GEORGES PLAINS

FLOODPLAIN RISK MANAGEMENT PLAN

BATHURST REGIONAL COUNCIL

JANUARY 2008
The Georges Plains Floodplain Risk Management Plan has been prepared by Bathurst Regional Council and the Georges Plains Floodplain Management Committee and is a direct extract from the Georges Plains Risk Management Study prepared by Cardno Willing.

JANUARY 2008
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SUMMARY

The purpose of this Floodplain Risk Management Plan is to examine the flood liability and effects on flooding of the village of Georges Plains, near Bathurst, and to recommend floodplain management options.

History of Flooding

Georges Plains has a history of flooding from Georges Plains Creek, which runs through the village before joining Vale Creek. The Georges Plains Creek is potentially affected by backwater from the Vale Creek. Vale Creek is a tributary of the Macquarie River, which it joins at the railway bridge at Bathurst, however the flood levels in Vale Creek at Georges Plains are not affected by the Macquarie River.

Computer models have been set up in order to examine the flooding in more detail.

Hydrology

An XP-RAFTS computer model has been set up covering the entire Macquarie River catchment area. Storages were included to represent Oberon Dam and Chifley Dam.

Catchment boundaries were derived from the 1:25,000 scale topographic mapping.

Hydraulic Model

A quasi-2D branched XP-SWMM branched hydrodynamic model was previously set up for the Macquarie River floodplain from downstream of Eglinton to Perthville (on Vale Creek) and White Rock (on Macquarie River). The model has been regularly updated, and it was calibrated at Bathurst for the August 1998 flood.

The existing XP-SWMM hydraulic model was extended upstream to Georges Plains using additional survey data provided by Bathurst Regional Council. Flow estimates are derived from an XP-RAFTS hydrologic model. The model was verified against recorded flood levels at Georges Plains for the 1990 flood.

Existing Flood Conditions

The models were run for the 1%, 5%, 10% and 20% AEP floods as well as an extreme flood approximating the Probable Maximum Flood (PMF), and for a range of storm durations. Maps have been prepared showing the approximate extent and nature of flooding, and the hazard identified in terms of depth and velocity of floodwaters.

The modelling studies show that a total of 9 buildings would be flooded above floor level in the 1% AEP flood. The total damage at Georges Plains in this flood is estimated to be $162,000. The estimated Average Annual Damage is $22,000.
Floodplain Risk Management Options

Based on the nature of flooding as identified by modelling, and on the first round of community consultation, a range of suitable management options were identified for further assessment.

Options to reduce flood impacts on existing development

- Creek channel formalisation,
- Channel clearing,
- Clearing of debris at bridge,
- Levee banks, or
- Voluntary purchase.

Planning controls to ensure that new development is compatible with flood hazards

- Restrictions on rezoning of non-urban land.
- Minimum Floor levels for new development.

Actions to manage the ongoing flood risk

- Flood information,
- Flood warning,
- Improvements to access road from Bathurst

Other options such as detention basins on Georges Plains Creek were suggested, but are not considered to be a viable option due to cost and the lack of suitable land.

Three options to reduce flood impact on existing development were assessed. These options (Options 1 to 3) are described below.

The aim of Option 1 is to restore the capacity of Georges Plain Creek so that nuisance flooding of flood-prone properties in Georges Plain can be eliminated. It was apparent during the site inspection that the creek channel has been filled with deposited sediment and choked with vegetation including weeds. This has reduced the effective flow capacity.

The scope of works of Option 1 includes the clearing of creek vegetation, the clearing of debris under the bridge, and formalising of the irregular creek channel into a regular creek channel over a length of approximately 930 metres. The affected creek segment is shown in Figure 7 as a dark green line, commencing approximately 230 metres upstream of the Georges Plains bridge.

The aim of Option 2 is to create a levee on the left bank between nodes GP_230 and GP_220, upstream of the Rockley Road bridge, to block breakout onto the left overbank.
Option 3 is voluntary purchase of existing flood affected buildings. This option has no significant hydraulic impact. If existing buildings were to be purchased and demolished, there might be some minor redistribution of flood flows but it is not considered to be significant.

In addition to these options, which are structural in nature, details are provided in the report of recommended planning controls, and measures to manage the ongoing flood risk.

**Assessment of Options: - Options to reduce flood impacts on existing development**

The hydraulic effectiveness of proposed options 1 to 3 has been assessed using the computer models. The social and economic impact of these options has also been reviewed.

An indicative benefit-cost analysis was undertaken for Options 1 and 2. The total indicative cost of this work in 2007 dollars is $448,000. The benefit of the Option, based on modelling, was approximated as a lowering of flood levels in the 1%, 2%, 5% and 10% AEP by 0.2 metres in the vicinity of Georges Plains bridge. No reduction in flood levels was assumed for the 0.05% AEP flood or the PMF.

