CABONNE COUNCIL

MOLONG FLOOD RISK MANAGEMENT STUDY AND PLAN 2024

OCTOBER 2024

VOLUME 1 – REPORT

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FOREWORD

NSW Government's Flood Policy

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

Under the Policy, the management of flood liable land remains the responsibility of local government. The State subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their flood risk management responsibilities. The Policy provides for technical and financial support by the State through the following four sequential stages:

1.	Data Collection and Flood Study	Collects flood related data and undertakes an investigation to determine the nature and extent of flooding.
2.	Flood Risk Management Study	Evaluates management measures for the floodplain in respect of both existing and proposed development.
3.	Flood Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4.	Implementation of the Plan	Construction of flood mitigation works to protect existing development. Use of Local Environmental Plans to ensure new development is compatible with the flood hazard. Improvements to flood emergency management procedures.

Presentation of Study Results

The results of the recently completed *Molong Flood Study* (Lyall & Associates, 2024) have been used as the basis for preparing the *Molong Flood Risk Management Study and Plan 2024*. The *Molong Flood Risk Management Study and Plan 2024* have been prepared under the guidance of the Flood Risk Management Committee comprising representatives from Cabonne Council, the NSW Department of Climate Change, Energy, the Environment and Water, the NSW State Emergency Service and community representatives.

ACKNOWLEDGEMENT

Cabonne Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Climate Change, Energy, the Environment and Water.

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ABBREVIATIONS

AEP	Annual Exceedance Probability (%)
AHD	Australian Height Datum
ARI	Average Recurrence Interval (years)
ARR 2019	Australian Rainfall and Runoff (2019 Edition)
BoM	Bureau of Meteorology
Council	Cabonne Council
DECC	Department of Environment and Climate Change
DCCEEW	Department of Climate Change, Energy, the Environment and Water
FRMM	Flood Risk Management Manual, 2023
FRMC	Flood Risk Management Committee
FPL	Flood Planning Level
FPA	Flood Planning Area
FRMS	Flood Risk Management Study
FRMP	Flood Risk Management Plan
FRMS&P	Flood Risk Management Study and Plan
LEP	Local Environmental Plan
LiDAR	Light Detection and Ranging (survey)
MHFL	Minimum Habitable Floor Level
NSWG	New South Wales Government
NSW SES	New South Wales State Emergency Service
PMF	Probable Maximum Flood
VP	Voluntary Purchase

SUMMARY

S1 Study Objectives

Following the completion of the *Molong Flood Study* (Lyall & Associates, 2024), Cabonne Council (**Council**) commissioned the *Molong Flood Risk Management Study and Plan 2024 (**Molong FRMS&P 2024**)*. The overall objectives of the current *Molong Flood Risk Management Study* (***Molong FRMS 2024***) were to reassess the impacts of flooding, review existing Council policies as they relate to development of land in flood liable areas, reconsider measures for the management of flood affected land and to develop a contemporaneous flood risk management plan for Molong (***Molong FRMP 2024***) which:

i) Proposes modifications to existing Council policies to ensure that the development of flood affected land is undertaken so as to be compatible with the flood hazard and risk.

ii) Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding.

iii) Provides a program for implementation of the proposed works and measures.

The study area for *Molong FRMS&P 2024* applies to areas that are affected by the following two types of flooding at Molong:

- **Main Stream Flooding** which occurs when floodwater surcharges the inbank area of Molong Creek, Reedy Creek, Boree Hollow, Moss Hollow Creek and Foys Creek. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater but can include shallower and slower moving floodwater on the overbank of the aforementioned watercourses.
- **Major Overland Flow**, which is experienced during periods of heavy rain and is generally characterised by relatively shallow and slow-moving floodwater that is conveyed overland in an uncontrolled manner toward the abovementioned watercourses.

Figure 1.1 is a location plan, while **Figure 2.1** shows the extent of of the 300 km^2 Molong Creek catchment upstream of its confluence with the Bell River, the western boundary of which forms the divide between the Macquarie and Lachlan River basins, **Figure 2.2** (3 sheets) shows the key features of the existing stormwater drainage system at Molong.

S2 Study Activities

The activities undertaken in this present study included:

1. Review of available data and the undertaking of a consultation program to ensure that the Molong community was informed of the objectives, progress and outcomes over the course of the study (**Chapter 1** and **Appendix A**).
2. Review of the flood history and flood risk management at Molong, as well as flooding patterns that are presented in the *Molong Flood Study* for flood events up to the Probable Maximum Flood (**PMF**). (**Chapter 2**, **Appendix B** and **Appendix C**).
3. Review of the economic impacts of flooding that are presented in the *Molong Flood Study*, including the numbers of affected properties and estimation of flood damages (**Chapter 2**).

4. Review of current flood related planning controls for Molong and their compatibility with flooding conditions (**Chapter 2**).
5. Strategic review of potential flood risk management works and measures aimed at reducing flood damages, including an economic assessment of the most promising measures and recommended inclusions/updates to the *Cabonne Local Environmental Plan 2012* (***Cabonne LEP 2012***) and *Cabonne Development Control Plan No. 10 – Flood Prone Land in Molong* (***Cabonne DCP No. 10***) (**Chapter 3** and **Appendix D**).
6. Ranking of works and measures using a multi-objective scoring system which took into account economic, financial, environmental and planning considerations (**Chapter 4**).
7. Preparation of *Molong FRMP 2024* (**Chapter 5**).

S3 Summary of Flood Impacts

While nuisance type flooding is experienced in parts of Molong, the main breakouts of flow which cause the most damage/disruption to existing residential and commercial development occur at the following four locations:

- from the left (western) and right (eastern) banks of Molong Creek upstream of the Euchareena Road Bridge;
- from the right (eastern) bank of Moss Hollow Creek upstream of Market Street; and
- along the Pillans Park Drainage Line where the piped drainage system has a capacity of less than 20% (1 in 5) Annual Exceedance Probability (**AEP**).

Figures 2.3 and **2.4** (3 sheets each) show the indicate extent and depth of above-ground inundation at Molong, as well as the indicative depth of above-floor inundation in existing residential, commercial/industrial and publicly owned properties for the 1% AEP and PMF events, respectively. **Appendix B** of this report contains several photos showing flood behaviour that was observed in parts of Molong during floods that occurred in February 1928, March 1956, November 2005, July 2016, January 2020, November 2021 and November 2022.

