure 3.1 of the draft Report are indicative only. The Floodplain Risk Management Study is a strategy study, the purpose of which is to identify and compare the relative merits of alternative flood management measures. It provides indicative sizes of scheme components which are gradually refined in later, more detailed studies, once the strategy for managing the flooding problems have been agreed to by Council's adopting the Floodplain Risk Management Plan.*

*A feasibility study (which would include a Community Consultation component so that residents would have the opportunity to comment on the proposal) is included in the draft Plan as a project – ref. Measure 4 of Table S.2.*

*The Feasibility Study would take into account all of the issues raised in this letter, including:*

- *Incorporation of the existing farm water storages into the design.*
- *Maintenance of access to the property and continuation of existing services.*
- *A program of maintenance of the scheme by Council to ensure that it continues to function at its design hydraulic capacity.*
- *Issues regarding the taking of easements over the channel route.*

*10.3.2.4 Letter Dated 22 February 2011 from Jane Bender on Behalf of Residents Against The Blackjack Creek Floodplain Risk Management Plan. Reference is Made to the Numbered Paragraphs of this Letter as Follows:*

*Paragraph 1. In our opinion, the presence of flood debris and local obstructions in the channel, as was claimed in the letter to have occurred during the January 1984 flood, are not valid arguments for rejecting this major flood event for the purposes of testing the flood models developed for the Blackjack Creek Flood Study, 2005.*

*If major historic flood events were rejected on this basis, no model testing would be carried out for any flood. Each flood has its own peculiar characteristics such as intensity and area distribution of rainfall over the catchment, contemporary conditions in the catchment, stream channels and floodplain, etc, which are taken into account by investigators when testing their models, to the extent that data are available.*

*In the case of Blackjack Creek, under major flood conditions the channel conveys less than 50 per cent of the total flow generated by the catchment. Most of the flow is conveyed across the floodplain, which includes the residential area to the east of Wandobah Road as well as the undeveloped area on the western side of the channel. Consequently, in our opinion obstructions such as the car bodies noted in the letter would have had only a localised and minor effect on flooding patterns.*

*The January 1984 flood was used in the Flood Study, 2005 to test the ability of the models to reproduce observed flood conditions. On the basis of recorded rainfall intensities the storm was a major event; around 1 in 50 year return period. Therefore to ignore its occurrence would not have been justified.*

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*In regard to the inadequacies in the local piped stormwater and overflow of the Golf Course dam identified in the letter, our opinion is that these occurrences may have the potential to cause nuisance flooding in allotments and overland flows in the street system as the local catchment flow is conveyed with the prevailing grade towards the creek. However, the flood levels and extents of inundation identified in the study occur as a result of intense storms on the whole of the Blackjack Creek catchment. The catchment has an area of 24 km<sup>2</sup> upstream of the Oxley Highway culverts and extends into the hills for a distance of over 3.5 km to the south of Lincoln Street.*

*As noted in the Summary Section S1 at the front of the report, the study focuses on mainstream flooding from Blackjack Creek. The solution of problems arising from surcharges of the local piped stormwater drainage system in the area east of Wandobah Road are outside the scope of this study.*

*However, as the residential area on the eastern side of Wandobah Road is part of the overall catchment it was included as several sub-catchment areas of the overall hydrologic model of the Blackjack Creek catchment. During catchment-wide flooding, because it is located near the downstream end of the catchment, runoff from the residential area would usually be discharged to the creek prior to the arrival of the main body of floodwaters from upstream. Consequently, as shown by the modelling, it would be expected that the peak discharge in the creek would not greatly increase over the reach from Lincoln Street to the Oxley Highway culverts.*

*Paragraphs 2, 3 The Consultants were not responsible for notifying residents after the preparation of the Flood Study, 2005. We understand however that the report was exhibited to the public after its completion and that no responses were received.*

*Paragraphs 4, 5, 6. These queries relate to the local stormwater system, which as mentioned were outside the scope of the investigation. We understand that Council has addressed them in separate correspondence.*