The calculated benefit-cost ratio of this option, assuming a 30 year life and 7% discount rate, is 0.15. This is a relatively low rate for floodplain management works. However, when other non-economic factors such as social and environmental factors are taken into account, the works can be justified.

The preliminary estimated cost of the levee option (Option 2) is $350,000. The calculated benefit-cost ratio of this option, assuming a 30 year life and 7% discount rate, is also 0.15. The option provides lesser protection to properties than Option 1 and therefore is not recommended.

Considerations for voluntary purchase of flood-liable properties typically include the degree of flood hazard, and the type and condition of the building. No economic analysis was done for Option 3. At Georges Plains, the property on the upstream side of the bridge is potentially suitable for voluntary purchase due to its high hazard rating. The old hotel on the downstream side may not be suitable because of the lower hazard and its historical value in the context of the village.

**Planning controls to ensure that new development is compatible with flood hazards**

**Actions to manage the ongoing flood risk**

No economic assessment has been undertaken for these options, including the proposal to remove low points in the road between Bathurst, Perthville and Georges Plains. The benefits of this work would extend beyond the area of Georges Plains village and include other rural and urban properties.

**Recommendations**

It is recommended that the Draft Floodplain Risk Management Plan set out overleaf be adopted for the village of Georges Plains.
<table>
<thead>
<tr>
<th>Action</th>
<th>Priority</th>
<th>Indicative Budget Cost Estimate</th>
<th>Social &amp; Environmental Impact</th>
<th>Cost-Benefit Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue debris removal program at road bridges</td>
<td>High</td>
<td>On-going</td>
<td>Positive – reduces risk of bridge waterway blockage</td>
<td>N/a</td>
</tr>
<tr>
<td>Undertake creek channel improvements along Georges Plains Creek (refer Figures 7 and 8)</td>
<td>High</td>
<td>$ 448,000</td>
<td>Positive – returns creek to a more natural state, removes sediment and weeds</td>
<td>0.15</td>
</tr>
<tr>
<td>Investigate voluntary purchase of High Hazard property</td>
<td>High</td>
<td>Range up to $250K</td>
<td>Existing property is in poor condition</td>
<td>N/a</td>
</tr>
<tr>
<td>Confirm and implement development controls as part of revised LEP</td>
<td>High</td>
<td>low – staff time</td>
<td>Ensure that limited development can occur while preventing an increase in flood risk.</td>
<td>N/a</td>
</tr>
<tr>
<td>Investigate extension of the existing Bathurst flood warning system to encompass Georges Plains and Perthville</td>
<td>High</td>
<td>Unknown</td>
<td>Positive. Builds on existing successful Bureau of Meteorology flood warning system</td>
<td>N/a</td>
</tr>
<tr>
<td>Prepare or update emergency management plan (DISPLAN) for Georges Plains</td>
<td>High</td>
<td>SES and Council staff time</td>
<td>Positive – ameliorate social and economic impact caused by flooding</td>
<td></td>
</tr>
<tr>
<td>Rectify low points in road between Bathurst, Perthville and Georges Plains</td>
<td>Medium, to tie in with road projects</td>
<td>up to $ 500,000</td>
<td>Positive - improves flood access</td>
<td>N/a</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

1.1 BACKGROUND

The village of Georges Plains is located approximately 13 km south-west of Bathurst on the Trunkey Road. The village is located on the left bank of Georges Plains Creek immediately upstream of its confluence with Vale Creek (also known as Queen Charlottes Vale Creek). Anecdotal evidence suggests that the village can be affected by floodwaters from both creeks. Flooding from Georges Plains Creek can be exacerbated by flood debris collecting on the road bridge.

Due to its proximity to Bathurst, Georges Plains is experiencing some development pressure. On this basis also, there is a need to review the applicability of the former Evans Shire Council policy "Evans Shire Council, Flood Policy" dated November 1998.

Georges Plains is a small community with a population of fewer than 100 people. Consistent with the size of the community, a flood scoping study was undertaken in 2003 ("Georges Plains & Sofala Flood Scoping Study, Final Report: Georges Plains", SMEC, December 2003).

At a public meeting to discuss the Georges Plains Flood Scoping Study a number of issues were raised as being of concern to the community:

- Loss of bridge waterway area due to vegetation trapping sand and silt.
- There is a view that enlarging the channel of Georges Plains Ck from the confluence with Queen Charlottes Vale Ck and the upstream end of the village would solve the flood problems
- There is a view that sand and gravel extraction from the streams at regular intervals will reduce flooding impacts.
- The planting of a belt of trees upstream of the bridge on the right bank is perceived as having the potential to direct floodwaters onto existing development.
- Residents living in the two most frequently flooded properties suffer considerable anxiety during heavy rain.