At the 1% AEP level of flooding, 44 commercial/industrial buildings, 41 dwellings and nine publicly owned buildings would be subject to above-floor inundation resulting in total flood damages of about $11.8 Million. About 75% of the total flood damages that are experienced in Molong during a 1% AEP flood are attributable to floodwater which surcharges the inbank area of Molong Creek, with the Central Business District (**CBD**) area being a major focus of those flood damages.

For a discount rate of 7% pa and an economic life of 50 years, the *Present Worth Value* of damages at Molong resulting from both Main Stream Flooding and Major Overland Flow for all events up to 10% and 1% AEP is about $4.7 Million and $12.0 Million, respectively, while the *Present Worth Value* of damages for flooding due to floodwater which surcharges the inbank area of Molong Creek for all flood events up to 10% and 1% AEP is about $2.3 Million and $8.0 Million, respectively.

In regards the Molong CBD, the *Present Worth Value* of flood damages up to the 10% AEP and 1% AEP floods is $1.4 Million and $5.8 Million, respectively. These values represent the total amount that can be spent on measures which alleviate flood damages in the Molong CBD for all floods up to 10% and 1% AEP, respectively, while still being economically justifiable.

S4 Flood Risk and Development Controls

An approach which uses the concepts of *flood hazard* and *hydraulic categorisation,* and is aimed at imposing a graded set of controls over development according to the flood risk has been recommended for incorporation into *Cabonne DCP No. 10*. The delineation of flood planning constraint categories is based on the proximity to flow paths, depths and velocities of flow, the rate of rise of floodwaters and ease of evacuation from the floodplain in the event of a flood emergency.

Figure D1.1 in **Appendix D** of this report is an extract from the *Flood Planning Map* relating to the study area. The extent of the Flood Planning Area (**FPA**) (the area subject to flood related development controls) has been defined as follows:

- In areas subject to Main Stream Flooding, the FPA is based on the traditional definition of the area that lies at or below by the 1% AEP plus 0.5 m freeboard.
- In areas subject to Major Overland Flow, the FPA is defined as the extent of areas which act as a floodway, as well as areas where depths of inundation exceed 0.1 m in a 1% AEP event.

Figure D1.2 in **Appendix D** is an extract of the *Flood Planning Constraint Category Map* for the study area which shows the subdivision of the floodplain into four categories which have been used as the basis for developing the graded set of planning controls.

Minimum habitable floor level (**MHFL**) requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on **Figure D1.1**. The MHFLs for residential land use types is the level of the 1% AEP flood event plus freeboard, whereas for commercial and industrial land use types the MHFL is to be as close to the 1% AEP flood level plus freeboard as practical, but no lower than the 5% AEP flood level plus freeboard. In situations where the MHFL is below the 1% AEP flood level plus freeboard, a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard.[1]

S5 The Flood Risk Management Plan

Chapter 5 of this report presents *Molong FRMP 2024*, with the recommended works and measures summarised in **Table S1** at the end of this Summary. The recommended works and measures have been given a provisional priority ranking, confirmed by the Flood Risk Management Committee, according to a range of criteria, details of which are set out in **Section 4** of this report. *Molong FRMP 2024* comprises four “non-structural” management measures which could be implemented by Council and NSW State Emergency Service (**NSW SES**) using existing data and without requiring Government funding. The measures are as follows:

- **Measure 1** – Inclusion of a new special flood considerations clause in *Cabonne LEP 2012* which would apply to land which lies between the FPA and the extent of the PMF.
- **Measure 2** - The application of a graded set of planning controls for future development that recognise the location of the development within the floodplain; to be applied through the update of *Cabonne DCP No. 10*. Suggested wording for inclusion in *Cabonne DCP No. 10* is set out in **Appendix D** of this report.

[1] Freeboard is equal to 0.5 m for development being assessed in areas affected by Main Stream Flooding and 0.3 m for development being assessed in areas affected by Major Overland Flow.

- **Measure 3** - Improvements in the NSW SES emergency planning, including use of the flood related information contained in this study to update the *Cabonne Shire Local Flood Plan*. Information in this report which would be of assistance to NSW SES includes data on the nature and extent of flooding at Molong, times of rise of floodwaters, duration and depths of inundation at major road crossings for a range of flood events and properties affected by flooding.
- **Measure 4** - Council should take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplain of the flood risk. This could be achieved through the preparation of a *Flood Information Brochure* which could be prepared by Council with the assistance of NSW SES containing both general and site-specific data and distributed with rate notices.

In addition to the above measures, *Molong FRMP 2024* includes the following four "non-structural" management measures which would require Government funding to implement:

- **Measures 5** and **6** – The investigation, design and implementation of an integrated severe weather/thunderstorm and flood warning system for Molong. As water levels not only in Molong Creek, but also in its tributary arms and more minor drainage lines where they run through Molong, rise relatively quickly in response to intense rainfall (commonly referred to as "flash flooding"), there is merit in implementing an effective location-based messaging system which warns both residents and business owners of the potential for flood producing rain to be experienced over Molong and also of rising water levels in Molong Creek. (Estimated Capital Cost - $0.35 Million)
- **Measures 7** – The commissioning of a scoping study into the expansion of the existing voluntary house purchase scheme to include a total of 18 existing residential properties that are located in high hazard floodway areas, as well as the raising of up to four existing timber framed houses that are subject to above-floor inundation in a 1% AEP flood event at Molong. (Estimated Capital Cost - $0.05 Million)
- **Measure 8** – The voluntary acquisition of up to 18 residential properties (Estimated Capital Cost - $7.2 Million) and the raising of up to four existing houses (Estimated Capital Cost - $0.6 Million) as part of a combined voluntary house purchase and raising scheme for Molong.

