Jerilderie Shire Council

Jerilderie Floodplain Risk Management Study and Plan

Final Report

October 2015

Cover photograph: The Billabong Creek railway bridge located upstream of the Newell Highway, view looking downstream.

Preface

The NSW State Government's Flood Policy aims to provide solutions to existing flooding problems and ensure that new development within flood prone areas is compatible with the prevailing flood risk and does not create additional flooding problems in other areas.

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

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

- Flood Study – determines the nature and extent of the flooding problem.
- Floodplain Risk Management Study – evaluates management options for the floodplain in respect of both existing and proposed development.
- Floodplain Risk Management Plan – the formal plan adopted by Council for the management of the floodplain.
- Plan Implementation – implementation of the various structural and non-structural measures proposed by the Plan.

This report documents the above second and third stages in the process (Floodplain Risk Management Study and Floodplain Risk Management Plan). It follows the completion of the Flood Study in 2014.

The Jerilderie Shire Council has prepared this document with financial assistance from the NSW and Commonwealth Governments through the Natural Disaster Resilience Program. This document does not necessarily represent the opinions of the NSW or Commonwealth Governments.

Table of Contents

Table Index

Figure Index

Appendices

1. Introduction

The primary objective of the NSW Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods.

The Jerilderie Floodplain Risk Management Study (FRMS) has been undertaken to provide the Jerilderie Shire Council and other stakeholders with a Floodplain Risk Management Plan (FRMP) which clearly defines flooding risks at Jerilderie and identifies preferred options for implementation to reduce future flood risks and associated damages.

The FRMP will also assist Council and other government agencies to make appropriate decisions in relation to future land use planning.

The FRMS and FRMP represent the second and third steps in the floodplain management process as set out by the NSW Floodplain Development Manual (NSW Government, 2005). The four steps are:

- Flood Study – technical assessment to define the nature and extent of flooding under existing conditions. The Jerilderie Flood Study completed in 2014 documents this step;
- Floodplain Risk Management Study - evaluates management options for the floodplain giving consideration to hydraulic, environmental, social and economic issues;
- Floodplain Risk Management Plan – formal plan prepared which outlines the adopted strategies to manage flood risk and flood management issues; and
- Plan Implementation – measures nominated by the plan are put in place.

The extent of the area for which this FRMP applies is shown on Figure 1. It encompasses the township of Jerilderie and the immediate surrounds. The FRMP takes into account flooding risks associated with both Billabong Creek and Wangamong Creek.

Current land use zonings at Jerilderie as per the 2012 Local Environmental Plan (LEP) are shown on Figure 2. The Billabong Creek route is designated as Natural Waterway W1). Parts of the town are zoned Village (RU5), General Industrial (IN1), Large Lot Residential (R5), Public Recreation (RE1) and Infrastructure (SP2). Residential development is currently focused on the western fringe of the existing town area between the Conargo Road and Billabong Creek.

Notes / Limitations:

1. The derivation of the flood levels and extent shown on this plan has been based on the available ground surface survey elevation information and subsequent hydraulic modelling.

2. Areas shown outside the mapped flood extent may be subject to inundation by more extreme floods.

3. It should not be assumed that the floor level of buildings located within the mapped inundation area is below the flood level. Building floor levels should be compared with the design flood levels to determine whether their floors are above or below the design flood level.

1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Flood Extent and Depth (m)

- < 0.10
- 0.10 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 4.00
- > 4.00
- Study Area Boundary
- Cadastre
- Flood Level Contours (mAHD)
- Railway

Jerilderie Shire Council
Floodplain Risk Management Study

Job Number 23-14980
Revision A
Date 09 Jun 2015

100 Year ARI Flood Event Study Area Plan

Figure 1

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Data source: DEPI, VicMap, 2014; Jerilderie Shire Council, aerial, LiDAR, 2013; GHD, flood extents & contours, 2014. Created by:slmartin

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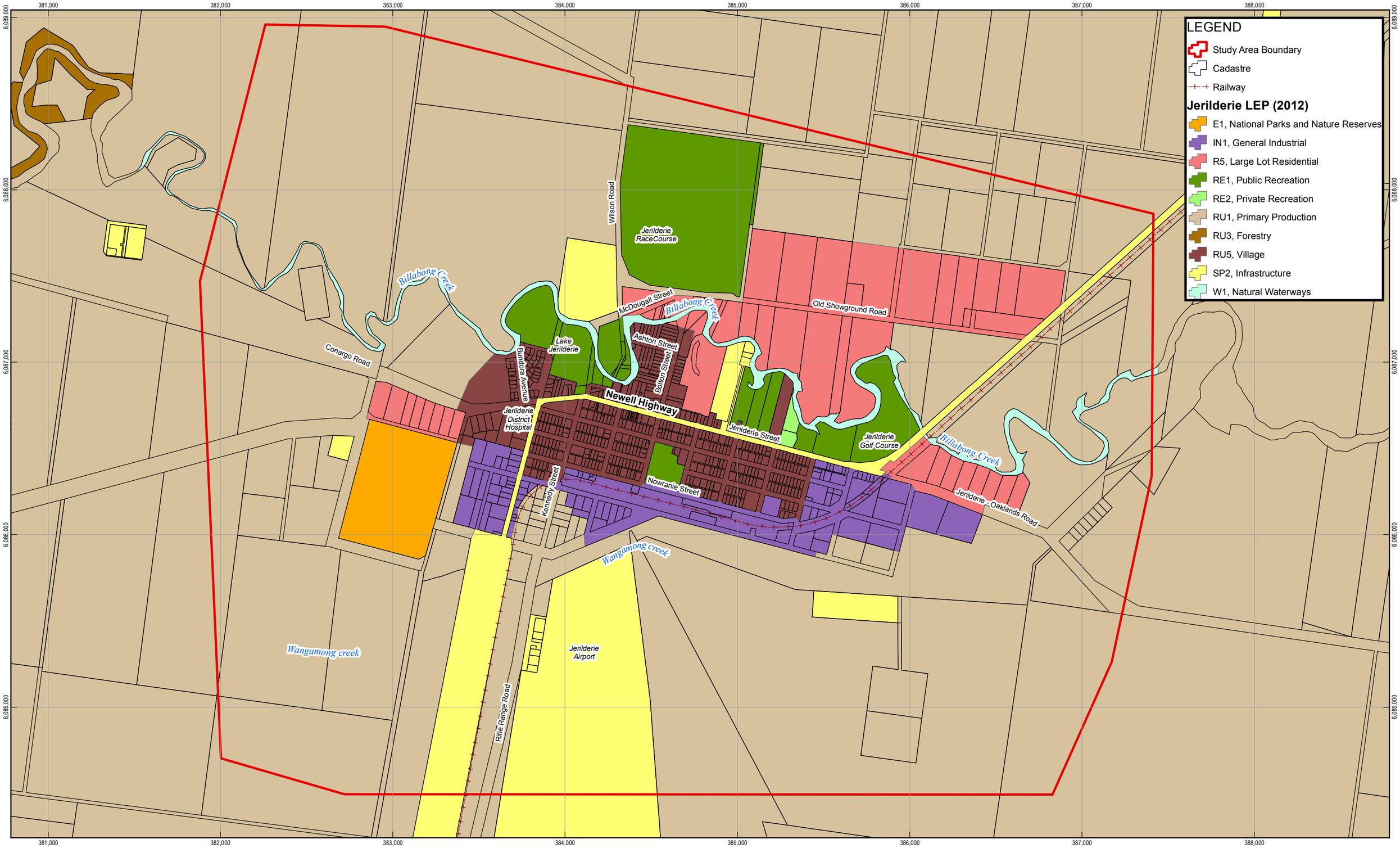

1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Jerilderie Shire Council
Floodplain Risk Management Study

Job Number 23-14980
Revision A
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Land Use Zones
Jerilderie LEP 2012

Figure 2

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Data source: DEPI, VicMap, 2014; Jerilderie Shire Council, aerial, LiDAR, 2013; GHD, flood extents & contours, 2014. Created by:sldouglas

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2. Community Consultation

2.1 Floodplain Risk Management Committee

Council established a Floodplain Risk Management Committee to oversee the Jerilderie Flood Study, Floodplain Risk Management Study and Plan. The eight person Committee consists of the following members:

- Three Council staff representatives. One of the Council staff is also the SES Local Incident Controller at Jerilderie.
- Two Councillors.
- One local community representative.
- SES Representative (final meeting only)
- One OEH representative.

2.2 Flood Study Consultation Activities

The following community consultation activities occurred during the Flood Study phase:

- Distribution of a newsletter to all residents and businesses within the township of Jerilderie in September 2013.
- Public exhibition of the draft report in June 2014.
- Public meeting held during the public exhibition period of the Flood Study report in June 2014.

2.3 Public Exhibition of the draft FRMS & FRMP Report

The draft FRMS and FRMP document was placed on public exhibition in August 2015. A hard copy of the report was made available for viewing at Council's offices. The draft document was also posted on Council's web site.

No submissions on the draft FRMS and FRMP document were received at the completion of the public exhibition period.

2.4 Public Meeting

A public meeting was held in August 2015 during the public exhibition period of the draft FRMS / FRMP document as also occurred with the preceding Flood Study report. An overview of the draft FRMS and FRMP document was presented to those present followed by a question and answer session.

3. 2014 Flood Study Summary

3.1 Scope

The Jerilderie Flood Study (GHD, 2014) identifies flooding conditions for a range of varying size Billabong Creek and Wangamong Creek flood events. The flood study consisted of the following stages:

- LiDAR terrain survey of Jerilderie township and the surrounds. Outputs from the survey included a 1m grid digital elevation model (DEM) of the ground surface.
- Estimation of design flows for the two subject creeks, Billabong Creek and Wangamong Creek, using flood frequency analysis of gauged streamflow data and other techniques.
- Estimation of design flood levels, velocities and extents for a range of flood events using the TUFLOW two dimensional hydraulic model.
- Preparation of hydraulic category and provisional flood hazard mapping.
- Reporting including the flood map outputs.