The study area for this study includes the whole of the area covered by the SMEC, 2003 report together with the Vale Creek floodplain downstream to the village of Perthville. The existing modelling was extended to cover the whole of the study area.

1.2 OBJECTIVES

The overall objective of the study is to develop a draft floodplain risk management plan for the study area that addresses the existing, future and continuing flood problems, in accordance with the NSW Government's Flood Policy, as detailed in the "Floodplain Development Manual: the management of flood liable land", New South Wales Government, April 2005. The study is being undertaken in two phases:
Phase 1 - Extensions to the existing modelling and a floodplain risk management study in which the floodplain management issues confronting the study area are assessed, management options investigated and recommendations made. The scope and detail of the investigations undertaken should be consistent with the size of the community, the relative magnitude of the flood problems and should concentrate on the major local issues.

Phase 2 - Draft floodplain risk management plan developed from the floodplain risk management study detailing how flood prone land within the study area is to be managed.

1.3 FLOODPLAIN RISK MANAGEMENT ISSUES

The following issues specific to Georges Plains were identified in the Brief.

- Loss of bridge waterway area due to vegetation trapping sand and silt.
- Enlarging the channel of Georges Plains Ck from the confluence with Queen Charlottes Vale Ck and the upstream end of the village as a floodplain management option.
- The impacts of sand and gravel extraction for commercial purposes (assumed to be minimising flooding impacts).
- Voluntary purchase of low lying properties as a floodplain management option
- The impact of the belt of trees upstream of the bridge on flooding.

In consultation with the local NSW SES, the study is to identify which emergency management issues would assist the community in being prepared for flood events. This should include flood intelligence, information forecasting, flood warning etc.

- Identify specific guidelines for new release areas, major rezoning as subdivisions, including lot sizes, allowable fill, building and development controls, section 94 plans etc.
- Identify specific flood mitigation options available.
2. EXISTING FLOOD CONDITIONS

2.1 FLOOD BEHAVIOUR

Figure 1 gives a schematic indication of the behaviour of the 1% AEP flood. The main flow directions are, as expected, along the channels of Georges Plains Creek (from node GP_CK3) and Vale Creek (from node GEORGES). The modelling indicates that significant flow bypasses the road bridge to enter the village at node GP_220 from where it flows down Tracey Street towards the low point at the corner of Victoria Street (node GP_210). Flow over the left bank bridge approaches is being driven by the low ground levels in the village, and partly to the low channel capacity of Georges Plains Creek. The waterway area of the bridge itself is considered to be adequate and bridge afflux is not a significant factor.

Although the 1% AEP flow enters the village at the northern end of the bridge, flows along Rockley Road are not significant. Most flow continues in a south-east direction along Tracey St. The area at the southern end of Victoria Street is low-lying and subject to deep inundation, with flow occurring both northwards along the shallow creek channel and eastwards towards Vale Creek.
For comparison, Figure 2 gives a schematic indication of the behaviour of the 10% AEP flood which is representative of the smaller, more frequent events. Again the main flow directions are, as expected, along the channels of Georges Plains Creek (from node GP_CK3) and Vale creek (from node GEORGES). In the 10% AEP event significant flows do not enter the village but they do inundate low-lying land on both side of the road bridge.

In the 10% AEP flood, flow spills out of the channel on both sides in the low-lying area east of the road bridge. On the left bank it enters a low area of land at the corner of Tracey St and Victoria St, although there are no houses on this land. On the right bank, some flow from Georges Plains Creek spills towards Queen Charlotte Creek. East of Victoria Street, the 10% AEP flow is not contained within the small channel of Georges Plains Creek but spreads widely and inundates low-lying land. This land is understood to be subject to an application for proposed development.

Preliminary analyses were also done for flows larger than the 1% AEP for damage analysis purposes. In a large event such as 0.05% AEP significant flows can enter the town and flow along Rockley Road towards the railway line, thence north easterly towards the marble factory.
The Probable Maximum Flood (PMF) was also analysed. The indicative extent of the PMF is shown as a pink line on Figure 3.

**2.2 FLOOD LEVELS AND FLOOD EXTENT**

The peak 1% AEP flood levels at model nodes are shown in Figure 3. Peak 2% and 5% AEP levels are shown in Figure 4. The Figures show the estimated indicative flood extent, including the estimated extent of the PMF.