Measure 9 of *Molong FRMP 2024* comprises the commissioning of a feasibility study and concept design of the following flood modification measures which are aimed at reducing the impact that both Main Stream Flooding and Major Overland Flow has on existing residential and commercial development that is located in the immediate vicinity of the Molong CBD collectively referred to in *Molong FRMS 2024* as the "**Molong CBD Flood Mitigation Scheme**"):

a) The upgrade of the existing stormwater drainage system in the Molong CBD (denoted Potential Flood Modification Option (**PFMO**) 1a in *Molong FRMS 2024*). (Estimated Capital Cost - $3.7 Million)

b) The purchase and demolition of commercial buildings adjacent to the sag in Banks Street which would be aimed at reducing both the depth and duration of local stormwater runoff which would other pond above back-of-footpath levels in the road reserve (PFMO1b). (Estimated Capital Cost - $2.0 Million)

c) The construction of a levee along the western bank of Molong Creek extending from a location upstream of the Euchareena Road bridge to a location downstream of the Molong Creek Railway Bridge which would prevent the breakout of floodwater from the watercourse for all floods up to 10% AEP in magnitude (PFMO2). (Estimated Capital Cost - $4.0 Million).

d) The lowering of the eastern overbank of Molong Creek over a distance of about 500 m downstream of the Molong Creek Railway Bridge (PFMO3). (Estimated Capital Cost - $1.5 Million)

e) The realignment of Watson Street and Hill Street at their intersection, the realignment of a 150 m section of the aforementioned levee and the lowering of the western overbank of Molong Creek over a distance of about 200 m downstream of the Molong Creek Railway Bridge (PFMO4). (Estimated Capital Cost - $5.4 Million)

f) The duplication of the existing Molong Creek Railway Bridge on the western overbank of Molong Creek in combination with the lowering of its overbank area where it runs between the Euchareena Road Bridge and the railway corridor (PFMO5). (Estimated Capital Cost - $20.5 Million)

g) The duplication of the existing Euchareena Road Bridge on the eastern overbank of Molong Creek in combination with the lowering of its eastern overbank area where it runs between the extension of Dean Street and the road crossing. (Estimated Capital Cost - $7.2 Million)

Due to the significant time and costs associated with implementing the full suite of measures comprising the Molong CBD Flood Mitigation Scheme, *Molong FRMS 2024* determined that there would be merit in staging their design and construction as follows:

- **Phase 1** – Undertaking of a feasibility study and the preparation of a detailed concept design of the various measures comprising the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $0.6 Million) (**Measure 9**)
- **Phase 2** – Preparation of the detailed design and implementation of PFMO1a, PFMO1b, PFMO2 and PFMO3 of the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $11.2 Million) (**Measure 10**)
- **Phase 3** – Preparation of the detailed design and implementation of PFMO4, PFMO5 and PFMO6 of the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $33.1 Million) (**Measure 11**)

In addition to the above, *Molong FRMP 2024* includes the preparation of the concept design (**Measure 12**), as well as the detailed design and construction of flood mitigation works on the Pillans Park Drainage Line (denoted in *Molong FRMS 2024* as the '**Pillans Park Drainage Line Improvements**") (Estimated Cost - $1.3 Million) (**Measure 13**)

Molong FRMS 2024 also concluded that there is merit in developing and implementing a vegetation management plan that is specific to the reach of Molong Creek which runs through Molong (**Molong Creek at Molong Vegetation Management Plan**) (Estimated Cost - $0.5 Million) (**Measure 14**).

S6 Timing and Funding of Molong FRMP 2024 Measures

The total estimated cost to implement *Molong FRMP 2024* is **$54.9 Million**, exclusive of Council and NSW SES staff costs. The timing of the measures will depend on Council's overall budgetary commitments and the availability of both Local, State and Commonwealth Government funds.

Assistance for funding qualifying projects included in *Molong FRMP 2024* may be available upon application under Commonwealth and State funded floodplain management programs, currently administered by the NSW Department of Climate Change, Energy, the Environment and Water.

S7 Council Action Plan

1. Council to update *Cabonne LEP 2012* to include the NSW Government's *Special Flood Considerations* clause and also *Cabonne DCP No. 10* to incorporate the suggested form of wording set out in **Appendix D** of this report (**Measures 1** and **2** of *Molong FRMP 2024*).

2. NSW SES to update the *Molong Shire Local Flood Plan* using information on flooding patterns, peak flood levels, times of rise of floodwaters and flood prone areas identified in this report (**Measure 3** of *Molong FRMP 2024*).

3. Council to inform residents of the flood risk, based on the information presented in *Molong FRMS* (e.g. displays of flood mapping at Council offices, preparation of *Flood Information Brochure* for distribution with rate notices, etc) (**Measure 4** of *Molong FRMP 2024*).

4. Council to commission the investigation and design of a severe weather/thunderstorm and flood warning system for Molong, followed by its implementation (**Measures 5** and **6** of *Molong FRMP 2024*)

5. Council to commission a scoping study to investigate the expansion of the existing voluntary house purchasing scheme to include up to 18 existing residential properties and to raise the floor levels of up to four existing timber framed dwellings to the FPL (**Measure 7**).

6. Depending on the outcomes of the aforementioned scoping study. Council to proceed with the voluntary acquisition of up to 18 residential properties and the raising of up to four existing timber framed dwellings to the FPL (**Measure 8** of *Molong FRMP 2024*).

7. Council to commence Phase 1 of the Molong CBD Flood Mitigation Scheme (**Measures 9** of *Molong FRMP 2024*) followed by Phase 2 of its implementation (**Measure 10** of *Molong FRMP 2024*).

8. Subject to the availability of adequate funding, Council to proceed with Phase 3 of the Molong CBD Flood Mitigation Scheme (**Measure 11** of *Molong FRMP 2024*).

9. Council to commission the preparation of the concept design of the Pillans Park Drainage Line Improvements (**Measure 12** of *Molong FRMP 2024*), followed by its detailed design and construction (**Measure 13** of *Molong FRMP 2024*).

10. Council to develop and implement the Molong Creek at Molong *Vegetation Management Plan* (**Measure 14** of *Molong FRMP 2024*).