The 2014 Jerilderie Flood Study was the first detailed study undertaken focusing on riverine (creek) flooding at Jerilderie. It is possible that parts of Jerilderie are affected by local overland flow flooding which was not assessed as part of the 2014 study.

3.2 Key Outcomes

There were a number of complicating issues with the gauged streamflow data that impacted on the flood frequency analysis of the gauged records at the Billabong Creek Jerilderie gauging station. These issues including some uncertainty in regards to gauge height zero datums are discussed in the Flood Study report.

The TUFLOW hydraulic model was able to be calibrated using recorded flood levels for the recent March 2012 flood. The 100 year ARI design flow was then derived based on the flow which resulted in a modelled flood level which matched the 100 year ARI flood level at the gauging station as determined by the flood frequency analysis.

The adopted design flows and flood levels at the Jerilderie Billabong Creek gauging station are given in Table 1. The adopted design flows for Wangamong Creek are also given.

The following flood mapping is included in the 2014 Jerilderie Flood Study report:

- Design Flood Extent and Depth maps for the 5, 10, 20, 50, 100, 200 year ARI events and an extreme flood event. The 100 year ARI flood extent and depth is shown on Figure 1.
- Provisional Flood Hazard mapping for the 20 and 100 year ARI design events.
- Hydraulic Category mapping for the 20 and 100 year ARI design events.

The hydraulic modelling identified that the Newell Highway, Jerilderie-Oaklands Road and the Conargo Road at Jerilderie are not overtopped in a 200 year ARI flood.

Existing developed properties affected by Billabong Creek flooding are located in Bolton Street, Ashton Street, Powell Street and the Old Showground Road. Floodwater from Billabong Creek will spill into Lake Jerilderie in flood events more severe than a 80 year ARI flood.

The airport is subject to shallow inundation from Wangamong Creek in a 100 year ARI flood. Wangamong Creek does not cause any serious flooding impacts (e.g. above floor flooding) to existing development up to at least a 100 year ARI event.

Table 1 Adopted Design Event Flows and Flood Levels

Design Event (years)	Billabong Creek at Jerilderie			Wangamong Creek at Jerilderie
	Flood Level (m)	Flood Level (m AHD)	Peak Flow (ML/day)	Peak Flow (ML/day)
5	1.74	107.14	4,100	1,300
10	2.12	107.52	5,400	1,800
20	2.45	107.85	7,400	2,200
50	2.87	108.27	11,600	3,200
100	3.17	108.57	15,500	3,800
200	3.45	108.85	20,200	4,900
Extreme	3.95	109.35	62,000	15,200

Notes:

1. Flood levels in Table 1 coincide with the Billabong Creek gauging station site (410016) located 600 metres upstream of the Jerilderie Weir.
2. Current gauge zero datum at the gauging station site is 105.402 m AHD.
3. Extreme event is based on a flow rate equal to four times the adopted 100 year ARI event flow.

3.3 Hydraulic Categories

The 2005 FDM defines the following three hydraulic categories:

- **Floodway** – are those parts of the floodplain where a significant volume of water flows during floods and if blocked or partially blocked, would result in a significant redistribution of flow.
- **Flood Storage** – are those parts of the floodplain that are important for the temporary storage of floodwater during the passage of a flood.
- **Flood Fringe** – are the remaining parts of the floodplain after floodway and flood storage areas have been defined.

Planning and development controls vary for the above hydraulic categories. Development constraints are more restrictive for floodway areas.

The mapped hydraulic categories for the 100 year ARI event at Jerilderie are presented on Figure A2 in Appendix A.

3.4 Hazard Categories

The 2005 FDM defines the following two hazard categories:

- **High Hazard** – are those parts of the floodplain where there is possible danger to personal safety, evacuation by trucks would be difficult, able-bodied adults would have difficulty in wading to safety and there is potential for significant structural damage to buildings.
- **Low Hazard** – are those parts of the floodplain where trucks could evacuate people and their possessions and able-bodied adults would have little difficulty in wading to safety.

Provisional hazard mapping is included in the 2014 Flood Study report. The provisional hazard mapping reflects hydraulic conditions only (i.e. depth and velocity of floodwaters).

The provisional hazard mapping has been reviewed as part of this current FRMS. This is discussed in Section 4.2.4. Additional considerations in updating the hydraulic category mapping include the rate of rise of floodwaters, duration of flooding, available flood warning time, level of flood awareness/readiness in the community and flood access and evacuation considerations. The amended flood hazard mapping is presented on Figure A3 in Appendix A.

3.5 Flooding Impacts

A floor level survey of buildings located within the flood affected area at Jerilderie was completed. The subsequent comparison with the modelled design flood levels enabled those buildings (i.e. houses or principle building on each property) which are subject to above floor flooding to be identified.

Flood damages were estimated using the outcomes from the comparison of building floor levels with flood levels and flood damage data.

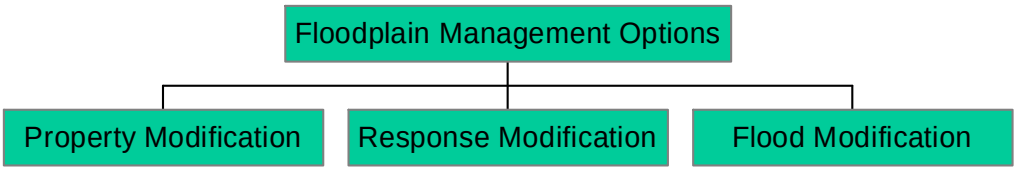
The main outcomes were:

- Negligible flood damage for events up to and including the 20 year ARI flood. There are no properties subject to above floor flooding in a 20 year ARI event (excludes minor buildings such as sheds, carports, garages etc).
- Total flood damage in a 50 year ARI event is $118,000. There is one property subject to above floor flooding in a 50 year ARI event.
- Total flood damage in a 100 year ARI event is $733,000. There are seven properties subject to above floor flooding in a 100 year ARI event (five houses, one block of flats and one school building). Four of the seven properties are located in Bolton Street with one each in Powell Street, Ashton Street and the Old Showground Road.
- Total flood damage in the extreme event assessed is $5.6 million. There are an estimated 56 properties subject to above floor flooding. The probability of an event of this severity occurring is extremely low (likely to be less than 1 in 100,000).
- The average annual flood damage at Jerilderie is $31,000 per annum.

4. Floodplain Management Options

4.1 Overview of Types of Measures

As described in the 2005 FDM, there are three different approaches to modifying the flood risk to reduce future flood impacts as shown below:



Property modification measures are designed to avoid any future development within areas which have a high flood risk and to also reduce the damage inflicted on existing development by means of flood proofing. Property modification measures include:

- Land use planning including zonings and development control
- Voluntary house raising
- Flood proofing of buildings
- Improvements to flood access
- Voluntary purchase of high hazard properties

Response modification measures are designed to modify the response of the population at risk prior to, during and after a flood. Response modification measures include:

- Flood education and awareness
- Flood warning system establishment/improvements
- Flood response improvements
- Flood recovery improvements

Flood modification measures are designed to modify the behaviour of the flood itself by reducing flood levels or velocities or by excluding floodwaters from the area under threat. Flood modification measures include:

- Retarding basins
- Levees
- Waterway channel and structure modifications
- Bypass floodways
- Vegetation management and maintenance of creeks and culverts

4.2 Property Modification Measures – Planning & Development Controls

4.2.1 Overview

Land use planning controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Planning not to develop land within high hazard floodway or land that has the potential to impact flood behaviours in other areas represents an essential component of a floodplain management plan.

Land use planning controls can be achieved through zoning in the Local Environment Plan (LEP) and associated flood related controls incorporated into a Development Control Plan (DCP). Planning documents can be used as a floodplain management tool by controlling where development can occur, floor levels, freeboard, fill or excavation in the floodplain, site access during flood events, location of utilities and services, building materials and structural fitness of buildings when subject to flooding.

The Jerilderie Local Environmental Plan 2012 (LEP 2012) is the principal planning document which controls future development within the Shire. Clause 6.2 of the LEP relates to Flood Planning and is the standard NSW Department of Planning flood clause for inclusion in LEPs. The existing Clause 6.2 adopts a freeboard allowance of 500 mm above the 100 year ARI flood as the basis for the Flood Planning Level (FPL).

Land use planning issues requires that the FRMP identify the future basis for defining the FPL and the Flood Planning Area (FPA).

4.2.2 Flood Planning Levels

The Flood Planning Level (FPL) is the combination of flood levels and freeboards selected for floodplain risk management purposes.

The NSW Floodplain Development Manual states that in general the FPL for standard residential development is the 100 year ARI flood plus a freeboard of typically 0.5 metre, with minimum fill levels at the 100 year ARI flood level.

The 100 year ARI flood is almost always adopted as the design flood for floodplain management purposes in NSW. The freeboard selected can however vary significantly depending on local flooding characteristics. Freeboard provides a factor of safety to provide protection against:

- Uncertainties in the estimation of flood levels.
- Increases in flood level as a result of wave action.
- Changes in rainfall patterns as a result of climate change.

Individual FPLs can be specified for different types of development (e.g. residential, non-residential), for different flooding sources (e.g. riverine flooding, local overland flow) and for different locations (e.g. very broad floodplain reach, very confined floodplain reach).

Selecting a larger freeboard will reduce the risk of future flood impacts. It will also however result in a social and economic cost associated with the more restricted land use which follows from adopting a larger freeboard and therefore a larger FPA. Jerilderie Shire Council are conscious of avoiding an overly cautious approach which results in large portions of both the existing town and future development areas which have extremely low flood risk being included within the FPA.