The flood extent is indicative because it has only been plotted relative to survey data along the surveyed cross-section lines. The flood extent at other locations can only be determined by comparing the flood levels with surveyed ground levels. Flood levels may need to be interpolated between model nodes. Refer "Georges Plains Floodplain Risk Management Study – Final Report", July 2007

**2.3 PROVISIONAL HAZARD**

Figure 5 shows the calculated provisional 1% AEP flood hazard rating in each link of the model, using the definitions given in the FDM. The rating takes into consideration the flowpaths within the creeks as well as overland flows along roads and through private property. The reliability of the mapping is limited by the limited amount of topographic data available.

Hazard to vehicles is commonly expressed as:

- \( V \times D < 0.4 \) Low Hazard
- \( 0.4 < V \times D < 0.6 \) transitional zone
- \( V \times D > 0.6 \) High Hazard

The FDM states that the provisional rating shall then be refined based on other relevant factors affecting the safety of individuals, such as flood warning, flood awareness, flood readiness, possible evacuation problems etc. At Georges Plains an adjustment is required at the road bridge. Although the road bridge is above the 1% AEP flood level, it is surrounded by deeper floodwaters which would make evacuation difficult. In particular, the bridge is not a suitable flood refuge. Therefore the bridge itself has been included in the High Hazard category.

**2.4 HYDRAULIC CATEGORIES**

Figure 6 indicates the Hydraulic Categories under existing conditions in the 1% AEP flood, using the definitions in the Floodplain Development Manual.

Floodways were defined as the extent of flow occurring in the 5% AEP flood. It is noted that the peak 5% AEP flow is approximately 70% of the peak 1% AEP flow in Georges plains Creek. In general, a floodway follows Georges Plains Creek with a floodway also on the left bank starting at the north end of the road bridge, towards Tracey St and the low-lying land at the intersection.
of Tracey St and Victoria Street. The land between Georges Plains Creek and Vale Creek is also a floodway in the 1% AEP flood.

The remaining areas within the flood extent are classified as flood storage. The hydrodynamic model shows that any significant loss of flood storage in these areas could potentially affect flood behaviour further downstream.

The hydraulic categories are very similar for the 2% AEP flood so no separate map was prepared. Figure 6 sheet 2 shows the indicative extent of the PMF, and the indicative extent of hydraulic categories for this flood. The definition adopted for ‘floodway’ in the PMF was the area carrying 70% of the total flow of the PMF, which is comparable to the floodway definition for the 1% AEP as described above. The mapped extents are very approximate as they based mainly on the limited 10m contour data.
2.5 FLOOD DAMAGE

Detailed flood damage calculations have been carried out using a spreadsheet for the range of floods from 10% AEP to the PMF. Based on information from the Scoping Study, damage is assumed to be negligible in the 50% AEP (1 in 2 year) flood. The calculations were done on a building by building basis, using surveyed floor level data. For detailed calculations refer “Georges Plains Floodplain Risk Management Study – Final Report”, July 2007.

A stage-damage relationship was adopted from SKM (2005), who investigated flood damages in the Lower Parramatta River floodplain. The house types considered in the Lower Parramatta River study are similar to the houses at Georges Plains.

In the 1% AEP flood the modelling confirms that 9 buildings would be flooded. These buildings and the depth of flooding is shown by coloured squares on Figure 5. The estimated direct flood damage in the 1% AEP flood at Georges Plains is nearly $ 82,000.

The estimated direct flood damage figures have been multiplied by a factor of 2.0 to account for indirect damages, such as damage to vehicles, appliances and yards. The estimates of flood damage are listed in table below. Full details are given in “Georges Plains Floodplain Risk Management Study – Final Report”, July 2007, Table D.2, Appendix D.

### Summary of Flood Damage Estimate

<table>
<thead>
<tr>
<th>Flood Case Probability</th>
<th>PMF 1.00E-07</th>
<th>Rare 0.05%</th>
<th>Design 1%</th>
<th>2%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Buildings overfloor Direct damage – buildings &amp; yards</td>
<td>36</td>
<td>19</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Direct Damage – buildings &amp; yards</td>
<td>$1,326,106</td>
<td>$189,705</td>
<td>$61,906</td>
<td>$56,820</td>
<td>$40,765</td>
<td>$24,846</td>
<td>$0</td>
</tr>
<tr>
<td>No. yard only flooded Direct Damage – Yards only</td>
<td>20</td>
<td>9</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>Direct Damage – Yards only</td>
<td>$20,000</td>
<td>$9,000</td>
<td>$19,000</td>
<td>$19,000</td>
<td>$20,000</td>
<td>$22,000</td>
<td>$28,000</td>
</tr>
<tr>
<td>Total direct damage</td>
<td>$1,346,106</td>
<td>$198,705</td>
<td>$80,906</td>
<td>$75,820</td>
<td>$60,765</td>
<td>$46,846</td>
<td>$28,000</td>
</tr>
<tr>
<td>Adjusted total damage</td>
<td>$2,692,211</td>
<td>$397,411</td>
<td>$161,812</td>
<td>$151,640</td>
<td>$121,531</td>
<td>$93,693</td>
<td>$56,000</td>
</tr>
</tbody>
</table>

The average Annual Damage (AAD) is estimated to be $22,000. This value is derived by calculating the area under the damage-probability curve, as described in “Georges Plains Floodplain Risk Management Study – Final Report”, July 2007, Appendix D.
3. OPTION ASSESSMENT

3.1 OPTIONS SELECTED FOR ANALYSIS

The floodplain risk management options selected for detailed consideration and evaluation at Georges Plains are listed below and shown in Figure 7.