**10.3.2.5 Letter Dated 6 March 2011 from Jane Bender on Behalf of Residents Against the  
Blackjack Creek Floodplain Management Plan**

*We have no knowledge of the “remedial flood mitigation works” noted in the letter as having been carried out by Council which have altered the course and structure of Blackjack Creek. We understand from the letter that they may have been carried out in the channel. As noted previously, most of the flow during major flood events is conveyed on the floodplain. Consequently, the works may not have had the effect on flow patterns claimed in the letter. However, we would be pleased to provide an opinion on the likely impacts of the works if their location and extent could be identified by the respondents.*

*In regard to the comment on the validity of the flood levels and flow patterns computed in the Flood Study, 2005, we note that the study report and its findings were reviewed by DECCW following the completion of the investigation. No technical issues were raised by DECCW on the results of the investigation.*

*In regard to the comment on the flooding of the Namoi Valley Brick Works in the 1955 Namoi Valley flood, we note that whilst Namoi River flooding may influence 100 year flood levels downstream of the Oxley Highway, Blackjack Creek controls 100 year flooding upstream of that location. Our understanding is that the problems referred to in the letter were caused by rising groundwater levels due to infiltration of rainfall into the soil following a prolonged wet period and were not caused by surface runoff in Blackjack Creek. Namoi Brickworks has provided a response to the draft Floodplain Risk Management Study dated 31 January 2011 (see below) which describes the nature of the rising groundwater tables experienced in periods of heavy rainfalls.*

*The 1955 flood was not used as a “reference tool” in the Flood Study, 2005 as claimed in the letter. Section 2.2 of the report notes that while the February 1955 rainfalls may have resulted in major flooding in the Namoi Valley, local falls on Blackjack Creek were less severe than in the overall valley wide catchment and were only around the 1 in 10 year return period. On the Blackjack Creek catchment, rainfall intensities in January 1984 were much more severe than in*

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*February 1955 and consequently, modelling of the former event was of greater value when testing the models developed in the study.*

**10.3.2.6 Letter Dated 31 January 2011 from Namoi Valley Brickworks Pty Ltd**

*This letter describes the reaction of the underground water table to high rainfalls. It notes that rises of several metres can be experienced resulting in flooding problems in the kiln tunnels. The most recent experience of flooding from this source was in December 2010, when pumping was required to control groundwater levels.*

*A minor fresh was experienced in Blackjack Creek during this period which resulted in bank full conditions in the channel. It appears that in addition to groundwater levels rising as a result of infiltration of rainfall, there may also be a sub-surface hydraulic connection between the channel and the area occupied by the Brickworks. The method presently adopted by the Brickworks to mitigate the problem, namely bunding and pumping appears to be an appropriate solution, as the problem is groundwater related rather than one of surface runoff.*

*On the basis of mapping currently available to us, the property is outside the extent of the 1 in 100 year flood and is therefore on an area we have termed the "outer floodplain". There may be a local reduction in flood levels in the floodplain if the Riparian Corridor/Improved Channel scheme were implemented, which, given the hydraulic connection mentioned above, may provide a mitigating effect on ground water levels at the Brickworks.*

**10.3.2.7 Letter Dated 30 January 2011 from Lightfoot and Co. Gunnedah**

*This letter refers to flooding problems experienced at the Memorial Park Lawn Cemetery where sandbagging was required to prevent inundation during recent flooding. The letter expresses concerns about the potential of the flood protection levee to increase upstream flood levels at the property.*

*From our initial modelling of this proposal the development appears to be upstream of influences of the levee. The Riparian Corridor/Channel Improvement scheme was the preferred scheme in the draft study report. This scheme has the advantage of providing substantial reductions in flood levels along its extent which may continue upstream of Lincoln Street. However, if the levee were adopted as the preferred scheme it would be necessary in the design to ensure that flooding conditions in existing developments were not exacerbated by rises in flood levels.*