TABLE S1
RECOMMENDED MEASURES FOR INCLUSION IN MOLONG FLOOD RISK MANAGEMENT PLAN 2024

Measure	Required Funding	Features of the Measure	Benefit/Cost Ratio	Priority
1. Update of *Cabonne LEP 2012*	Council staff costs	➢ A new *special flood considerations* clause should be incorporated in *Molong LEP 2012* which applies to land that lies between the FPA and the PMF. The new clause relates to development with particular evacuation or emergency response issues (e.g. group homes, residential aged care facilities, etc). It is also aimed at protecting the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.	-	**High Priority**: this measure is designed to mitigate the flood risk to future development and has a high priority for inclusion in *Molong FRMP*. It does not require Government funding.
2. Incorporate recommended approach to managing future development on flood prone land in *Cabonne DCP No. 10*.	Council staff costs	➢ Graded set of flood controls based on the type of development and their location within the floodplain, defined as land inundated by the PMF. ➢ Floodplain divided into four zones based on the assessed flood hazard and hydraulic categorisation. ➢ The minimum floor levels for all land use types is the level of the 1% AEP flood event plus 0.5 m freeboard in the case of areas affected by Main Stream Flooding and plus 0.3 m freeboard in areas affected by Major Overland Flow. ➢ Additional controls applied to development that is located on land which lies above the Flood Planning Level where the large flood range is considered to pose a significant risk to life. ➢ Council to continue implementing controls on the discharge of stormwater runoff from future subdivisions. ➢ Council to explore opportunities for implementing a regional-detention basin type strategy for the control of stormwater runoff from future growth areas.	-	**High Priority**: this measure is designed to mitigate the flood risk to future development and has a high priority for inclusion in Molong *FRMP*. It does not require Government funding.
3. Ensure flood data in *Molong FRMS* are available to the NSW SES for improvement of flood emergency planning.	NSW SES costs	➢ NSW SES should update the *Cabonne Shire Local Flood Plan* using information on flooding patterns, times of rise of floodwaters and flood prone areas identified in this report.	-	**High Priority**: this measure would improve emergency response procedures and has a high priority. It does not require Government funding.
4. Implement flood awareness and education program	Council staff costs	➢ Council to inform residents of the flood risk, based on the information presented in *Molong FRMS*. (e.g. displays of flood mapping at Council offices, preparation of *Flood Information Brochure* for distribution with rate notices, etc).	-	**High Priority**: this measure would improve the flood awareness of the community and has a high priority. It does not require Government funding.
5. Investigate and design an integrated severe weather/thunderstorm and flood warning system for Molong	$0.05 Million	➢ Liaison with the Bureau of Meteorology and NSW SES to determine the most appropriate set of measures which would provide the maximum warning time of impending severe weather or thunderstorms, as well as actual rising water levels in Molong Creek. ➢ Implementation of an integrated severe weather/thunderstorm and flood warning system, which may as a minimum comprise the following: ○ Extension of the flood models that were developed as part of the *Molong Flood Study* about 15 km upstream to the location of WaterNSWs telemetered *Molong Creek at Downstream Borenore Creek* (GS 421178) stream gauge so as to more accurately define its rating curve and also the travel time of the flood wave between it and Molong. ○ The replacement of the manually read *Molong (Wellington Street Bridge)* flood gauge with a new telemetered stream gauge. ○ The determination of pre-determined alert levels on both the *Downstream Borenore Creek* stream gauge and *Molong (Wellington Street Bridge)* flood gauge for warning residents and business owners of rising water levels in Molong Creek. ○ A location-based text messaging service that alerts subscribers to: a) the issuing of a Severe Weather or Thunderstorm Warning from the Bureau of Meteorology; and b) the exceedance of the aforementioned pre-determined alert levels on both the *Downstream Borenore Creek* stream gauge and *Molong (Wellington Street Bridge)* flood gauge.	-	**High Priority**: this measure would improve the reaction time of the community to potential and actual flooding in parts of Molong and therefore reduce flood damages.
6. Implement integrated severe weather/thunderstorm and flood warning system for Molong	$0.30 Million			

Cont'd Over

TABLE S1 (Cont'd)
RECOMMENDED MEASURES FOR INCLUSION IN MOLONG FLOOD RISK MANAGEMENT PLAN 2024

Measure	Required Funding	Features of the Measure	Benefit/Cost Ratio	Priority
7. Commission Voluntary House Purchase and Raising Scoping Study	$0.05 Million	➢ Council to approach the owners of the 18 properties that are located in the High Hazard Floodway area to assess their willingness to participate in the NSW Government's Voluntary House Purchase Scheme. Upon gaining agreement, Council to seek grant funding from the NSW Government to purchase the relevant properties. ➢ Council to approach the owners of the four eligible properties that are located outside the High hazard Floodway area but have floor levels below the FPL to assess their willingness to participate in the NSW Government's Voluntary House Raising Scheme. Upon gaining agreement, Council to seek grant funding from the NSW Government to raise the dwelling to the required level.	-	**High Priority – This measure would remove people who are living in areas where there is an unacceptable risk to life.**
8. Implement Voluntary House Purchase and Raising Scheme for Molong	$7.8 Million	➢ The voluntary purchase of up to 18 residential properties that are located in high hazard floodway areas and the raising the floor levels of up to four houses to the FPL or above.	-	**Medium Priority – This measure would reduce flood damages that would be incurred in residential development that lies below the FPL.**
9. Investigate and prepare concept design of the Molong CBD Flood Mitigation Scheme (Phase 1)	$0.6 Million	➢ Underground utilities search ➢ Geotechnical investigation to assess foundation conditions ➢ Hydraulic modelling to confirm sizes of the key elements of individual elements of the measure, as well as the flood mitigating benefits of removing a select number of existing commercial buildings on Banks Street ➢ Prepare concept design and cost estimate ➢ Cost-benefit analysis to confirm the economics of the scheme ➢ Prepare a submission for Council and Government funding for detailed design and construction	-	**High Priority**: this measure would significantly reduce the impact of flooding on the community by protecting existing residential and commercial development that is located in the immediate vicinity of the Molong CBD from damaging flooding for events up to 10% AEP in magnitude.
10. Prepare detailed design and construct the first three components of the Molong CBD Flood Mitigation Scheme (Phase 2)	$11.2 Million	➢ Tasks involved are as follows: o Prepare detailed design and documentation o Prepare a submission for Council and Government funding. ➢ Construct works associated with PFMO1a, PFMO1b, PFMO2 and PFMO3 of the scheme.	0.12	
11. Prepare detailed design and construct remaining three components of the Molong CBD Flood Mitigation Scheme (Phase 3)	$33.1 Million	➢ Tasks involved are as follows: o Prepare detailed design and documentation o Prepare a submission for Council and Government funding. ➢ Construct works associated with PFMO4, PFMO5 and PFMO6 of the scheme.	0.13	**Medium Priority**: while this measure would further reduce the impact that flooding has on existing residential and commercial development that is located in the immediate vicinity of the Molong CBD it will require Council to secure adequate funding for its detailed design and construction .
12. Investigate and prepare concept design of the Pillans Park Drainage Line Improvements	$0.1 Million	➢ Underground utilities search ➢ Geotechnical investigation to assess foundation conditions ➢ Hydraulic modelling to confirm sizes of the key elements of individual elements of the measure ➢ Prepare concept design and cost estimate ➢ Cost-benefit analysis to confirm the economics of the scheme ➢ Prepare a submission for Council and Government funding for detailed design and construction	-	**High Priority**: this measure would formalise key elements of the existing drainage line and reduce the effects of damaging flooding from occurring in existing residential development at a number of locations.
13. Prepare detailed design and construct the Pillans Park Drainage Line Improvements	$1.2 Million	➢ Tasks involved are as follows: o Prepare detailed design and documentation o Prepare a submission for Council and Government funding. ➢ Construct various elements of the Pillans Park Drainage Line Improvements.	-	
14. Develop and implement the *Molong Creek at Molong Vegetation Management Plan*	$0.5 Million	➢ The *Molong Creek at Molong Vegetation Management Plan* will identify the reaches of the watercourse that require regular maintenance. It will also describe the scope of any rehabilitation works which would be required following the completion of any inbank works. ➢ The required funding would permit the development of the *Molong Creek at Molong Vegetation Management Plan*, the removal of dense vegetation from the inbank area of the watercourse where it runs through Molong and the implementation of a regular maintenance program over a five-year period.	-	**High Priority**: this measure would reduce the risk of a blockage being experienced at the major road crossing, as well as reduce the frequency of overbank flooding.
Total Estimated Cost	**$54.90 Million**			