Options Selected for Analysis

<table>
<thead>
<tr>
<th>Options Selected for Analysis</th>
<th>Description</th>
<th>Comments / Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options to reduce flood impacts on existing development</td>
<td>Creek channel formalisation, channel clearing, Clearing of debris at bridge, Voluntary purchase, Levee banks</td>
<td>Assess impacts if any on adjacent development.</td>
</tr>
<tr>
<td>Planning controls to ensure that new development is compatible with flood hazards</td>
<td>Select Flood Planning Level. Minimum Floor levels for new development &amp; redevelopment. Restrictions on rezoning of non-urban land.</td>
<td>Does not assist existing development.</td>
</tr>
<tr>
<td>Actions to manage the ongoing flood risk</td>
<td>Flood information, flood warning, improvements to access road from Bathurst</td>
<td>Possible link to overall Bathurst flood warning system.</td>
</tr>
</tbody>
</table>

Of the common types of structural Floodplain Risk Management Options canvassed in the Floodplain Development Manual, a number were excluded based on preliminary site observation and feedback from community consultation. The excluded options were either clearly impractical when site conditions are taken into account, and/or were not supported by the community.

**Options to reduce flood impacts on existing development**
- Creek channel formalisation,
- Channel clearing,
- Clearing of debris at bridge,
- Voluntary purchase,
- Levee banks

**Planning controls to ensure that new development is compatible with flood hazards**
- Select flood planning level and delineate flood extent,
- Restrictions on rezoning of non-urban land,
- Minimum Floor levels for new development.
Actions to manage the ongoing flood risk

Flood information,
Flood warning,
Improvements to access road from Bathurst

3.2 STATUTORY REGULATION

Native Vegetation Act 2003

It is noted that any actions to control or clear vegetation for flood management purposes would need to comply with applicable legislation including the NSW Government's *Native Vegetation Act 2003*.

The Native Vegetation Act 2003 (NV Act) regulates the clearing of native vegetation on all land in NSW except for national parks and other conservation areas, state forests and reserves and urban areas. The NV Act replaced the Native Vegetation Conservation Act 1997 on the 1 December 2005.

The objectives of the NV Act are:

(a) To provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State, and
(b) To prevent broadscale clearing unless it improves or maintains environmental outcomes, and
(c) To protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation, and
(d) To improve the condition of existing native vegetation, particularly where it has high conservation value, and
(e) To encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation, in accordance with the principles of ecologically sustainable development.

Under the Native Vegetation Act the local Macquarie Catchment Management Authority (CMA) can approve the clearing of remnant vegetation or protected regrowth when the clearing will improve or maintain environmental outcomes.

3.3 ASSESSMENT OF STRUCTURAL OPTIONS

The structural flood management options were assessed in terms of their:

- hydraulic effectiveness,
- environmental impacts including social impacts and community acceptance; and
- cost, and cost/benefit ratio
Hydraulic effectiveness was assessed using the computer models previously set up (refer to Section 3).

**Option 1 Creek Rehabilitation**

The aim of Option 1 is to restore the capacity of Georges Plain Creek so that nuisance flooding of flood-prone properties in Georges Plain can be eliminated. It was apparent during the site inspection that the creek channel has been filled with deposited sediment and choked with vegetation including weeds. This has reduced the effective flow capacity.

The scope of works of Option 1 includes the clearing of creek vegetation, the clearing of debris under the bridge, and formalising of the irregular creek channel into a regular creek channel. The affected creek segment is shown in **Figure 7** as the dark green line.

For costing purposes the following design concept has been adopted:

- The invert of Georges Plain Creek between node GP_230 and GP_300 being uniformly lowered by 1.0 metre by means of digging and removing of silt material;
- A trapezoidal and grassed channel being formed with a bed width of 4.0 m, a side slope of 1(h):2 (w), a depth (relative to TOB of the existing channel) of 1.5 m, and a top width of 10.0 m; and
- The floodway on top of the regular trapezoidal channel being maintained.

A typical cross section is illustrated in **Figure 8** in which the dotted blue line represents the existing cross section and the pink solid line represents the proposed cross section, at GP_200.