*Unfortunately, during the course of preparing the draft study it was not possible to develop a community scheme which could provide protection to the property. The area may be amenable to protection by earth bunds provided aesthetic constraints and the problem of disposing of runoff generated by rain falling within the protected area could be resolved. However it is likely that they would have to be privately funded.*

*In regard to possible increases in runoff resulting from developments we note that management of local stormwater from such developments is a matter for comment by Council.*

**10.3.3 Potential Improvement Works**

The submissions received did generally identify that the proposed Channel Reconstruction/Riparian Corridor was overall the favoured option. The 'cleaning out of the Blackjack Creek' was also raised in a large number of submissions however this was not defined in the flood mitigation context.

At its March Meeting Council resolved that the General Manager, as a matter of priority, undertake the following:

- a. Present to Council fully costed options for clearing out of Blackjack Creek including stormwater outlets;
- b. Ensure the options include potential funding sources from the current budget as well as potential allocations in the 2011/2012 Management Plan; and

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- c. Provide advise to Council as to the possibility of expending Council's contribution to any flood mitigation works in the Blackjack Creek area as a result of the final adoption of the Blackjack Floodplain Risk Management Study & Draft Plan

The requested report will be considered by Council at its meeting on 20 April 2011.

It should be noted that funding from the State Governments to undertake flood mitigation works cannot be secured retrospectively.

**10.3.4 Agency Appraisal**

DECCW has raised a number of points which should be considered.

1. *Council may wish to consider in their decision making process an alternative option if during the feasibility/detail design stage the preferred option, being the Channel Improvement, does not satisfy either environmental, technical or economic standards. It is understood that this may cause additional community concern however the Benefit/Cost analysis shows that there is not one option that is significantly better than some others*
2. *We consider that there should be further analysis/checking of the following to clarify the issues –*
  - *A check on the flood levels at Jane Bender's house which she says is high, and how it would compare with the 1984 flood level*
  - *1984 flood levels – are there any other levels or extents to confirm the 1984 flood, including known houses flooded above floor*
  - *2008 flood levels and extents and houses flooded*
  - *Analysis of the possible effects of the car bodies at their claimed location in the 1984 flood to show that there was significant overbank flow and minimal effect on the overall flow pattern (or otherwise if that is the case). Maybe the same for the debris/fill which it is claimed has been dumped in the creek area. It is expected that these would have minimal impact on major flood levels and should be looked at to be able to answer those claims.*
  - *These would give greater clarification of known flood extents and show how much flooding we have already seen, and confirm the modelling outcomes.*

**10.3.4.1 Consultant's Response**

Lyall & Associates provided the following response to the issues raised by DECCW.

*Issue 1: Our preliminary conclusion from the FRMS work is that the Riparian Corridor is the superior solution. In a pure economic sense, there is not much difference in benefit/cost between the Corridor and the levee. We felt that there were greater uncertainties with the levee, however, including the issues of how to discharge the local runoff from the residential area, as well as environmental constraints (loss of views of the creek from the residential area east of Wandobah Road etc). Hence we proposed a feasibility study and community consultation to confirm the riparian corridor. The report states that if the riparian corridor proves infeasible, then the levee could be considered as an alternative. So there is no inconsistency with DECCWs suggestion.*

*Issue 2: Council supplied us with the data on flooding patterns in Blackjack Creek for the January 1984 flood used in the 2005 Flood Study. The most important data were the peak level experienced at the Oxley Highway Bridge and the fact that the culverts were overtopped. Council also advised that the floodplain east of Wandobah Road had been inundated by breakouts from the creek. Our results were in agreement with Council's observations.*

*In regard to the comment on the 2008 flood, our analysis of the Gunnedah pluviograph data suggests that if these rainfalls had been experienced over the Blackjack Creek catchment, then they would have resulted in rainfalls between 10 and 20 year ARI. However we are making no comment about flood flows in the creek for that storm. Flood flows would depend on whether the recorded rainfall intensities were actually experienced over the catchment, as well as antecedent rainfall conditions, etc. Modeling of the 2008 event to allow a response to DECCWs comments would involve data collection plus modeling.*

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*Similarly, in regard to impacts of the car bodies and fill we are presently unable to quantitatively assess their likely impacts without further analysis. The modeling would require some creek cross sectional survey at their locations, plus runs with the channel blocked/unblocked.*

*10.3.4.2 Director Infrastructure Services' Response*

Further to the response from Lyall & Associates, Council's Director of Infrastructure Services, Mr. Wayne Kerr provided the following response.