1 INTRODUCTION

1.1 Study Background

Cabonne Council (**Council**) commissioned the preparation of a contemporaneous flood risk management study and plan for the township of Molong in accordance with the New South Wales Government's *Flood Prone Land Policy* (***Molong FRMS&P 2024***). **Figure 1.1** shows the extent of the study catchment at Molong.

The current *Molong Flood Risk Management Study (**Molong FRMS 2024**)* reviewed baseline flooding conditions and the economic impacts of flooding that were assessed as part of the recently completed *Molong Flood Study*. It also assessed the feasibility of potential measures which are aimed at reducing the impact of flooding on both existing and future development at Molong. This process allowed the formulation of a contemporaneous flood risk management plan for Molong (***Molong FRMP 2024***).

The study focuses on the following two types of flooding which are present in different parts of the study area:

- **Main Stream Flooding** which occurs when floodwater surcharges the inbank area of Molong Creek, Reedy Creek, Boree Hollow, Moss Hollow Creek and Foys Creek. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater but can include shallower and slower moving floodwater on the overbank of the aforementioned watercourses.
- **Major Overland Flow**, which is experienced during periods of heavy rain and is generally characterised by relatively shallow and slow-moving floodwater that is conveyed overland in an uncontrolled manner toward the abovementioned watercourses.

1.2 Background Information

The following documents were used in the preparation of this report.

- *Molong Flood Study* (Lyall & Associates, 2024)
- *Flood Risk Management Manual* (New South Wales Government (NSWG), 2023) (***FRMM***)
- *Cabonne Local Environmental Plan, 2012* (***Cabonne LEP 2012***)
- *Cabonne Development Control Plan No. 10 – Flood Prone Land in Molong* (***Cabonne DCP No. 10***)
- *Cabonne Shire Local Flood Plan* (NSW State Emergency Service (**NSW SES**), 2013)

1.3 Overview of Molong FRMS&P Report

The results of *Molong FRMS 2024* and *Molong FRMP 2024* are set out in this report. The contents of each Chapter of the report are briefly outlined below:

- **Chapter 2**, **Baseline Flooding Conditions**. This Chapter includes a description of the existing drainage system at Molong, as well as the nature of flood behaviour in the study area based on the findings of the *Molong Flood Study*. The Chapter also summarises the economic impacts of flooding on existing urban development, reviews Council's flood planning controls and management measures, as well as NSW SESs flood emergency planning.

- **Chapter 3**, **Potential Flood Risk Management Measures**. This Chapter reviews the feasibility of flood risk management measures for their possible inclusion in *Molong FRMP 2024*. The list of measures considered is based on input from the Community Consultation process, which sought the views of residents and business owners in the study area in regard to potential flood risk management measures which could be included in *Molong FRMP 2024*. The measures are investigated at the strategic level of detail, including indicative cost estimates of the most promising measures and benefit/cost analysis.
- **Chapter 4**, **Selection of Flood Risk Management Measures**. This Chapter assesses the feasibility of potential flood risk management strategies using a multi-objective scoring procedure which was developed in consultation with the Flood Risk Management Committee (**FRMC**) and outlines the preferred strategy.
- **Chapter 5, Molong Flood Risk Management Plan 2024** presents *Molong FRMP 2024* which comprises a number of structural and non-structural measures which are aimed at increasing the flood awareness of the community and ensuring that future development is undertaken in accordance with the local flood risk.
- **Chapter 6** contains a glossary of terms used in the study.
- **Chapter 7** contains a list of References.

Three technical appendices provide further information on the study results:

- **Appendix A** – Summarises the residents' and business owners' views on potential flood risk management measures which could be incorporated in the *Molong FRMP 2024*.
- **Appendix B** - Contains photographs showing flood behaviour that was observed in parts of Molong during floods that occurred in February 1928, March 1956, November 2005, July 2016, January 2020, November 2021 and November 2022.
- **Appendix C** – Contains a set of A3 colour figures showing the nature of flooding at Molong for a range of design flood events.
- **Appendix D** - Presents guidelines for the control of future urban development in flood prone areas in the Cabonne local government area. The guidelines cater for both Main Stream Flooding and Major Overland Flow.

1.4 Community Consultation

A *Community Newsletter* was prepared by the Consultants and distributed to residents and business owners by Council at the same time that the *Molong Flood Study* was on public exhibition. A *Community Questionnaire* was also distributed by Council at the same time seeking details from residents and business owners regarding their attitudes toward potential flood risk management measures.

Community responses are summarised in **Chapter 3** of this report, with supporting information in **Appendix A**. The views of the community on potential flood risk management measures to be considered in the study were also taken into account in the assessment presented in **Chapter 3** of this report.

1.5 Flood Frequency and Terminology

In this report, the frequency of floods is referred to in terms of their Annual Exceedance Probability (**AEP**). The frequency of floods may also be referred to in terms of their Average Recurrence Interval (**ARI**). The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) – %	Average Recurrence Interval (ARI) – years
0.2	500
0.5	200
1	100
2	50
5	20
10	10
20	5

The AEP of a flood represents the percentage chance of its being equalled or exceeded in any one year. Thus a 1% AEP flood, which is equivalent to a 100 year ARI, has a 1% chance of being equalled or exceeded in any one year and would be experienced, on the average, once in 100 years; similarly, a 20 year ARI flood has a 5% chance of exceedance, and so on.