Residential development tends to be viewed as warranting a higher freeboard due to the increased exposure associated with habitable buildings including people being present at the time of flooding.

Commercial and industrial development can be less sensitive to flooding. Property owners tend to be willing to take on a higher risk. Flood proofing of commercial and industrial buildings is often a suitable measure. Consideration to allowing commercial and industrial buildings to have reduced minimum flood levels whilst require flood proofing to the FPL is an option.

Some types of development should where possible be positioned outside the FPA, or if inside the FPA be allocated a FPL which is higher than that for other development types (e.g. hospitals, critical infrastructure, senior's housing).

The nature of flooding at Jerilderie is described within the 2014 Flood Study report. The two flooding sources assessed are the Billabong Creek and the Wangamong Creek. Local overland flow (stormwater) flooding was not assessed, however is not known to cause serious flooding problems at Jerilderie.

Billabong Creek and Wangamong Creek flooding characteristics are described as follows:

- Flood warning time. The amount of flood warning time at Jerilderie is measured in weeks. Typically the flood peak at Jerilderie occurs approximately two weeks after the flood peak at Walbundrie and five days after the flood peak at Innes Bridge. This amount of warning time allows response agencies and Jerilderie residents to thoroughly prepare for the coming flood so as to minimise the actual flood damage.
- Flood duration. Flood levels at Jerilderie will generally stay high for days or even on occasions weeks. This protracted duration of flooding could have a significant impact on flood response operations, particularly if islands of high ground were present with development present. This is not the case at Jerilderie, where even in an extreme event, road access into and out of the town remains available via the north side Newell Highway route.
- Flooding conditions at Jerilderie are characteristic of '*Areas with Rising Road Access*'. There is very little potential for persons to become isolated by floodwaters unless they significantly delay their evacuation. Flood levels at Jerilderie in recent significant floods (e.g. March 2012, July 1990) have risen at rates of 7 to 9 cm per day over a two to three week period prior to peaking. Assuming a similar rising limb duration, the rate of rise in a 100 year ARI event is expected to be approximately 15 cm per day. This is higher however than the actual rate of flood level rise in the large 1956 and 1974 floods, which averaged rises closer to 3 cm per day.
- Given the slow rate of rise and lengthy warning time available, there is therefore little or no likelihood of persons being slow to react and finding themselves isolated by floodwaters. Flood risks are therefore aligned with property damage risks rather than personal safety risks.
- Variation in flood level with the flood ARI. The variation in flood level with ARI is documented in the 2014 Flood Study report. The Billabong Creek 200 year ARI flood level is 0.28 metre above the 100 year ARI flood level. The extreme event Billabong Creek flood level (four times the 100 year ARI flow) is approximately 0.8 metres above the 100 year ARI flood level. This extreme flood level is a higher bound figure as the hydraulic modelling study area boundary confines the extent of flooding resulting in a higher modelled flood level. In relation to Wangamong Creek, the 200 year ARI and extreme event flood levels are approximately 0.2 metre and 0.7 metre respectively above the 100 year ARI flood level. Both these modelled flood levels are influenced however by the hydraulic model boundary which confines the extent of 200 year ARI and the extreme extent flooding.

- Uncertainty in the estimation of flood levels. The flood levels at Jerilderie are based on lengthy stream gauging records in the case of Billabong Creek (1913 onwards). The hydraulic model is a calibrated full two dimensional model which uses a study area wide LiDAR survey to define the floodplain ground surface.
- Wind induced wave action. A detailed analysis of wind induced wave conditions has not been undertaken. Both sides of the Billabong Creek waterway channel are heavily treed at Jerilderie. This will tend to limit the effective fetch and / or disperse the impact of wind generated waves.
- Climate change. A 15% increase in the design flow caused by potential climate change influences would result in an increase in the 100 year ARI Billabong Creek flood level at Jerilderie of 0.13 to 0.18 metre as documented in the Flood Study report (GHD, 2014).

Following discussions at multiple FRM Committee meetings, the Committee concluded that a freeboard of 0.3 metres is appropriate for Jerilderie. In making this decision, the Committee was particularly conscious of the local flooding characteristics (i.e. warning time measured in weeks, rates of rise of less than 1 cm per hour, rising road access present for most of the town) which render the risk of loss of life to be negligible. The flood risk is therefore reduced to a property damage risk which needs to be weighed up against the down side of having a higher freeboard. The Committee views the 0.3 m freeboard as representing an appropriate balance.

4.2.3 Flood Planning Area

The Flood Planning Area (FPA) represents the area below the FPL and thus subject to flood related development controls.

The FPA therefore depends directly on the adopted basis for the FPL and in particular the freeboard adopted. The previous section provides discussion on the issues influencing the selection of freeboard at Jerilderie. The Jerilderie FRM Committee has adopted a freeboard of 0.3 metre for all Jerilderie (i.e. both Billabong Creek and Wangamong Creek floodplain areas).

The FPA for Jerilderie will coincide with the area below the 100 year ARI flood level plus 0.3 metre. The resultant defined FPA area is shown on Figure A1 in Appendix A. The draft flood related planning and development controls included in Appendix A will apply to this area.

4.2.4 Flood Hazard

Provisional flood hazard mapping is presented in the Flood Study report (GHD, 2014). The provisional hazard mapping is based on hydraulic conditions (i.e. depth and velocity of floodwaters) as determined using the hydraulic model and Figure L2 of the 2005 FDM.

The provisional flood hazard is reviewed during a FRMS, taking into account factors other than hydraulic conditions. Other factors taken into account include:

- Effective warning time. In regards to Jerilderie, there is in the vicinity of two weeks warning in advance following the upstream peak at Walbundrie.
- Flood readiness. Given the infrequent nature of flooding and limited impacts at Jerilderie, flood awareness and readiness within the community is not high. This is offset to some extent by the more detailed understanding of flooding conditions held by flood response personnel as a result of the 2014 Flood Study.
- Rate of rise of floodwaters. The rate of rise of floodwater at Jerilderie is very slow.
- Duration of flooding. The duration of flooding at Jerilderie is reasonably protracted. In March 2012, the flood peaked at 1.74 m. Flood levels remained above 1.5 m for six days.

- Evacuation access considerations. Evacuation access at Jerilderie is reasonably favourable with major roads unaffected up to a 200 year ARI event.

The updated flood hazard coinciding with 100 year ARI flooding conditions is shown in Figure A3 in Appendix A. The major differences in comparison with the provisional flood hazard mapping is a number of low hazard island areas (i.e. low hazard areas surrounding by high hazard) have been altered to high hazard.

4.2.5 Flood Planning Policies and Development Controls

The detailed flood modelling investigations carried out as part of the 2014 Jerilderie Flood Study has enabled detailed flood mapping to be prepared for the Billabong Creek and Wangamong Creek floodplain at Jerilderie. The flood mapping has included the:

- Delineation of the extent and depth of flooding in a range of design flood events as per the Appendix B map series in the 2014 Flood Study report. Maps include:
  - 100 year ARI Flood Extent and Depth (refer to Figure 1).
  - Extreme Flood Extent and Depth (equivalent to an indicative probable maximum flood scenario).
- Delineation of the Hydraulic Category as per Figure D1 of the 2014 Flood Study report (reproduced as Figure A2 in this report).
- Delineation of the Flood Hazard, updated as part of the current FRMS as per Figure A3 in Appendix A of this report.

Each of the above Flood Hazard and Hydraulic Category zones represents differing flooding conditions and risks. The highest risk category is land that is both High Hazard and Floodway. In general, development within Floodway and / or High Hazard areas is limited to flood compatible development (i.e. development which will not obstruct flow conveyance and will not be significantly damaged in a flood).

Draft Flood Planning and Development Controls for the Jerilderie LGA are provided in the attached Appendix A. Key points are summarised as follows:

- High Hazard Floodway areas - development excluded except for flood compatible uses.
- All other High Hazard areas – development excluded unless a report from an accredited Consulting Engineer demonstrates no adverse impacts on flooding conditions result.
- Low Hazard Flood Storage and Flood Fringe areas – all new development should comply with the minimum floor level requirements. The minimum floor levels of new residential development to be at the 100 year ARI flood level plus 0.3 metre. The minimum floor level of new commercial, industrial or agricultural development is to be at the 100 year ARI flood level plus 0.3 metre or the building is flood proofed to the same minimum level.
- All new critical infrastructure and particularly vulnerable development should be positioned outside the FPA and where possible outside the Extreme Flood extent.

The maintenance of flood storage volume is not considered necessary at Jerilderie. There is an enormous quantity of floodplain storage upstream of Jerilderie. Potential cumulative new development at Jerilderie will not result in a loss in floodplain storage volume which is significant relative to the broader available floodplain storage volume. Given this, it is proposed that the principle of requiring development to comply with no net loss of floodplain storage not be applied. Controls for new development within Flood Storage and Flood Fringe areas will therefore be similar.

The following recommendations are made in relation to flood based planning and development controls:

- Clause 6.2 of the 2012 LEP to be updated to reflect the adopted FPL and FPA basis. This should include reference to a map defining the FPA to be included in a future update of the LEP.
- The draft Flood Planning and Development Controls should be reviewed by Council and following any ensuing amendments incorporated into the Jerilderie Shire Development Control Plan 2012.

4.3 Property Modification Measures – Other Measures

4.3.1 Voluntary House Raising

House raising is generally only implemented in low hazard and/or flood fringe areas. House raising involves lifting building floor levels above the flood planning level to avert damage to buildings, improve personal safety and reduce stress and post-flood trauma. House raising is often a potential solution to flooding in rural areas for isolated houses, particularly for dwellings constructed from fibro or timber.