*The concrete debris fill as referenced in Mrs Bender's concerns at the most recent public meeting were undertaken well before my engagement with Council. I am unaware of the extent of debris fill but don't believe it was extensive as the bed appears more soil than concrete.*

*I did advise the use of small amounts of road base during my time to fill channelling ruts in the bottom mown portion of the channel to permit grassing across the bed for tractor slashing but these were quite small amounts that wouldn't have influenced any drainage modelling. It involved a couple of loads of fill across some of the tracks across the watercourse (maybe 2 or 3 tracks) in the length of the watercourse.*

*With regards to Point 1 I suspect the benefit/cost ratio of the channel would far exceed those of the levee which will create self flooding opportunities of the residential area below the golf course. These were well outside the scope of the Study and the study area. Any conclusions would be quite subjective without detailed survey and runoff re-routing due to fencing between properties. I therefore believe that Riparian Corridor Channel Reconstruction is the clear benefit/cost ratio winner and I'm led to believe has the greater community support. The environmental considerations of the Study will be onerous but technically achievable even if the channel has to be designed to be three times as wide and shallower than the design in the draft Plan.*

*10.3.4.3 Floor Level Survey*

The surveyed floor levels at 4 Kilcoy Street have been confirmed by Council's Development Engineer and where cross referenced against 6 Kilcoy Street and 28 Wandobah Road. Floor levels were benchmarked off State Survey Mark 15154 (located corner of King Street and George Street). The survey levels established by Stewart Surveys are correct.

**10.3.5 Planning Certificates – Section 149, Environmental Planning & Assessment Act 1979**

In respect of Section 149 certificates Council has sought legal advice from Mallik Rees Solicitors, Environmental Law Specialist of Cessnock. The advice has sought clarification of responses in s149 (2) and s149 (5) certificates to Flood Related Development Controls as well as future responses on certificates under section 149 having regard to the new Gunnedah Local Environmental Plan and the new standard flood.

The advice will be considered by Council at its meeting on Wednesday 20 April 2011.

**10.3.6 Environmental Considerations**

A number of submissions highlighted a variety of environmental issues and impact. These matters are more properly addressed in a Design Concept Study. This is a recommendation within the draft plan.

**10.4 Exemption of Liability**

The committee should be aware of Section 733 of the Local Government Act which provides Council with an indemnity for, inter alia, any information it provides if the information is given in good faith. The relevant parts of the section regarding advice relating to flood prone lands are as follows:

**733 Exemption from liability – flood liable land, land subject to risk of bush fire and land in coastal zone**

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1. *A council does not incur any liability in respect of:*
  - (a) *any advice furnished in good faith by the council relating to the likelihood of any land being flooded or the nature or extent of any such flooding, or*
  - (b) *anything done or omitted to be done in good faith by the council in so far as it relates to the likelihood of land being flooded or the nature or extent of any such flooding.*
2. . . .
- 2A. . . .
3. *Without limiting subsections (1), (2) and (2A), those subsections apply to:*
  - (a) *the preparation or making of an environmental planning instrument, including a planning proposal for the proposed environmental planning instrument, or a development control plan, or the granting or refusal of consent to a development application, or the determination of an application for a complying development certificate, under the Environmental Planning and Assessment Act 1979, and*
  - (b) . . ., and
  - (c) *the imposition of any condition in relation to an application referred to in paragraph (a), and*
  - (d) *advice furnished in a certificate under section 149 of the Environmental Planning and Assessment Act 1979, and*
  - (e) *the carrying out of flood mitigation works, and*
  - (f) . . ., and
  - (f1) . . ., and
  - (f2) . . ., and
  - (f3) *the failure to upgrade flood mitigation works or coastal management works in response to projected or actual impacts of climate change, and*
  - (f4) . . ., and
  - (f5) *the provision of information relating to climate change or sea level rise, and*
  - (f6) . . ., and
  - (g) *any other thing done or omitted to be done in the exercise of a Council's functions under this or any other Act.*
- (4) *Without limiting any other circumstances in which a council may have acted in good faith, a council is, unless the contrary is proved, taken to have acted in good faith for the purposes of this section if the advice was furnished, or the thing was done or omitted to be done, substantially in accordance with the principles contained in the relevant manual most recently notified under subsection (5) at that time.*
- (5) *For the purposes of this section, the Minister for Planning may, from time to time, give notification in the Gazette of the publication of:*
  - (a) *a manual relating to the management of flood liable land, or*
  - (b) . . .



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(c) . . .

*The notification must specify where and when copies of the manual may be inspected.*

(6) *A copy of the manual must be available for public inspection, free of charge, at the office of the council during ordinary office hours.*

(7) *This section applies to and in respect of:*

(a) *the Crown, a statutory body representing the Crown and a public or local authority constituted by or under any Act, and*

(b) *a councillor or employee of a council or any such body or authority, and*

(c) *a public servant, and*

(d) *a person acting under the direction of a council or of the Crown or any such body or authority,*

*In the same way as it applies to and in respect of a council.*

(8) *In this section:*

. . .

. . .

**manual** *includes guidelines.*

In relation to the abovementioned “manual”, this is a reference to the “Floodplain Development Manual – the management of flood liable land” released by the New South Wales Department of Infrastructure, Planning and Natural Resources in April 2005.

In terms of the adoption of the Blackjack Creek Floodplain Management Plan, the Committee in making a recommendation to Council needs to be conscious of the provisions of Section 733.

Accordingly, the Committee needs to be aware that whilst there is no problem with Council not proceeding with the mitigation work, as that is dependent upon Council's finances, a problem would arise if Council does not adopt a Development Control Plan to control development in the flood plain, as then it could be said that Council did not act in good faith so as to invoke the indemnity under Section 733 of the Local Government Act. If Council determines not to do the mitigation work for whatever reason then Council should at least consider adopting the study by drafting a Development Control Plan to limit development in the area the subject of flooding in the absence of the flood mitigation work.

Should limitations be adopted in a Development Control Plan, notation of such would be necessary in planning certificates under Section 149 of the Environmental Planning & Assessment Act 1979.

The issue of maintenance of the Flood Planning Level of 100 year ARI and 500 millimetres is a matter to be considered by Council post completion of the flood mitigation works. Council will be considering legal advice on this issue at its meeting on 20 April 2011. Any action in this regard must be done in accordance with the Flood Planning Manual in order for Council to be entitled to the indemnity under Section 733 of the Act. Formal advice in respect of this issue will also be sourced from DECCW and the Department of Planning prior to Council determining this issue.

## **10.5 Draft Floodplain Risk Management Plan Recommendations**

The Draft Floodplain Risk Management Plan recommends that flood modification measures are the most effective option to mitigate against the flooding of Blackjack creek. The riparian corridor/channel reconstruction should be adopted as the most appropriate floodplain

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management option. This option was weighted against all other options and the most economical, environmentally and socially effective measure of mitigating the impact of flooding in the Blackjack Creek floodplain. A Concept Design Study is recommended as first priority in the implementation phase of the management plan.

The Study incorporates:

- Engineers design
- Environmental approval
- Environmental assessment
- Economic assessment
- Further hydraulic analysis
- Further survey data

The levee scheme was also considered in the draft plan. This option has not been favoured due to the difficulties of dealing with stormwater issues and the aesthetic influence of such a structure and therefore should only be considered in the event that the riparian corridor/channel reconstruction is deemed to be unfeasible.