The 1% AEP flood (plus freeboard) is usually used to define the Flood Planning Level (**FPL**) and Flood Planning Area (**FPA**) for the application of flood related controls over residential and commercial/industrial development. While a 1% AEP flood is a major flood event, it does not define the upper limit of possible flooding. Over the course of a human lifetime of, say 70 years, there is a 50 per cent chance that a flood at least as big as a 1% AEP event will be experienced. Accordingly, a knowledge of flooding patterns in the event of larger flood events up to the Probable Maximum Flood (**PMF**), the largest flood that could reasonably be expected to occur, is required for land use and emergency management planning purposes. In the *Molong Flood Study*, flooding patterns in the study area have been assessed for design floods ranging between 20% AEP event and the PMF.

2 BASELINE FLOODING CONDITIONS

2.1 Physical Setting

The township of Molong has a population of about 1,600 and is located on the banks of Molong Creek in the Cabonne Council Local Government Area (**LGA**). **Figure 1.1** shows that Molong is located in the headwaters of the Macquarie River Valley catchment. Molong Creek flows in a northerly direction through the urbanised parts of Molong and has a total catchment area of about 300 km^2 at the point at which it discharges to the Bell River approximately 13 km to the north of the town.

Existing residential development int Molong is generally bounded by the Orange-Broken Hill Railway to the north, Bertie Cole Street to the east, South Street to the south and King Street to the west, while there are pockets of large-lot residential type development at the following locations:

- in the area bounded by the Orange-Broken Hill Railway to the west, Hill Street to the north, King Street to the east and South Street to the south;
- in the area bounded by Euchareena Road to the north, Back Saleyards Road to the east, Molong Creek to the south and Shadforth Street/Bertie Cole Street to the west; and
- on the northern side of Banjo Patterson Way to the east of Molong Cemetery Road.

The commercial centre of the town which comprises both general residential and commercial type development is located on the left (western) overbank of Molong Creek in the area bounded by Hill Street to the north, Watson Street to the east, Riddell Street to the south and Edward Street to the north (referred herein as the "**Molong CBD**").

There are pockets of land zoned for industrial type development at the following locations:

- on the eastern and western side of the railway to the north of Marsden Street;
- in the area bounded by Riddell Street to the north, George Street to the east, Wellington Street to the south and Boree Hollow to the west;
- in the vicinity of the intersection of Starrlea Road and Hill Street; and
- in the vicinity of the intersection of Market Street and Castle Street.

2.2 Drainage System

The headwaters of the Molong Creek catchment are located about 30 km to the south of Molong in the vicinity of Mount Canobolas. The catchment is characterised by undulating pastoral land with pockets of state forest. **Figure 2.1** shows the extent of the catchments which contribute to flow in Molong Creek at the location of two WaterNSW operated stream gauges that are located on the watercourse, and at its confluence with the Bell River.

The inbank area of Molong Creek generally comprises an incised 20 m wide by 3 m deep channel which has a grade of about 3.5% where it runs through the urbanised parts of Molong. **Figure 2.2** (sheet 3) shows the location of the five bridge crossings and two inline weirs of Molong Creek at Molong.

Figure 2.2 shows that Reddy Creek, Boree Hollow, Moss Hollow Creek and Foys Creek discharge to Molong Creek in the vicinity of the town, as do a number of unnamed drainage lines that flow through the study area and discharge to the main arm of the creek. **Figure 2.2** shows the alignment of a concentrated flow path that runs through the urbanised part of Molong between Pillans Park and Molong Creek which is denoted herein as the "**Pillans Park Drainage Line**".

Figure 2.2, sheets 2 and 3 show the layout of the existing piped drainage system which generally comprises piped and culvert crossings beneath the roads and grass lined table drains that convey overland flow towards Molong Creek and its tributaries. Enclosed drainage systems comprising piped elements and stormwater inlet pits are present at the following locations:

- between Park Street and South Street to the east of Gidley Street;
- in the vicinity of the intersection of the Mitchell Highway and Wellington Street;
- along Riddell Street between Edward Street and Molong Creek;
- in the vicinity of the intersection of Watson Street and Bank Street; and
- along Gidley Street between Bank Street and Molong Creek.

Figure 2.2, sheets 2 and 3 also show the location of eight flood gates that have been fitted to the outlets of the existing piped drainage system to prevent floodwater in Molong Creek backing up the local drainage system, the location of which were based on information that is contained in SMEC,2018.

2.3 Flood History

Parts of Molong have been impacted by major flooding in February 1928, March 1956, August 1990, November 2005, November 2021 and November 2022. Of these, the November 2022 flood is considered to be the flood of record at Molong. **Table 2.1** sets out the approximate AEP of the four most recent flood events to have been experienced at Molong as determined by the *Molong Flood Study*.

TABLE 2.1
APPROXIMATE ANNUAL EXCEEDANCE PROBABILITY OF FOUR MOST RECENT FLOOD EVENTS AT MOLONG

Historic Flood	Approximate AEP
2 August 1990	15% (1 in 7) AEP
8 November 2005	3.2% (1 in 31) AEP
26 November 2021	10% (1 in 10) AEP
14 November 2022	0.45% (1 in 220) AEP

1. Source: *Molong Flood Study*

A number of respondents to the *Flood Study Questionnaire* provided photographic evidence of flooding that has recently been experienced in parts of Molong, copies of which are contained in Appendix C of the *Molong Flood Study* and have been reproduced herein in **Appendix B** of this report. **Plates 1** and **2** over the page also show flooding that was experienced in Bank Street during the floods that occurred in February 1928 and March 1956, respectively.

Plate 1 – Flooding experienced in Bank Street in February 1928, when floodwater was said to be lapping at the steps of the old Post Office building at 52 Bank Street.

Plate 2 – Flooding experienced in Bank Street in March 1956, when floodwater was said to have reached the old Commonwealth Bank building at 42 Banks Street.

2.4 History of Flood Risk Management

2.4.1 New South Wales Inland Rivers Flood Plain Management Studies – Macquarie Valley (Sinclair Knight & Partners, 1984)

An assessment of the existing flood risk at Molong, as well as measures that were aimed at reducing the impact of flooding on the existing community was first undertaken in 1984 as part of the series of floodplain management studies that were undertaken by Sinclair Knight & Partners (**SKP**) for the inland rivers of NSW.