Consideration must be given to the type of house being raised, the level of hazard to be avoided, the duration of flooding expected and social issues (access to balance of funding). An important consideration is that house raising will not mitigate flood risk entirely, since the effects of a flood of greater magnitude than the FPL (potentially up to the PMF) could still result in risk and damage.

Given the low risk of above floor flooding (threshold greater than a 50 year ARI flood event except for one house), house raising is not recommended.

4.3.2 Voluntary Purchase

Voluntary purchase involves the acquisition of flood affected properties, in particular those inundated in high hazard areas, and the subsequent demolition of the building on the acquired property.

Voluntary purchase is not considered suited to any of the flood affected properties at Jerilderie, given the low risks and infrequent nature of above floor flooding.

4.3.3 Flood Proofing of Buildings

Flood proofing includes the following scenarios:

- Achieved through the design and construction of the building (i.e. water resistant building materials, electrics positioned above the water line).
- Temporary flood barriers. This involves the use of plastic sheeting and sand bags at points of water entry (e.g. doorways, vents).

Properties at Jerilderie are potentially suited to flood proofing measures achieved through temporary barriers. There is substantial flood warning time available for occupants of individual properties to set up barriers at points of entry.

The 2014 Flood Study has identified those properties most at risk of above floor flooding. In the event that a major flood is forecast for Jerilderie, temporary barriers could be erected at the identified buildings / houses which are suited to temporary flood proofing measures. These houses have not been individually identified within this report as requested by Council.

4.4 Response Modification Measures

Response modification measures are reactions to flooding that reduce potential social, economic and environmental damages from flooding. While response modifications will reduce the risk to life and may reduce direct damages, they will not prevent flooding. Therefore, they will not address all the social impacts and damages associated with flooding.

4.4.1 Flood Warning Systems

Depending on warning time and resources available, flood warning systems and evacuation plans can be used to protect buildings, evacuate people, provide relief to evacuees and provide recovery assistance to those in flood affected areas.

The Billabong Creek catchment has Bureau of Meteorology (BOM) telemetered streamflow gauges at Walbundrie and Jerilderie (refer to Figure 3). Continuously recorded flood heights at both gauges can be viewed in real time on the BOM web site.

The time lag between the peak at Walbundrie and the peak at Jerilderie is typically in the order of two weeks. A gauge is located at Innes Bridge closer to Jerilderie. The lag between the peak at Innes Bridge and the peak level at Jerilderie is typically in the order of four to five days.

Recent floods in 2010 and 2012 have highlighted the limited understanding of the complex relationship between the recorded peak height at Walbundrie and the associated forecast peak flood level at Jerilderie. The peak flood levels at Walbundrie in 2010 and 2012 were the second highest and equal third highest on record exceeded only by the 1931 flood. The subsequent peak flood levels at Jerilderie in 2010 and 2012 only reached the 5 year ARI flood level.

The following sample data highlights this issue:

- March 2012 Flood
  - Walbundrie – peak level 8.7 m – 5 March (equal third highest level on record)
  - Jerilderie – peak level 1.74 m – 19 March (equivalent to a 5 year ARI event)
- October / November 2010 Flood
  - Walbundrie – peak level 9.1 m – 17 October (second highest level on record)
  - Jerilderie – peak level 1.74 m – 4 November (equivalent to a 5 year ARI event)
- July / August 1990
  - Walbundrie – peak level 6.3 m – 7 July (tenth highest level on record)
  - Jerilderie – peak level 2.08 m – 4 August (equivalent to a 10 year ARI event)

The forecast peak flood height at Jerilderie cannot reliably be predicted based solely on the recorded peak flood height at Walbundrie. The volume of runoff reflected by the rate of rise and fall at Walbundrie is equally important in determining the subsequent flood peak at Jerilderie. Both the 2010 and 2012 floods rose and receded relatively quickly at Walbundrie. The subsequent peak at Jerilderie was consequently lower than expected.

Another significant factor influencing the peak flood height at Jerilderie is the starting condition of the floodplain storages between Walbundrie and Jerilderie, notably Lake Urana, which can absorb a substantial portion of flood flows if the lake is not full prior to the flood event.

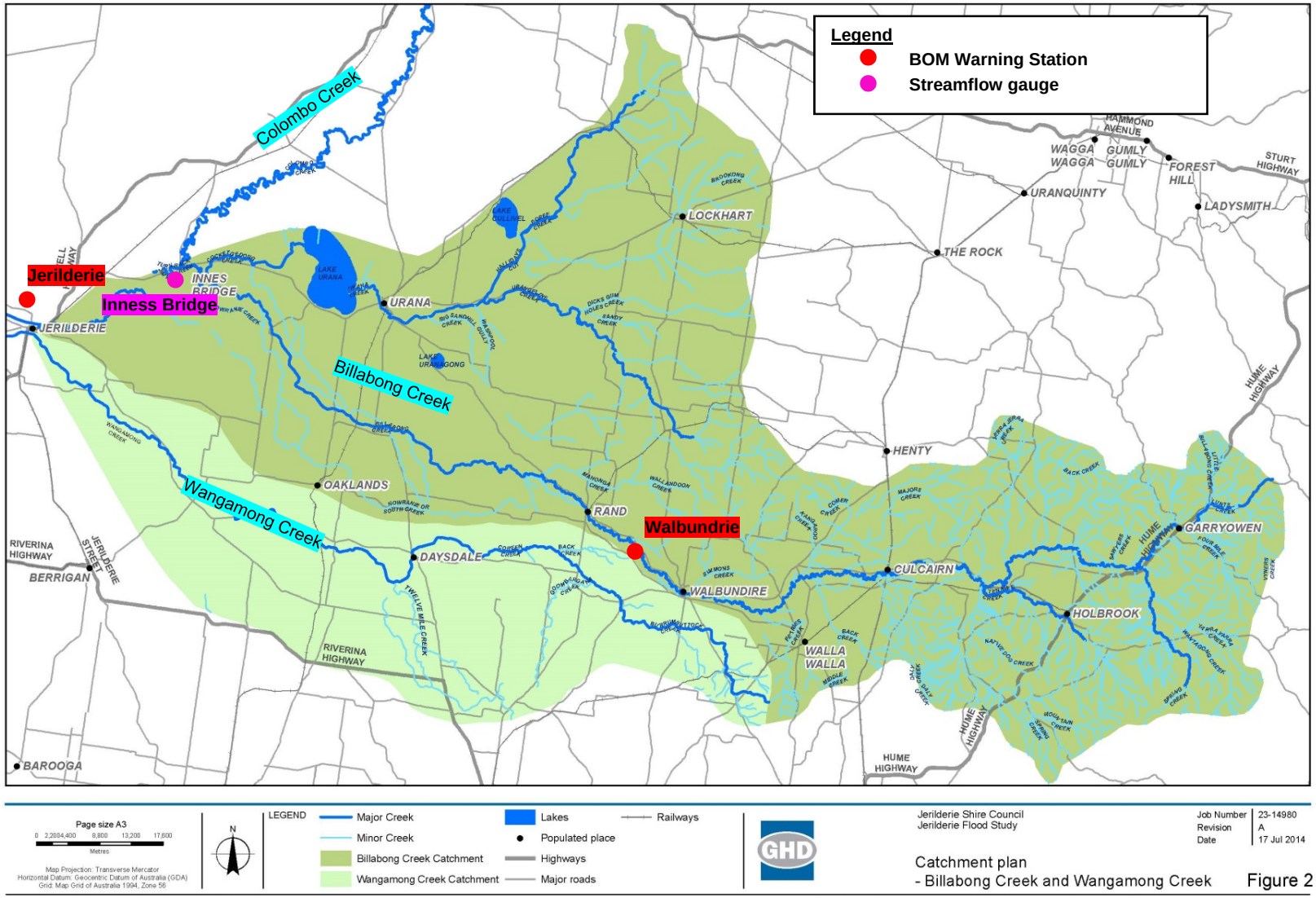


Figure 3 Location of Flood Warning Gauges

A further factor influencing the peak flood height at Jerilderie is the severity and timing of flooding in the Murrumbidgee River. Breakaway flows from the Murrumbidgee River floodplain discharge into the Billabong Creek system via the Colombo Creek. These flows enter the Billabong Creek floodplain between Lake Urana and Jerilderie. The March 2012 Murrumbidgee River flood peak at Narrandera was the equal highest recorded on record, equal with the 1974 peak recorded level and lower than the 1931 peak. The subsequent peak flood level at Jerilderie was only equivalent to a 5 year ARI event, which indicates that the floodplain storage condition between Walbundrie and Jerilderie is a very important factor in determining the severity of flooding at Jerilderie.

The Billabong Creek gauge at Innes Bridge provides the best indicator as to the likely severity of flooding at Jerilderie. The Inness Bridge gauge is located downstream of Lake Urana and the Colombo Creek inflows from the Murrumbidgee River system. There are no further significant inflows or major storages impacting on flooding between Inness bridge and Jerildie.

The Inness Bridge gauge has only been operating since 1995. The largest flood during its 20 year operating period is the March 2012 event, equivalent to a 5 year ARI flood. More data is required for the Inness Bridge station before flood heights for very large floods at Jerilderie can be predicted based on the recorded height at Inness Bridge.

'Every flood is different' is a phrase often used in describing floods. The Billabong Creek system is a complex system. Time and budgetary constraints do not allow for the necessary system analysis which would be required to identify an accurate flood forecasting model for Jerilderie which takes into account all of the variables influencing flooding at Jerilderie.

Table 2 lists selected recorded historical flood levels at the Walbundrie and Jerilderie gauges in the first and second columns. The third column is the probable flood level range at Jerilderie based on the recorded peak flood level at Walbundrie in column 1.