Property modification measures are proposed to supplement the flood modification measures. Building and development controls would involve the imposition of measures aimed at flood proofing future developments including:

- Minimum habitable floor levels for residential, commercial & industrial including appropriate freeboard provision
- Appropriate flood compatible building materials
- Egress routes from buildings.

The floodplain of Blackjack Creek has been divided into four zones according to the level of the flood risk.

- Floodway - The Policy considers that new development is an unsuitable use for land which is located in the Floodway.
- Intermediate Floodplain – In this zone there would still be a significant risk of flood damages, but these damages may be minimised by the application of appropriate development controls.
- Flood Fringe – In this zone the risk of damages is low and no flood related controls would apply to residential development, apart from the minimum floor level requirements.
- Outer Floodplain – There would be no flood related development controls for residential and commercial and industrial development in this zone, although Council would check proposed floor levels to ensure they were above the Flood Planning Level.

The Floodplain Development Manual requires the minimum floor level (Flood Planning Level) for new residential development to be equal to the 100 year ARI flood, plus an allowance of 500 mm for freeboard.

## **10.6 CONCLUSION**

The Blackjack Creek Floodplain Risk Management Study and Draft Plan has been prepared by Lyall & Associates Consulting Water Engineers in accordance with the Floodplain Development Manual. It identifies the issue of flooding on the Blackjack Creek Floodplain and proposes to implement flood modification measures, property modification measures and response medication measures to alleviate the impact of current and future flooding within the study area.

The Study has assessed each of the flood control measures against each other using a cost benefit analysis. The cost benefit analysis shows the riparian corridor/channel reconstruction as the most suitable option with use of property modification and response modification measures as support. This will be subject to a Concept Design Study and as such the levee option should be retained as a second option.

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It should be noted that the riparian corridor/channel improvements will assist Council being able to effectively deal with stormwater issues in the urban area.

**Committee Deliberations**

The Director Planning & Environmental Services advised that Council had received a report and responses from the Consultants, Lyall & Associates Consulting Water Engineers and he invited Mr Scott Button from the company to expand further.

Mr Button advised that the final report and responses had addressed the issues that were raised during the exhibition period and through submissions but that issues relating to Council imposed conditions on recent subdivisions in the area were not addressed.

The Director Planning & Environmental Services said that the recommendation proposes the adoption of the Blackjack Creek Floodplain Management Plan and course of action as per the exhibited document. He noted that the mitigation works would have to undergo a Concept Design Study, but he said that this is also contained in the recommendation.

Mr Silver referred to the Section 149 certificate issue and reported that Council has sought legal advice with the matter to be considered at the Council meeting on 20 April 2011. He stressed that although there is a relationship between the Blackjack Creek Floodplain Risk Management Study and Draft Plan and the Section 149 certificates, they are in fact two separate matters. He stated that the Section 149 certificates involve Council acting in an appropriate manner and in accordance with Section 733 of the Local Government Act to ensure indemnity.

The Director Planning & Environmental Services advised that should the Floodplain Risk Management Plan be adopted by Council that a Development Control Plan would then be necessary to outline the flood related development controls. This would result in a notation being made on Section 149 certificates. Mr Silver stated that the reality is that should the Plan be adopted and Council proceeded to seek funding to undertake the mitigation works, it could take 3-5 years to complete the works. He indicated that in the interim period there would need to be a response on Section 149(2) certificates to the effect that a DCP provides flood related development controls. This response would be maintained whilst ever the mitigation works are uncompleted.

The Director Planning & Environmental Services stated that Council is aware that a flood study was done in 2005 and Council needs to ensure it acts in a responsible manner in releasing that information, particularly in relation to Section 733 of the Local Government Act.