Chapter 25 of the report that deals with the Macquarie Valley (SKP, 1984) deals with flooding at Molong. SKP, 1984 identified that much of the central business district of Molong lies within the natural floodplain of Molong Creek. The report refers to the March 1956 flood and the fact that there was up to 1 m of water in shops and businesses located in Watson Street and Banks Street. The report attributes the raised railway station, goods and trucking yards as providing a level of protection from overbank flooding. It also attributes elevated flood levels to the piers of the old timber bridge which historically captured a large amount of debris due to their skewed nature. **Plate 3** is a photo which has been taken looking in the upstream direction at the old timber bridge at Molong.

Plate 3 – Old Molong Creek Railway Bridge crossing of Molong Creek.

SKP, 1984 notes that since 1956, Council replaced the old timber bridge on Euchareena Road (denoted the Old Shades Road bridge in SKP, 1984) with a major concrete structure that increased its waterway area and adopted a 400 mm freeboard to the peak 1% AEP flood level. A similar design standard is also said to have been adopted for the then new Wellington Street bridge, with its soffit level set 530 mm above the peak 1% AEP flood level.

SKP, 1984 notes that Council carried out stream clearing works over a 4.2 km length of Molong Creek extending from Copper Street to the Molong Creek Railway Bridge between 1971-1980, which local residents advised at the time had reduced the frequency of overbank flooding.

SKP, 1984 noted that stormwater has historically backed up the existing drainage system and inundated the CBD area every 10 years on the average.

SKP, 1984 recommended that the following flood risk management measures be implemented at Molong:

- *Subject to State Rail Authority plans to upgrade/replace their existing structures it is suggested that they provide effective waterway areas equivalent to those provided under the Council bridges upstream.*
- *There is sufficient land further west of the current centre of Molong to allow for future expansion of the town away from the flood plain. It is therefore recommended that no infill development be permitted within the area inundated by the flood of 1956. Any redevelopment plans of existing buildings within that area should be governed by a floor level control of 500 millimetres above the 1956 flood level.*
- *Additional minor stream clearing works both upstream and downstream from the earlier works are recommended.*
- *A hinged reflux valve should be fitted to the stormwater outlet to Molong Rivulet.*
- *Single dwelling within floodway to be purchased by agreement.*

While SKP, 1984 recognised that it would be feasible to construct a short length of levee to prevent any breakout flow from occurring south of the railway station, such a restriction to the natural floodplain flow was seen as producing a significant afflux, noticeably along Betts Street. As a result, the construction of a levee at this location was not recommended as part of SKP, 1984.

2.4.2 Molong Floodplain Management Study (Bewsher Consulting, 1999)

A floodplain management study was commissioned by Council in 1999, the findings of which are set out in the report entitled "*Molong Floodplain Management Study*" (Bewsher Consulting, 1999). The study identified that a total of 28 dwellings and 42 non-residential properties would be above-floor inundated in a 1% AEP flood, with significant flood risk present during rarer floods, with a total of 170 properties affected during a PMF event.

Bewsher Consulting, 1999 recommended that the following flood risk management measures be implemented at Molong:

- *Stormwater Floodgates (Option 1.6)*

  The installation of floodgates on the stormwater drainage outlets was evaluated. It was found that this would result in significant reduction of damage to the commercial area. However a minor increase in flood levels would occur at a few properties on the eastern side of the creek. It is recommended that floodgates not be installed until an option which mitigates flooding at these properties is completed.

- *Vegetation Management (Option 1.7)*

  A significant portion of Molong Creek within the study area is overgrown with exotic vegetation which slows the flow of floodwaters and traps debris. Clearing this vegetation could lower flood levels by more than 0.2 m at some locations. A strategy for clearing exotic vegetation from the creek corridor and rehabilitation with indigenous vegetation has been prepared. The cost of this option would be about $0.4 million. Although this option cannot be justified on economic grounds, there are significant intangible benefits and failure to manage the vegetation may result in the worsening of flooding.

- *Voluntary Purchase (Option 2.1(a))*

  The opportunity to raise some seriously flood prone houses and/or to offer owners the opportunity to have their properties purchased voluntarily, was also assessed. The Floodplain Management Plan contains a recommendation that five existing properties (currently flooded in a 20 year event) be purchased. These properties are all on the eastern side of Molong Creek.

- *Building and Development Controls (Option 2.3)*

  Another measure investigated was a revision to the current planning and building controls which apply to developments in the floodplain. As discussed above, a graded set of controls relating to flood height, community awareness, building components, evacuation, etc. are proposed for varying land uses and flood risks.

- *Community Awareness and Education (Option 3.1)*

  Increasing the flood awareness of the community was investigated. By increasing the community's understanding and awareness of floods, flood damages in future flood events will be reduced. Components of the proposed awareness program would include flood totem poles, use of local media and public displays.

- *Flood Warning System (Option 3.2)*

  A flood warning system for Molong Creek catchment has also been evaluated and recommended for implementation. It involves the provision of two river gauges and the use of existing rain gauges.

- *Emergency Planning and Management and Evacuations During Floodings*

  The State Emergency Service has been closely involved in the study and has reviewed its existing emergency management plans for Molong during the course of the study. The SES has recommended the establishment of a flood warning system and improved access to SES headquarters in Molong.

Bewsher Consulting, 1999 estimated that it would cost about $0.9 million to implement the above measures.

While Bewsher, 1999 identified that the railway bridge forms an obstruction to flow and results in a 0.5 m increase in peak 1% AEP flood levels, it recommended that Council write to the Railway Services Authority to make them aware of the impact that the bridge has on flooding, and requesting that if the bridge is to be reconstructed in the future, the new design should have minimal impact on flood levels.

Bewsher, 1999 also assessed the merits of constructing a levee along both sides of Molong Creek, but dd not recommend it for inclusion in the Floodplain Management Plan for Molong given its height would render it unattractive visually and may cause a significant reduction in the amenity of the floodplain area. It also noted that local drainage problems would also occur behind the levee and that significant problems would occur if the levee was overtopped.

2.4.3 Review of Molong Floodplain Risk Management Study (URS, 2011)

Following the flooding that was experienced in Molong in November 2005, Council engaged URS to undertake a review of Bewsher Consulting, 1999, the findings and recommendations of which are set out in the report entitled "*Review of Molong Floodplain Risk Management Study*" (URS, 2011).