The probable flood level range in column 3 of Table 2 is quite large. For example, the peak flood level at Walbundrie in 2010 was 9.1 metres followed by a peak of 1.7 metres at Jerilderie. The peak flood level at Walbundrie in 1990 was less by comparison at 6.3 metres, however the subsequent peak at Jerilderie was 2.08 metres. The probable flood level range given in column 3 of Table 2 is therefore by necessity quite large.

Once flood data for future large flood events is accumulated at the Inness Bridge station site, more reliable flood heights at Jerilderie will be able to be predicted based on the recorded height at Inness Bridge. The time lag between the Inness Bridge peak and the Jerilderie peak is four to 5 days.

Table 2 Billabong Creek Gauging Station Flood Levels

Walbundrie Recorded Level (m)	Jerilderie Recorded Level (m)	Probable Flood Level Range at Jerilderie (m)
> 9.65	-	> 3.1 (> 100)
9.65 (1931)	-	2.9 to 3.4 (50 to 200 year ARI)
9.1 (2010)	1.7 (2010)	1.7 to 3.2 (5 to 100 year ARI)
8.7 (both 2012 & 1983)	1.7 (2012) & 2.0 (1983)	1.7 to 3.0 (5 to 60 year ARI)
8.4 (1974)	2.9 (1974	1.7 to 2.9 (5 to 50 year ARI)
7.7 (1970)	2.3 (1970)	1.7 to 2.6 (5 to 30 year ARI)
7.6 (both 2011 & 1995)	1.7 (2011) & 1.6 (1995)	1.6 to 2.5 (< 5 to 25 year ARI)
7.3 (1975)	1.4 (1975)	1.4 to 2.4 (< 5 to 20 year ARI)
6.3 (both 1986 & 1990)	1.6 (1986) & 2.1 (1990)	1.4 to 2.2 (< 5 to 10 year ARI)
5.85 (both 1992 & 1993)	1.3 (1992) & 1.8 (1993)	1.3 to 1.8 (< 5 to 6 year ARI
5.15 (both 2000 & 1984)	0.8 (2000) & 1.1 (1984)	0.8 to 1.1 (< 5)

Notes:

1. Jerilderie flood levels given in Table 2 are relative to the current gauge zero datum of 105.402 m AHD (station 410016).

2. Walbundrie flood levels given in Table 2 are relative to the current gauge zero datum of 167.095 m AHD (station 410091).

4.4.2 Flood Response Arrangements

The Jerilderie Shire Disaster Plan (DISPLAN) was last updated in 2007. It includes a Jerilderie Flood Sub Plan in an annexure. Notable aspects of the DISPLAN are:

- Jerilderie Shire Emergency Operations Centre is located at Council's offices at 35 Jerilderie Street.
- The Flood Sub Plan provides general information on flooding sources, historical floods, risk areas, hazard warnings and response operations.

The DISPLAN is to be replaced by the Jerilderie Shire Local Emergency Management Plan (EMPLAN). This is expected to include the preparation of a Jerilderie Shire Flood Emergency Sub Plan, which will be a sub plan of the EMPLAN.

Monash Park, a sporting complex located at the corner of Bolton Street and Mahonga Street is the current emergency evacuation centre at Jerilderie. This site is free from flooding in the extreme flood event modelled (refer to Figure B8 of the 2014 Flood Study report) and is therefore a favourable evacuation centre site from a flood risk perspective.

Given historical flood level data at both Walbundrie and Jerilderie and the above floor flooding thresholds identified in the 2014 Flood Study report, the following conclusions can be made:

- A recorded flood height of 7.3 metres or more at Walbundrie could result in above floor flooding of one house on the north side of Billabong Creek.
- A recorded flood height of 8.4 metres or more at Walbundrie could result in above floor flooding of the seven buildings identified as being subject to above floor flooding in a 100 year ARI event.
- A recorded flood height of 9.1 metres or more at Walbundrie could result in above floor flooding of the 21 buildings identified as being subject to above floor flooding in a 200 year ARI event.

The above represents what could occur. What actually occurs at Jerilderie will depend on the volume of floodwaters and the floodplain storage conditions prior to floodwater being conveyed between Walbundrie and Jerilderie and also the severity and timing of flooding in the Murrumbidgee River system.

Both the Walbundrie and Jerilderie Billabong Creek stations are part of the BOM's telemetered river height station network. There is a further Billabong Creek gauge located at Innes Bridge between Lake Urana and Jerilderie. There are multiple flood warning BOM gauges along the Murrumbidgee River system including the gauge at Narrandera.

Importantly the Jerilderie Hospital site is free from flooding to in excess of a 200 year ARI event. In an extreme flood (e.g. four times the size of a 100 year ARI event and equivalent to greater than a 10,000 year ARI event), grounds flooding around the fringe of the Hospital site may occur.

The Electricity Transmission and Distribution site at the corner of the Conargo Road and Watson Lane is at extremely low risk of flooding given most of the site is not inundated in an extreme flood.

The major roads at Jerilderie (Newell Highway, Conargo Road, Jerilderie-Oaklands Road) are not inundated in up to a 200 year ARI event. Evacuation access for the town should remain possible via the Newell Highway to the north in an extreme event (four times the 100 year ARI event). The other main road routes in and out of the town are expected to be inundated in an extreme flood event.

Bolton Street is overtopped on the south side approach to Billabong Creek in a 40 year ARI event close to the Ashton Street intersection. The depth of flooding over Bolton Street in a 100 year ARI event is 0.3 metre.

Further details on roadway overtopping are provided in the 2014 Flood Study report.

4.4.3 Education and Awareness Measures

Increasing public awareness of flooding risks assists in increasing the readiness of the community to prepare for and respond to floods. Measures to increase flood awareness within the local community could include:

- The dissemination of a Flood Information Pack that could be sent to all owners, business operators and residents of potential flood impacted properties.
- The dissemination of flood certificates on a regular basis which would inform each property owner of the flood situation at their particular property, flood data and advice.
- Signage or flood markers in public access flood prone areas giving notification of potential and historic flood levels (e.g. potential locations for a flood marker include parkland next to Lake Jerilderie, public pathway footbridge near Ashton Street).
- Providing a readily accessible flood information portal on Council's web site.

Heightening the flood awareness of the community at Jerilderie is in some ways less important than other towns due to the protracted flood warning time available. If a large flood is expected, there will be considerable time available (typically two weeks) to prepare for the flood so as to minimise risks to property and persons.

Education and awareness measures which are considered worthwhile are listed as follows:

- **Provide flood information on Council's web site**. A large amount of information can be included on the web site including documents such as flood study reports, flood maps and flood warning system information. It is noted that Council has posted the 2014 Jerilderie Flood Study report on its web site.
- **Certificates**. The issuing of flood certificates to those residents / occupants within flood prone areas is an effective measure for raising community awareness. Certificates can present the recorded ground, floor and flood levels for a property. This provides the property occupant with an improved understanding of their flood risk. Individual property flood specific certificates could be periodically posted out with rate notices (e.g. say every two years). Section 149 (2) and 149 (5) certificates issued by Council can include property specific flood information.
- **Flood markers**. Flood markers are another measure which can raise the level of flood awareness in the community. Flood markers erected in prominent locations showing the level of past floods act as a good reminder to the community of what can happen in a flood.

4.5 Flood Modifications Measures

4.5.1 Waterway Channel and Structure Modifications

None of The Billabong Creek waterway structures at Jerilderie represent significant impediments to flood flows.

The larger infrastructure bridge crossings (Newell Highway bridge, Bolton Street bridge, railway bridge) have sufficient waterway area to pass the 100 year ARI design flow with minimal afflux. The smaller pedestrian crossings similarly do not cause any adverse impacts.

The Newell Highway and to a lesser extent the railway line crossing of Wangamong Creek both induce a significant afflux in a 100 year ARI design flood. The afflux at the Newell Highway culvert structure is 0.7 metre. The afflux at the railway bridge structure is 0.25 metre.

The Wangamong Creek railway structure is effectively redundant. Its removal would reduce the flooding risk to the airport. Shallow inundation of the airport occurs for flood events more severe than a 50 year ARI event.

Given the limited benefits associated with the railway bridge removal, it has been excluded as a recommended flood mitigation measure following consultation with Council.

Upgrading the Newell Highway culvert structure at Wangamong Creek does not appear to be warranted given its limited impacts on upstream development.

The Jerilderie-Oaklands Road effectively acts as a levee bank, preventing backwater flooding from Billabong Creek inundating the floodplain depression to the south of the road, which links up with the Wangamong Creek floodplain. A small cross drainage culvert under the Jerilderie-Oaklands Road would need to be sandbagged to prevent backwater flooding of the depression south of the road.

4.5.2 Levee Protection

The purpose of a levee is to mitigate flooding and associated economic and social consequences of flooding by preventing floodwaters from entering the area affected by flooding.

Whilst levees can be effective at reducing the impact of flooding, it is important to ensure that the flood risk for other areas outside the levee protected area is not significantly increased.

Levees can also create increased risks in extreme events which are large enough to overtop the design crest of the levee. This can result in rapidly rising flood levels within the previously protected area resulting in a high risk to the safety of any persons present.

Council has previously erected temporary levees using sand bags in past floods, including along Ashton Street / Bolton Street, at the rear of the Bolton Street school property and the rear of the Willows property in Powell Street.

The 2014 Flood Study has identified those buildings most at risk of flooding. Aside from one house on the north side of Billabong Creek where the above floor flooding threshold is approximately 30 years ARI, above floor flooding of the remaining six buildings requires in excess of a 50 year ARI flood.

Permanent or temporary levee protection to the seven properties subject to 100 year ARI above floor flooding is not favoured. A ring levee protecting the Bolton Street / Ashton Street area will result in some afflux (increases in flood level) which will increases the risk of flooding on adjoining properties outside the ring levee protected area.