The Director Planning & Environmental Services explained that the process to be followed would involve Council endorsing an amendment to the current Development Control Plan to include the Blackjack Creek Floodplain Risk Management Plan, making application for funding in the 2012 funding round for the Concept Design Study and allocation of Council's proportion of funds in its management plan to undertake the study.

Mr Button explained that the response provided by the consultants was limited to the technical nature of the 2005 Flood Study and reference to the 1984 flood was used to test the models and reproduce observed flood conditions. He commented on the debris during the 1984 flood, stating that every flood is different and will carry different degrees of debris which could have a localised impact. The evidence indicates that during a major flood event, inundation of residences would occur and the extent of the inundation is fairly well known. Mr Button said the 1984 flood was a benchmark flood approaching the 1 in 100 year event for which planning controls were proposed and nothing that had been said by residents would lead the consultants to revise their assessment.

The Chairman opened the meeting to committee members for discussion.

Mr Finlay advised that he would be abstaining from voting as he was awaiting legal advice. He said that not a lot of the residents were asked about the affects of flooding on individual properties and although the DPES says that the Blackjack Creek Plan and the Section 149 Certificates are separate issues, they are tied together. Mr Finlay said that the residents have not come to a satisfactory solution with Council. He said he was speaking for all the residents and he believes that until all residents are personally contacted no agreement can be reached.

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The Director Planning & Environmental Services replied that every effort had been made to notify residents, citing the distribution of about 180 questionnaires, the public exhibition period and further extension, a discussion session with residents and notification of this meeting to all persons who had made submissions.

The Chairman explained that no provision had been made for representations from the public at this committee meeting.

Mr Finlay said that probably about half of the affected residents/owners have not been contacted and many probably don't realise what affect the changes will have on their investment. He said that until those people can be contacted he won't be accepting anything.

The Director Planning & Environmental Services said that the Flood Study and the subsequent analysis have been endorsed by the Office of Environment & Heritage and the methodology which has been used has been approved by the NSW Government and is in accordance with the NSW Floodplain Development Manual. Mr Silver encouraged residents to go to the website and read the Manual as it clearly sets out the obligations and liability of local government and how floodplain matters should be dealt with. Mr Silver said he was satisfied with the notification process but if the Committee wishes, the outcomes of this meeting can be provided to all affected residents.

The Chairman asked the Director Planning & Environmental Services to read the recommendations. Mr Silver read the recommendations and then drew the Committee's attention to a paragraph on page 15 of his report:

*... whilst there is no problem with Council not proceeding with the mitigation work, as that is dependent upon Council's finances, a problem would arise if Council does not adopt a Development Control Plan to control development in the flood plain, as then it could be said that Council did not act in good faith so as to invoke the indemnity under Section 733 of the Local Government Act.*

Mr Finlay said it's all very well to talk about good faith but the residents haven't seen much of that as far as this Floodplain Management Committee is concerned. He queried why Council would allow additional homes to be built up stream without proper stormwater provision, particularly when it has known about these flooding issues for so long.

The Director Planning & Environmental Services replied that the matter of additional dwellings is addressed in the determination of individual subdivision developments. He also indicated that there are differences between urban and rural residential subdivisions, particularly in respect of the sparseness of dwellings. He said that in the case of the Mornington Heights estate it was a condition of consent that detention basin works be undertaken, with the detention basin designed to manage a 100 year storm event in the sub-catchment and consequently mitigate discharges in that sub-catchment.

Mr Finlay stated that there should be proper stormwater runoff infrastructure and said that Council should have responsibility to control the flow of water to the river without detriment to residents. He asked what has happened to all the funding Council has received for stormwater from developers.

The Director Planning & Environmental Services replied that stormwater headworks funding in the Mornington Heights estate has been devoted to works associated with the detention basin. He said the works at the end of Wattle Street take in a catchment of 1.5 sq km with the lower levels of the catchment discharging to Blackjack Creek. These controlled works will control the runoff on that sub-catchment in a 100 year event. Accordingly, the net result is there is no detrimental impact from that subdivision on Blackjack Creek.