![Figure 8 Typical Cross Section of the Formalised Creek Channel (at GP_200)](image-url)
The selection of this cross-section has been done for preliminary modelling and costing purposes. The scope of this study does not include investigation of the most optimal cross-section either from a hydraulic, aesthetic or environmentally sustainable aspect, and this should be explored during a subsequent planning and design phase.

In comparing the peak flood levels and flows of Option 1 with existing conditions shows that with the implementation of Option 1:

- There will be significant flood level reduction at nodes GP_213 (immediately downstream of the bridge), 0.36 m reduction, GP_210 (Victoria Street) 0.20m reduction, GP_220 (Rockley Street), 0.13 m reduction during the 1% AEP flood event. Similar reductions occur in the 2% and 5% AEP events.
- The large existing flows between nodes GP_230 and GP_220 (link 760), GP_220 and GP_225 (link 763), and GP_220 and GP_210 (link 893), will be eliminated for flood events equal to or less than the 2% AEP flood event;
- Reduced overfloor flooding of 9 buildings,
- There is a residual risk of damage in floods greater than the 2% AEP flood.

The creek improvement option causes a re-distribution of flows, removing some of the overland flows within the village. Due to the redistribution of flows with the increased capacity of the Georges Plain Creek, there will be an increase of 0.08m of flood level at GP_300. This small increase will not affect the properties in the village but will affect adjacent farmland.

**Option 2  Levee Bank**

The aim of Option 2 is to create a levee on the left bank between nodes GP_230 and GP_220, upstream of the Rockley Road bridge, to block breakout of flows onto the left overbank. The levee would have a crest level of approximately RL 689.0, which is the 1% design flood with a 0.5m freeboard. The levee would be approximately 160 metres long. This option was also tested using XP-SWMM.

Comparing results with the 1% AEP existing conditions in Figure 3 shows that, although the left bank flow between GP_230 and GP_220 can be blocked by the levee, flood levels in the main channel of Georges Plain Creek will be increased by 0.03m-0.10m during the 1% AEP flood event. There is also a residual risk if the levee is overtopped in a large flood.

**Option 3  Voluntary Purchase**

Option 3 has no significant hydraulic impact. If existing buildings were to be purchased and demolished, there might be some minor redistribution of flood flows but it is not considered to be significant.

**3.4 ECONOMIC ASSESSMENT**
Preliminary cost estimates and indicative benefit-cost analyses were prepared for Option 1, the creek improvements, and Option 2. Details of the estimates are given in "Georges Plains Floodplain Risk Management Study – Final Report", July 2007 Appendix E. It is assumed that there are no constraints on excavation or disposal of the excavated material on nearby farmland. The estimates are subject to confirmation during further, more detailed investigations and design.

The total indicative cost of Option 1 in 2007 dollars is $448,000.

The benefit of the Option, based on modelling, was approximated as a lowering of flood levels in the 1%, 2%, 5% and 10% AEP by 0.2 metres between nodes GP_0 and GP_230. No reduction in flood levels was assumed for the 0.05% AEP flood or the PMF. Note that the Option reduces, but does not eliminate, flood damage. Re-computing the damages using these reduced flood levels gives a reduced residual damage estimate. The estimated AAD is reduced from $22,000 to $16,650. Details of the calculation are given in "Georges Plains Floodplain Risk Management Study – Final Report", July 2007 Appendix D.

The calculated benefit-cost ratio of this option, assuming a 30 year life and 7% discount rate, is 0.15. This is a relatively low ratio for floodplain management works. However, when other non-economic factors such as social and environmental factors are taken into account, the works may be justified.

The above analysis does not include maintenance costs. In practice there will be a need for catchment management programs including sediment control in order to maintain the capacity of the channel.

**Option 2, Levee Upstream of Bridge**

The preliminary estimated cost of the levee is $350,000 (see "Georges Plains Floodplain Risk Management Study – Final Report", July 2007 Appendix E). The calculated benefit-cost ratio of this option, assuming a 30 year life and 7% discount rate, is 0.15. This is a relatively low ratio for floodplain management works. The option provides lesser protection to properties than Option 1 and therefore is not recommended.

**Voluntary Purchase, Option 3**

Considerations for voluntary purchase of flood-prone properties typically include the degree of flood hazard, and the type and condition of the building. No economic analysis was done for Option 3. At Georges Plains, the property on the upstream side of the bridge is potentially suitable for voluntary purchase due to its high hazard rating. The old hotel on the downstream side may not be suitable because of the lower hazard and its historical value in the context of the village.