As previously discussed in Section 4.3.3, the use of temporary flood proofing barriers at a number of the properties identified as being most at risk of above floor flooding are favoured. There is sufficient time available to have these barriers in place. They will not lead to any adverse impacts on adjoining properties. Costs are low and they will only need to be used infrequently.

The individual properties most at risk of above floor flooding and suited to temporary flood proofing measures are not identified in this report as requested by Council. Details of the properties have however been provided to Council and will be available for those responsible for planning and carrying out flood response activities.

5. Draft Floodplain Risk Management Plan

5.1 Overview

Flooding at Jerilderie can occur from both Billabong Creek and Wangamong Creek. Historically, flooding impacts from these two creeks have affected only small parts of the town and quite infrequently.

The largest historical floods since records commenced in the early 1900s have occurred in 1931, 1956 and 1974. Recent minor flooding has occurred in 2010, 2011 and 2012 with these events equivalent to approximately a 5 year ARI flood.

Flooding impacts at Jerilderie consist of:

- 200 year ARI flood - Above floor flooding of seventeen houses and four other buildings.
- 100 year ARI flood - Above floor flooding of six houses and one school building.
- 50 year ARI flood – Above floor flooding of one house.
- 20 year ARI flood – no above floor flooding.

Flood damages at Jerilderie are estimated to amount to a relatively low $31,000/annum.

A range of measures have been assessed to mitigate flood impacts on existing development at Jerilderie and to also minimise the flood risk to future development. These measures can be categorised as:

- **Property modification measures** which are designed to avoid future development within areas which have a high flood risk or to reduce damages by flood proofing existing development.
- **Response modification measures** which are designed to modify the response of the population at risk prior to, during and after a flood.
- **Flood modification measures** which are designed to modify flooding conditions by lowering flow rates, flood levels or velocities and excluding floodwaters from protected areas.

Most of the draft recommended measures are property modification measures. Subject to feedback received from Council's Floodplain Risk Management Committee and the broader local community, these measures will be incorporated within the adopted Floodplain Risk Management Plan for Jerilderie.

5.2 Recommended Property Modification Measures

The recommended floodplain management plan measures are listed in Table 3. The table lists priorities based on a subjective assessment of the costs and benefits.

All of the measures are low cost property modification and response modification measures.

5.2.1 Land Use Planning and Development Controls

Implementing appropriate land use planning and development controls is an integral component of all floodplain risk management plans. In relation to Jerilderie, the following measures are recommended:

- Adoption of Flood Planning Levels (FPLs) based on the 100 year ARI flood level plus 0.3 metre of freeboard.
- Adoption of a Flood Planning Area at Jerilderie based on the area below the FPL as shown on Figure A1 of Appendix A.
- Adoption of the draft Planning and Development Controls (refer to Appendix A).
- Include property flood information where applicable on Council issued Section 149 certificates.
- Flood proofing of suitable buildings identified at most at risk of above floor flooding using temporary flood barriers at points of entry (sandbags, plastic sheeting).

5.3 Recommended Response Modification Measures

5.3.1 Flood Warning System Improvements

The following flood warning system improvement measures are recommended:

- Ensure that personnel who have roles and responsibilities in relation to the flood warning system understand the significance of the various gauge heights at Jerilderie and Walbundrie.
- EMPLAN – Flood Emergency Sub Plan to reflect the 2014 Jerilderie Flood Study findings and the 2015 Jerilderie Floodplain Risk Management Study and Plan recommendations.

5.3.2 Community Flood Awareness and Education Measures

The following community awareness measures are recommended:

- Establishment of a Flood Information facility on Council's web site where flood response information (e.g. Flood Sub Plan), detailed flood information (e.g. reports and maps from this project) and any other useful information relating to flooding can be accessed by the community.
- Periodic distribution of individual property Flood Certificates for those properties located within higher risk areas.
- Construction of a flood marker at Jerilderie.

5.3.3 Flood Data Collection

It is important that flood data be collected both during and in the aftermath of future flood events. The data can be used for future investigations associated with the update of the FRMP.

Future data collection should focus on:

- Large floods such as the 1974 event.
- Photographs if possible at or near the peak of flooding. Where possible, photographs to be date and time stamped.
- Recording reliable peak flood levels and their subsequent survey to the AHD datum.
- Details of instances of above floor flooding.

5.4 Recommended Flood Modification Measures

A range of possible flood modification measures were assessed. Given the relatively low impacts of flooding at Jerilderie on existing development, flood modification measures have not been recommended for inclusion within the Floodplain Risk Management Plan.

Table 3 Recommended Floodplain Management Plan Measures

Measure Description	Priority	Indicative Capital Cost ($)	Funding Sources
Property Modification Measures			
- Endorse land use planning approach outlined in Plan	High	Nil	Council
- Refine & incorporate flood planning and development controls into LEP & DCP	High	Nil	Council
- Include flooding information on S149 certificates	High	Ongoing	Council
Response Modification Measures			
- Develop flood information on Council's web site	High	5,000	Council / OEH / SES
- Prepare Flood Emergency Sub Plan to the EMPLAN	High	5,000	SES
- Data collection and documentation in future floods	High	Ongoing	Council / OEH / SES
- Construct Billabong Creek flood marker at prominent location	Moderate	5,000	Council / OEH
- Develop property flood certificates and distribute periodically	Medium	Ongoing	Council

Note:

1. Costs are indicative only and should be reviewed following any further design or investigation activities.

5.5 Implementation/Funding

There are a number of possible funding sources that could be considered by Council to assist with the implementation of the Floodplain Risk Management Plan. Potential funding sources include:

- Council contributed funds.
- NSW State Government and Australian Commonwealth Government funding programmes for the implementation of flood risk mitigation measures.
- SES for flood response improvement measures.

The majority of financial assistance is likely to come via the NSW Government Floodplain Management Program (the Program). The Program is administered by OEH. Applications under the most recent round of funding within this Program were also eligible for funding assistance under the jointly funded NSW and Commonwealth Government's Natural Disaster Resilience Program.

Funding under the Program is not available for assistance with measures associated with the applicant's core activities. This would include implementing land use planning and building development controls for example which is a core local government task. Eligible measures include implementing structural mitigation works, flood warning systems, evacuation management, voluntary house raising and voluntary purchase. Applicants are required to provide a certain level of funds for every $1 of grant funding. Given its limited rate base, Jerilderie Shire Council is likely to have to contribute $1 for every $6 of funding assistance, although this could change in the future. Funding of investigation and design activities is available. Funding for maintenance activities is generally not available.

6. Acknowledgements

The Jerilderie Shire Council has prepared this document with financial assistance from the NSW and Commonwealth Governments through the Natural Disaster Resilience Program. This document does not necessarily represent the opinions of the NSW or Commonwealth Governments.

The project has been completed with the assistance of the Jerilderie Shire Council's Floodplain Risk Management Committee, Council's staff, Office of Environment of Heritage's staff, NSW SES staff and the other government agency and local residents who have had involvement in the project. The assistance which has been provided is very much appreciated by Council.

7. Abbreviations and Glossary

7.1 Abbreviations

AAD	Average annual damage
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
BOM	Bureau of Meteorology
CMA	Catchment Management Authority
DEM	Digital elevation model
EMPLAN	Emergency Management Plan
LEP	Local Environmental Plan
FDM	Floodplain Development Manual (2005)
FPA	Flood planning area
FPL	Flood planning level
FRMS	Floodplain Risk Management Study
FRMP	Floodplain Risk Management Plan
OEH	Office of Environment and Heritage
PMF	Probable maximum flood
SES	State Emergency Service

7.2 Glossary

Annual Exceedance Probability (AEP) - AEP (measured as a percentage) is a term used to describe flood size. AEP is the long-term probability between floods of a certain magnitude. For example, a 1% AEP flood is a flood that occurs on average once every 100 years. It is also referred to as the '100 year flood' or 1 in 100 year flood'.

0.5% AEP sometimes referred to as the 1 in 200 year ARI event

1% AEP sometimes referred to as the 1 in 100 year ARI event

2% AEP sometimes referred to as the 1 in 50 year ARI event

5% AEP sometimes referred to as the 1 in 20 year ARI event

10% AEP sometimes referred to as the 1 in 10 year ARI event

20% AEP sometimes referred to as the 1 in 5 year ARI event

Afflux - The increase in flood level upstream of a constriction of flood flows. A road culvert, a pipe or a narrowing of the stream channel could cause the constriction.

Australian Height Datum (AHD) - A common national plane of level approximately equivalent to the height above sea level. All flood levels; floor levels and ground levels in this study have been provided in meters AHD.

Average annual damage (AAD) - Average annual damage is the average flood damage per year that would occur in a nominated development situation over a long period of time.

Average recurrence interval (ARI) - ARI (measured in years) is a term used to describe flood size. It is a means of describing how likely a flood is to occur in a given year. For example, a 100-year ARI flood is a flood that occurs or is exceeded on average once every 100 years.

Catchment - The land draining through the main stream, as well as tributary streams.

Critical Duration – The storm duration at which the peak flood flow and/or flood level occurs

Development Control Plan (DCP) - A DCP is a plan prepared in accordance with Section 72 of the *Environmental Planning and Assessment Act, 1979* that provides detailed guidelines for the assessment of development applications.

Design flood level - A flood with a nominated probability or average recurrence interval, for example the 100 year ARI flood is commonly use throughout NSW.

OEH (formerly DECCW, DECC, DNR, DLWC, DIPNR) - Office of Environment and Heritage. Covers a range of conservation and natural resources science and programs, including native vegetation, biodiversity and environmental water recovery to provide an integrated approach to natural resource management. The NSW State Government Office provides funding and support for flood studies.