Mr Finlay said that the consultants didn't take into consideration water that's been diverted to Blackjack Creek from other developments. He queried the existence of the big channel at the back of Hinton Drive, saying it was a deliberate diversion which Lyall and Associates did not include in their assessment.

The Director Infrastructure Services acknowledged that the channel was an outflow channel from the constructed detention basin and said that water would naturally have found its way into Blackjack Creek probably somewhere around George Street not near the railway line as alleged.

Mr Finlay said that if Council is diverting water at the top, the residents are getting everything in the residential area.

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The Director Planning & Environmental Services said he understood the concerns of residents but what is important is acknowledgement that the creek does flood and if the creek floods then works need to be done to mitigate that problem. The most important thing is to protect residential property. Mr Silver said if funding doesn't occur either Council doesn't do the work or it finds the funds totally from its own resources. However, it will take time to achieve that – probably 3-5 years. Mr Silver cautioned that if the works aren't done the risk still continues to people in that area; the Plan needs to be adopted and enacted otherwise the flood risk continues.

The Chairman asked at what stage will residents have further input particularly into the alignment of any channel improvements.

The Director Planning & Environmental Services said the exact design of the riparian channel improvements has not been determined with what is in the study being indicative. He said that once the Concept Design Study is undertaken locations will be determined and Council will then undertake negotiations with landholders. He said it should be noted that the current LEP and the one before it (gazetted in 1986), identified the private land through which Blackjack Creek flows as "future open space" so there is nothing untoward or secretive happening. He said that the purpose of the zoning was to identify that the land may be required at some time in the future for improvements to Blackjack Creek.

Mr Button reiterated that the consultant's report was based on the 2005 Flood Study but if there has been a diversion by debris or car bodies as suggested, then the Concept Design Study would take this into account and adjust the size of the channel to ensure optimum outcomes are achieved.

Mr Finlay expressed concerns that the levels would be higher than those indicated by the consultants because their assessment had not taken into account the water being added from the diversions.

Mr Button replied that due to the size of the Blackjack Creek catchment (24 square kilometres); any minor diversion would not have a great impact on levels but would nevertheless need to be considered during the design stage.

Mr Bernays said he sympathised with the residents of the area and the concern over Section 149 certificates but said that Council has to make a start and get it on the road to alleviate the risk of flooding.

**RECOMMENDATIONS:**

1. That Council adopt the Blackjack Creek Floodplain Management Plan with respect to the following measures:
  - 1.1 Flood Modification Measures – Riparian Corridor/Channel Reconstruction. A Concept Design Study will be the first priority in the implementation of the flood modification measures. In the event that this option is not considered economically or environmentally feasible the option of the Levee Scheme shall be investigated.
  - 1.2 Property Modification Measures shall supplement the flood modification measures through the imposition of measures aimed at flood proofing future developments including:
    - Minimum floor levels for residential, commercial & industrial development including appropriate freeboard provision
    - Use of appropriate flood compatible building materials
    - Incorporation of egress routes from buildings

A minimum floor level (Flood Planning Level) for new residential development equal to the 100 year ARI flood plus an allowance of 500mm for free board shall be applied.
  - 1.3 Response Modification Measures for:
    - Flood Warning & response
    - Flood Awareness

shall be initiated.
2. That Council amend its Development Control Plan – Principles of Development to incorporate the direction and actions established in the Blackjack Creek Floodplain Management Plan.
3. That Council make application for funding for the undertaking of the Riparian Corridor/Channel Reconstruction Concept Design from the NSW Floodplain Management Program and Council's

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contribution for the cost of the study being \$28,000 be included in the draft 2011-12 Management Plan.

*Committee Recommendation  
Moved Mr T Bernays, seconded Ms S Howett*

Mr L Finlay abstained from voting.

**11. GENERAL BUSINESS**

Nil

There being no further business the meeting closed 6.55 pm.

**Cr SF Benham  
CHAIRPERSON**