No economic assessment has been undertaken for other options, including the proposal to remove low points in the road between Bathurst, Perthville and Georges Plains. The benefits of this work would extend beyond the area of the Georges Plains village and include other rural and urban properties.
3.5 ENVIRONMENTAL ASSESSMENT

Option 1 is considered to be environmentally sound because it is returning Georges Plains Creek to closer to natural conditions. The existing sediment deposits and weed growths in the creek would be removed and suitably disposed of.

It will be necessary to ensure that the creek improvements are sustainable in the long term. It is proposed that as part of the detailed design, investigations should be made to identify and remove the sources of sediment and weeds (seed banks) upstream of the village.

3.6 PLANNING / DEVELOPMENT CONTROLS

Planning controls are recommended for properties within the village that are partly or wholly affected by the 1% AEP flood. Figure 9 shows the proposed extent of the planning and development controls.

The Flood Planning Level (FPL) defines the limit of land subject to flood-related planning controls. It usually involves a combination of historic floods or floods of specific AEPs, and a freeboard selected for floodplain risk management purposes.

In selecting the FPL consideration was given to the appropriate flood level for which protection to the residential and commercial properties is desired as well as an appropriate freeboard. In the case of Georges Plains it is recommended that the FPL be the 1% AEP flood level plus a freeboard of 0.5m.

Draft wording for the planning controls is provided later in this Plan.
Legend
- Land subject to Development Controls
- Extent of 1% AEP flood

NOTE: Rural land has not been classified

FIGURE 9
Land subject to Development Controls
4. RECOMMENDATIONS

4.1 FLOODPLAIN RISK MANAGEMENT PLAN

The recommended Floodplain Risk Management Plan for Georges Plains is listed below.

Floodplain Risk Management Plan for Georges Plains

<table>
<thead>
<tr>
<th>Action</th>
<th>Priority</th>
<th>Indicative Budget Cost Estimate</th>
<th>Social &amp; Environmental Impact</th>
<th>Cost-Benefit Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue debris removal program at road bridges</td>
<td>High</td>
<td>On-going</td>
<td>Positive – reduces risk of bridge waterway blockage</td>
<td>N/a</td>
</tr>
<tr>
<td>Undertake creek channel improvements along Georges Plains Creek (refer Figures 7 and 8)</td>
<td>High</td>
<td>$ 448,000</td>
<td>Positive – returns creek to a more natural state, removes sediment and weeds</td>
<td>0.15</td>
</tr>
<tr>
<td>Investigate voluntary purchase of High Hazard property</td>
<td>High</td>
<td>Range up to $250K</td>
<td>Existing property is in poor condition</td>
<td>N/a</td>
</tr>
<tr>
<td>Confirm and implement development controls as part of revised LEP</td>
<td>High</td>
<td>low – staff time</td>
<td>Ensure that limited development can occur while preventing an increase in flood risk.</td>
<td>N/a</td>
</tr>
<tr>
<td>Investigate extension of the existing Bathurst flood warning system to encompass Georges Plains and Perthville</td>
<td>High</td>
<td>Unknown</td>
<td>Positive. Builds on existing successful Bureau of Meteorology flood warning system</td>
<td>N/a</td>
</tr>
<tr>
<td>Prepare / update emergency management plan (DISPLAN) for Georges Plains</td>
<td>High</td>
<td>SES and Council staff time</td>
<td>Positive – ameliorate social and economic impact caused by flooding</td>
<td></td>
</tr>
<tr>
<td>Rectify low points in road between Bathurst, Perthville and Georges Plains</td>
<td>Medium</td>
<td>up to $ 500,000</td>
<td>Positive - improves flood access</td>
<td>N/a</td>
</tr>
</tbody>
</table>
4.2 IMPLEMENTATION PROGRAM

The recommended floodplain risk management measures may take some time to complete, given that it will occur in stages involving investigation, design, approval and implementation. Short term actions have been identified for early implementation. Short-term actions are listed in table above (section 4.1).

Management of the development of flood prone land can be undertaken by a combination of land use restrictions and development controls.

Flood Planning Level

The Flood Planning Level (FPL) defines the limit of land subject to flood-related planning controls. It usually involves a combination of historic floods or floods of specific AEPs, and a freeboard selected for floodplain risk management purposes.

The Floodplain Management Policy adopted by Bathurst Regional Council in 2005 defines flood prone land as either:

- Within the 1% AEP line defined by computer studies and mapping in the Bathurst Urban area, or
- Land which has been flood affected in the 1964, 1986 and/or 1990 floods, or
- Land likely to be affected by inundation from a natural watercourse or drainage channel.

Significantly, the definition also includes all lands outside the 1% AEP flood line but contiguous to it, less than 0.5 metres above the designated flood level. In the case of Georges Plains it is recommended that the FPL be the 1% AEP flood level plus a free board of 0.5m.

Planning and development controls should be applied to properties that lie within the limit of the FPL extent.