Discharge - The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m3/s) or megalitres per day (ML/day). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving.

Effective warning time - The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

Extreme flood - An estimate of the probable maximum flood (PMF), which is the largest flood likely to occur.

Flood - A relatively high stream flow that overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

Flood awareness - An appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response and evacuation procedures.

Flood Fringe - 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.'

Flood hazard - The potential for damage to property or risk to persons during a flood. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.

Flood level - The height of the flood described either as a depth of water above a particular location (e.g. 1m above a floor, yard or road) or as a depth of water related to a standard level such as Australian Height Datum (e.g. the flood level was 77.5 m AHD). Terms also used include flood stage and water level.

Flood liable land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood prone land. Note that the term flood liable land now covers the whole of the floodplain, not just that part below the flood planning level, as indicated in the superseded Floodplain Development Manual (NSW Government, 2005).

Flood Planning Levels (FPLs) - The combination of flood levels and freeboards selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. The concept of flood planning levels supersedes the designated flood or the flood standard used in earlier studies.

Flood Prone Land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood liable land.

Flood stage - see flood level.

Flood Storage - 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 Study - A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood sizes.

Floodplain - The area of land that is subject to inundation by floods up to and including the Probable Maximum Flood event, that is, flood prone land or flood liable land.

Floodplain Risk Management Study – Studies carried out in accordance with the Floodplain Development Manual and assess options for minimising the danger to life and property during floods.

Floodplain Risk Management Plan - The outcome of a Floodplain Management Risk Study.

Floodway - Those areas of the floodplain where a significant discharge of water occurs during floods. Floodways are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

Freeboard - A factor of safety expressed as the height above the design flood level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as “greenhouse” and climate change.

High Flood Hazard - For a particular size flood, there would be a possible danger to personal safety, able-bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be a potential for significant structural damage to buildings.

Hydraulics Term - given to the study of water flow in waterways, in particular, the evaluation of flow parameters such as water level and velocity.

Hydrology Term - given to the study of the rainfall and runoff process; in particular, the evaluation of peak discharges, flow volumes and the derivation of hydrographs (graphs that show how the discharge or stage/flood level at any particular location varies with time during a flood).

Local catchments - Local catchments are river sub-catchments that feed river tributaries, creeks, and watercourses and channelised or piped drainage systems.

Local Environmental Plan (LEP) – A Local Environmental Plan is a plan prepared in accordance with the *Environmental Planning and Assessment Act*, 1979, that defines zones, permissible uses within those zones and specifies development standards and other special matters for consideration with regard to the use or development of land.

Local overland flooding - Local overland flooding is inundation by local runoff within the local catchment.

Local runoff - local runoff from the local catchment is categorised as either major drainage or local drainage in the NSW Floodplain Development Manual, 2005.

Low flood hazard - For a particular size flood, able-bodied adults would generally have little difficulty wading and trucks could be used to evacuate people and their possessions should it be necessary.

Flows or discharges - It is the rate of flow of water measured in terms of volume per unit time.

Overland flow path - The path that floodwaters can follow if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Floodwaters travelling along overland flow paths, often referred to as 'overland flows', may or may not re-enter the main channel from which they left — they may be diverted to another watercourse.

Peak discharge - The maximum flow or discharge during a flood.

Probable Maximum Flood (PMF) - The largest flood likely to ever occur. The PMF defines the extent of flood prone land or flood liable land, that is, the floodplain.

Risk - Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

Runoff - the amount of rainfall that ends up as flow in a stream, also known as rainfall excess.

SES - State Emergency Service of New South Wales

Stage–damage curve - A relationship between different water depths and the predicted flood damage at that depth.

Velocity - the term used to describe the speed of floodwaters, usually in m/s (metres per second). 10km/h = 2.7m/s.

Water surface profile - A graph showing the height of the flood (flood stage, water level or flood level) at any given location along a watercourse at a particular time.

8. References

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Appendices

Appendix A – Draft Planning and Development Controls

Draft Local Flood Development Control Policy for Jerilderie

1. Land to which these Development Controls Applies

The development controls applies to the Flood Planning Area as per Figure A1.

2. Objectives

The floodplain development controls are intended to:

- Guide the development of flood prone land, applying balanced strategies to economically, socially and environmentally manage the potential flood risk to life and property.
- Ensure that sufficient land is set aside to convey and/or store floodwaters and to protect and enhance the riparian zone.
- Ensure that development, when considered both individually and in the context of cumulative development trends, will not cause unreasonable adverse flooding impacts in other locations.

3. Definitions

This section adopts the definitions under the 2012 LEP and those definitions listed hereunder:

Flood Fringe	The remaining area of land affected by flooding, after floodway and flood storage areas have been defined.
Flood Hazard	The potential for damage to property or risk to persons during a flood.
Flood Planning Area (FPA)	Represents the area below the FPL and thus subject to flood related development controls.
Flood Planning Levels (FPLs)	Is the combination of flood levels and freeboards selected for floodplain risk management purposes.
Flood Prone Land	Land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
Flood Storage Areas	Those parts of the floodplain important for the temporary storage of floodwaters during the passage of a flood.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Freeboard	Refers to a designated height above the design flood which is stipulated to incorporate a suitable factor of safety into development.

4. Site Classifications

- Flood Planning Area means land as defined by the attached Figure A1, coinciding with the area below the 100 year ARI flood level plus a freeboard of 0.3 metres.
- Floodway, Flood Storage and Flood Fringe Areas means land as defined by the attached Figure A2.
- Low Hazard and High Hazard Areas means land as defined by the attached Figure A3.

5. General - Development within the Flood Planning Area

General Development Standards applicable to the Flood Planning Area are as follows:

a) All development within the Flood Planning Area requires the consent of Council.

b) All development shall be generally assessed in accordance with the latest edition of the NSW Floodplain Development Manual as issued by the NSW Government.

c) Development will not be permitted unless Council is satisfied that the proposed development will not increase the flood hazard rating or likely flood damage to any other property.

6. Development within Floodway Areas

Development Standards applicable to Floodway Areas are as follows.

High Hazard Floodway Areas

Development within High Hazard Floodway areas is generally discouraged. Council may consider granting permission to minor developments including extensions provided the requirements for Low Hazard Floodway areas can be met.

Low Hazard Floodway Areas

a) No alteration in ground levels by more than 100 mm will be permitted, whether by excavation or filling, without the submission of a local hydraulic study and prior development consent.

b) The erection of any new habitable structure on land within Floodway Areas will only be permitted if the land is outside the High Hazard area and supported by a local hydraulic impact study demonstrating that the works will have no adverse flooding effect on any other property.

c) Extensions. Extensions of up to 60 m^2 to dwellings are permissible. The floor level of the extension is to be as high as practical without requiring modification to the existing roof line.

d) Fencing. Fences of a continuous (impermeable) design, such as metal cladding, shall not be permissible. Post and rail fences will be permitted providing they are designed to permit the unimpeded flow of floodwater.

7. Development within Flood Storage Areas and Flood Fringe Areas

Development Standards applicable to Flood Storage Areas and Flood Fringe Areas are as follows.

High Hazard Flood Storage and Flood Fringe Areas

The same requirements as those listed under Low Hazard Floodway Areas apply.

Low Hazard Flood Storage and Flood Fringe Areas

a) Development consent is required to be obtained prior to any work or building activity being carried out within the Flood Planning Area. A hydraulic study may be required to be submitted with any Development Application at the discretion of Council.

b) The floor level of any new habitable building is to be 0.3 metres above the 100 year ARI flood level.

c) Commercial and industrial development. At Council's discretion, either the floor level is to be a minimum of 0.3 metre above the 100 year ARI flood level or the building should be flood proofed to at least 0.3 metre above the 100 year ARI flood level.

d) Extensions to existing residential buildings.

    i. Where the area of the extension is less than 50% of the existing floor area and the floor level of the existing house is above the 50 year ARI flood level, the floor level of the extension may be constructed to the same level.

    ii. In other circumstances (e.g. existing floor level is below the 50 year ARI flood level and / or the extension is greater than 50% of the existing floor area), the floor level of the extension is to be a minimum of 0.3 metres above the 100 year ARI flood level.

e) Extensions to existing non-residential buildings. Extensions to existing non-residential buildings may be constructed at the same level as the existing building. The complete building is to be flood proofed to 0.3 metres above the 100 year ARI flood level.

f) Carports and open sheds. Carports and open sheds may be constructed at existing ground levels. They must be constructed from flood compatible materials.

g) Fencing. Post and rail fences will be permitted providing they are designed to permit the unimpeded flow of floodwater. Fencing of a continuous design may be permitted provided that the applicants can demonstrate that the proposed fencing does not cause adverse impacts on flooding.

8. Development Application Requirements

A development application lodged for development within the Flood Planning Area is to be accompanied by:

a) Existing ground levels of the subject site certified by a registered surveyor.

b) Floodway and High Hazard Areas. A report from an accredited Consulting Engineer detailing any adverse effects of the proposed development on potential flood damages to the subject property and any other property as a result of the development.

c) Floodway and High Hazard Areas. An evacuation plan for the development accompanied by evidence that the local division of the SES has been consulted in the formulation of the plan.

Notes / Limitations:

1. The derivation of the Flood Planning Area shown on this plan has been based on the available ground surface survey elevation information and subsequent hydraulic modelling.

2. Areas shown outside the mapped Flood Planning Area may be subject to inundation by more extreme floods.

381,000 382,000 383,000 384,000 385,000 386,000 387,000 388,000

6,089,000 6,088,000 6,087,000 6,086,000 6,085,000

Billabong Creek
Wangamong creek
Wilson Road
Jerilderie RaceCourse
McDougall Street
Old Showground Road
Conargo Road
Lake Jerilderie
Ashton Street
Bundora Avenue
Bolton Street
Newell Highway
Jerilderie District Hospital
Jerilderie Street
Jerilderie Golf Course
Nowranie Street
Kennedy Street
Jerilderie – Oaklands Road
Jerilderie Airport
Rifle Range Road

1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Flood Extent and Depth (m)

- Area Subject to 100 Year Flooding
- Study Area Boundary
- Cadastre
- Railway
- Flood Planning Area (FPA) Boundary

Jerilderie Shire Council
Floodplain Risk Management Study

Job Number	23-14980
Revision	B
Date	23 Jul 2015

100 Year ARI Flood Event Flood Planning Area

Figure A1

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Data source: DEPI, VicMap, 2014; Jerilderie Shire Council, aerial, LiDAR, 2013; GHD, flood extents & contours, 2014. Created by:sldouglas

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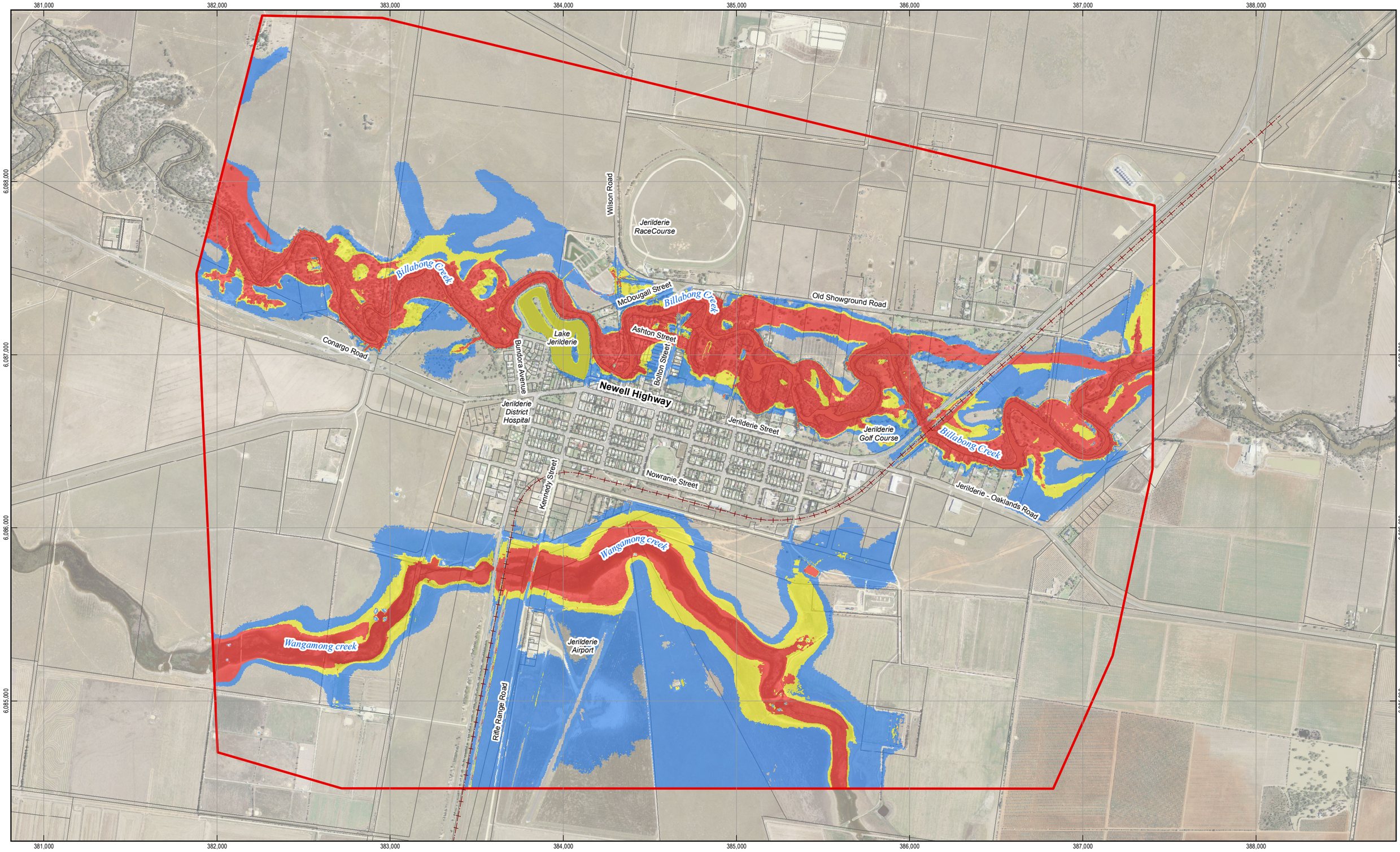

1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Study Area Boundary
- Cadastre
- Railway
- Flood Fringe
- Flood Storage
- Floodway

Jerilderie Shire Council
Floodplain Risk Management Study

Job Number	23-14980
Revision	A
Date	10 Jun 2015

100 Year ARI Flood Event Hydraulic Category Plan

Figure A2

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Data source: DEPI, VicMap, 2014; Jerilderie Shire Council, aerial, LiDAR, 2013; GHD, flood extents & contours, 2014. Created by:sldouglas

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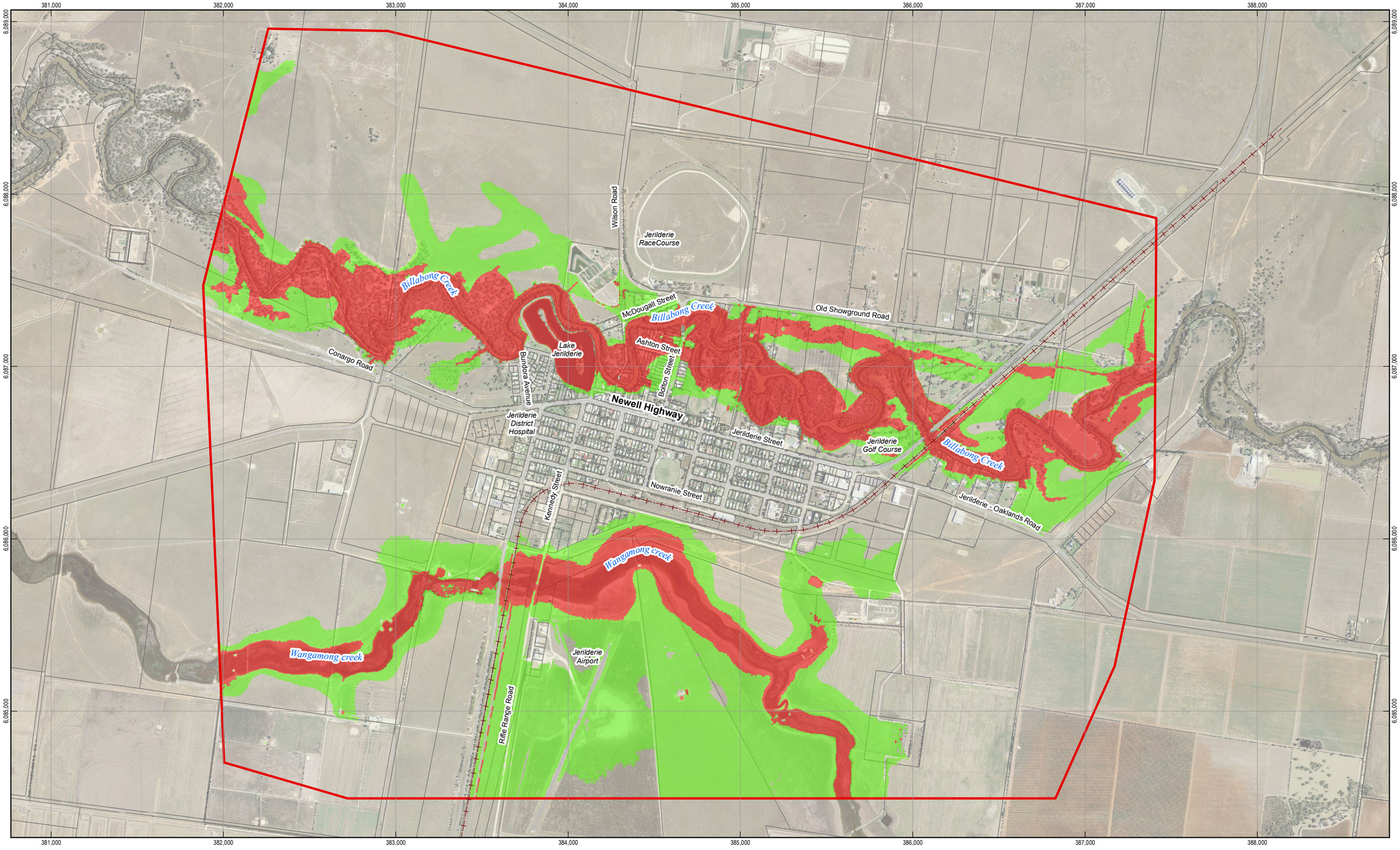

1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Study Area Boundary
- Cadastre
- Railway
- Low Hazard
- High hazard

Jerilderie Shire Council
Floodplain Risk Management Study

Job Number	23-14980
Revision	A
Date	10 Jun 2015

100 Year ARI Flood Event Hazard Category Plan

Figure A3

G:\23\14980\GIS\Maps\Deliverables\23_14980_Jerilderie_FRMS_Figure_A3_Rev_A.mxd

Data source: DEPI, VicMap, 2014; Jerilderie Shire Council, aerial, LiDAR, 2013; GHD, flood extents & contours, 2014. Created by:sldouglas

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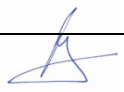
C	T Clark	R Berg		R Berg		3/8/2015
0	T Clark	R Berg		R Berg		19/10/2015

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