Flood Information

The Floodplain Management Policy enables Council to provide advice on planning certificates under Section 149(2).

Section 149 certificates of the Environmental Planning and Assessment Regulation, 1994 (EP&A Act) are attached to a contract when a property is sold in NSW. They provide information on whether there are flood related development controls on the land. The wording of these certificates should be clear and unambiguous. Care is required when preparing the wording to ensure that the information is not interpreted by the general public to mean the land is flood free when it is only free of development constraints. This is a common misunderstanding of the threat of extreme event flooding.

Section 149(2) and 149(5) of the EP&A Act provide information on the flood risk.

Section 149(2) Certificates are prescribed within Schedule 4 of the EP&A Act and includes whether or not Council has by resolution adopted a policy to restrict the development of land because of the likelihood of flooding or any other risk.
A Floodplain Management Policy was adopted by Bathurst Regional Council in 2005. This policy relates to flood prone land and can enable Council to provide advice on planning certificates under Section 149(2). Typical sentences sourced from the Floodplain Development Manual (NSW Government, 2005) that may be incorporated on Section 149(2) certificates include:

**A property above the flood planning level (FPL)**

“Council considers the land in question to be above the flood planning level and therefore its local flood risk management policy does not impose flood related development controls. However, the property may be subject to flooding in very rare flood events. Information relating to this flood risk may be obtained from Council.”

**A property below the FPL**

“Council considers the land in question to be below the flood planning level and therefore subject to flood related development controls. Information relating to this flood risk may be obtained from Council. Restrictions on development in relation to flooding apply to this land as set out in Council’s local flood risk management policy, which is available for inspection at the Council”.

Section 149(5) of the Act requires that Council includes advice on such other relevant matters affecting the land of which it may be aware.

Where information on various design floods is known

“the information available to Council indicates that the estimated 1% and 0.2% Annual Exceedance Probability (AEP) flood levels are XXX and YYY respectively. The probable maximum flood or extreme flood level is ZZZ.”

Where only historical information is known

“Flooding to a level of XXX, as determined by debris marks, occurred in the storm event of (date). The average chance of a storm of this magnitude happening in any given year is greater than the 1% AEP event.”

**Development Controls**

Part 8 of the draft BRC “Development Control Plan – Villages” includes proposed development controls for Georges Plains, based on zones displayed on a map (Map no. 5).

There are also general flood-related development controls under Part 5 of the draft DCP. The following table discusses the existing draft provisions and provides recommended changes in wording.
### Draft Planning and Development Controls

<table>
<thead>
<tr>
<th>Heading</th>
<th>Existing provisions (Draft DCP)</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential subdivision</td>
<td>“Council will not approve the residential subdivision of land where . . . the land is considered by Council to be affected by the 1% AEP flood . . .”</td>
<td>Amend to refer to the 1986 flood, for consistency with the FPL provisions below.</td>
</tr>
<tr>
<td>Land subject to inundation</td>
<td>“. . .the flood of August 1986 has been adopted as the flood standard . . .”</td>
<td>Amend to refer to the 1% AEP flood. Amend the term “flood standard” to “flood planning level”.</td>
</tr>
<tr>
<td>Freeboard of 0.5 metres above the flood standard (August 1986) is required for floor levels except where the damage potential is low.</td>
<td>Delete reference to August 1986 flood in existing clause.</td>
<td></td>
</tr>
<tr>
<td>Flood proofing may be required at the discretion of Council.</td>
<td>Flood proofing should be required for the portion of the structure below the Flood Planning level, unless it conflicts with heritage design guidelines. Electrical fixtures should be placed above the FPL.</td>
<td></td>
</tr>
<tr>
<td>Extensions to existing residential buildings</td>
<td>Where floor area of extension &lt; 50% of existing area and the floor level of the existing house is above the designated flood level, the floor level of the extension may be constructed to the same level. Where floor area of extension &gt; 50% of existing floor area, the extension is to be constructed with a floor level 500mm above the designated flood level.</td>
<td>Existing clause is confusing. It should read that for floor areas &gt; 50% of existing, the extension is to be constructed a minimum of 500mm above the FPL, otherwise the extension may be constructed to the existing floor level. (This provision is justified in order to minimise impacts on the heritage aspects of the existing village).</td>
</tr>
<tr>
<td>Development on flood prone land</td>
<td>No consent will be issued unless the development is capable of withstanding flood water pressure.</td>
<td>Retain existing clause</td>
</tr>
<tr>
<td>Flood impact assessment</td>
<td>At the request of Council a flood impact assessment may be required.</td>
<td>Flood impact assessment to be required for all land that is more flooded by more than 0.5 metre in the 1% AEP flood (ie. not Low Hazard)</td>
</tr>
</tbody>
</table>