Following a review of the flooding situation in Molong, the following flood risk management measures were recommended for inclusion in the flood risk management plan for Molong:

- ***Flood Modification Measures:***
  - *Upgrading of local drainage system with the objective of containing minor flows to pit/pipe/open gutter systems and major flows within the existing road reserves:*
  - *Consideration be given to providing temporary flood protection measures, such as the "Floodgate" line of products, to permanent commercial structures within the 100 year ARI flood extent; and*
  - *Asset management – specific measures be included in Council's asset management plan for the long-term maintenance of the various flood gates within the town.*

  It should be noted that the levee option is not supported for economic reasons and its impact of additional flooding in Betts Street. *[Bold added for emphasis]*
- ***Property Modification Measures:***
  - *The Cabonne Shire LEP should be structured in accordance with the Standard Instrument (Local Environmental Plans) Order 2006 and the suggested Clauses (Section 7) including the following provisions:*
    - *Consistency with definitions and terminology, including land use zoning;*
    - *Consistency with development standards; and*
    - *Flexibility to create dynamic land use solutions.*
    - *Any adjustments to zonings should give consideration of flood risk and terms outlined in the Manual for rezoning land within the flood planning areas.*
  - *The Flood Planning Level be adopted as equal to the 100 year ARI flood level plus 0.5m freeboard and stated in the LEP. A DCP specific to flood prone land may be useful in providing more comprehensive guidelines for development within flood prone land which would be in addition to the provisions of the LEP. A draft DCP is attached in Appendix H.*
  - *Specific statements for issue with Certificates under Section 149(2) and 149(5) of the EP&A Act in relation to floodplain risk management be prepared and adopted.*
  - *Provisions for consent applying to development in flood prone areas should be consistent with those in the Manual. Council is required to distinguish where flood related development controls are nominated for residential development and all other*

development. Graded land use control measures would reflect the flood risk and the nature of the proposed land use.

- *Council has specified the development permissible on areas of land and whether council consent is required within the LEP. When considering development applications, Council must have regard to the matters set out in Section 79C of the EP&A Act.*
- *The relevant sections of the management plan after completion are to be incorporated in Council's LEP, flood related DCP and/or policy.*

- ***Response Modification Measures:***
  - *Council work with the State Emergency Service to upgrade the Cabonne Local Flood Plan (April 2007) in accordance with; the Manual; the SES template and the Australian Emergency Manuals Series; and the information provided in this report, particularly the BoM Flash Flood warning system;*
  - *Council and SES work with Caravan park operators and owners to establish a "Floodsafe" program for the operating Caravan Parks; and*
  - *Council and SES to develop a community flood awareness and education program on the need to address flood risk across the full range of floods, covering issues such as noncompatible development and what measures are needed for floodplain risk management.*
- ***General***
  - *Council develop a data collection program, especially for Molong, so that future revision of the Floodplain Risk management Plan can be based on the most up-to-date data.*

2.4.4 Proposed Molong Town Levee – Feasibility Study – Levee Options Assessment (SMEC, 2018)

Council commissioned SMEC to undertake a feasibility study of the following three levee alignment options at Molong, the findings and recommendations of which are set out in the report entitled *"Proposed Molong Town Levee – Feasibility Study – Levee Options Assessment"* (SMEC, 2018):

- **Levee Alignment No. 1** - western side levee only;
- **Levee Alignment No. 2** - levees on both east and west sides of creek; and
- **Levee Alignment No. 3** - levees on both east and west sides of creek, but a longer east side levee.

Plate 4 over the page is taken from SMEC, 2018 showing the alignment of the three levee options noting that Segment A corresponds with Levee Alignment No. 1, Segment B corresponds with Levee Alignment No. 2 and Segment C corresponds with Levee Alignment No. 3.

The study brief limited the assessment of the level of flood protection afforded by the three levee options to 20%, 5% and 2% AEP given the potential for levees providing a higher level of protection to result in too great an impact on flood behaviour in existing development. The study also reviewed the benefits that would be provided by further stream clearing and the upgrade of the internal drainage system.

Plate 4 – Levee alignments assessed as part of SMEC, 2018 (Source: SMEC, 2018)

The key recommendations of SMEC, 2018 comprised the following:

- *Alignment 1 (western side levee) with 50 year ARI protection is the preferred levee option of all nine (9) options examined. It has the highest Benefit-Cost ratio (0.4).*
- *Assess the trend for Benefit-Cost ratio to increase beyond the 50 year ARI level, with a possible peak B/C around 75 year ARI.*
- *Undertake a feasibility assessment for a pump system to drain the ponded area at the Hill / Gidley Streets intersection.*
- *Consider potential liability issues and the possible provision of compensatory measures in East Molong, due to increased flood levels and flood damages associated with Alignment 1.*
- *Consider further voluntary purchase in East Molong, as it will enhance merit of Alignment 1 relative to Alignments 2 and 3 (levees on both sides of creek).*
- *Develop 1D/2D hydraulic model to rigorously assess Molong Creek and local overland flooding, including sensitivity testing riparian vegetation impacts to design flood levels and velocities.*
- *Confirm ownership for rain and river gauges, and procedures / protocols for issuing rainfall alerts, forecasting flood levels and issuing flood warnings for Molong. Update Molong LFP.*

Based on the findings and recommendations of SMEC, 2018, Council undertook to commission the *Molong Flood Study* which developed a new hydrologic model of the Molong Creek catchment, as well as a two-dimensional (in plan) hydraulic model of the Molong Creek floodplain at Molong. The findings of *Molong Flood Study* have been used as part of the present study to reassess potential flood risk management measures and prepare a contemporaneous flood risk management plan for Molong.

2.5 Design Flood Behaviour

Figures 2.3 and **2.4** (3 sheets each) show the nature of flooding at Molong for the 1% AEP and PMF events as defined in the *Molong Flood Study*, respectively, while **Figures B1.1** to **B1.6** of **Appendix C** show similar information for the 20%, 10%, 5%, 2%, 0.5% and 0.2% AEP flood events. These diagrams show the indicative extent and depth of inundation along Molong Creek and its associated tributaries, as well as along the Major Overland Flow paths for the range of design flood events.

In order to create realistic results which remove most of the anomalies caused by inaccuracies in the LiDAR survey data, a filter was applied to remove depths of inundation over the natural surface less than 100 mm. This has the effect of removing the very shallow depths which are more prone to be artefacts of the model, but at the same time giving a reasonable representation of the various overland flow paths. The depth grids shown on the figures have also been trimmed to the building polygons, as experience has shown that property owners incorrectly associate depths of above-ground inundation at the location of buildings with depths of above-floor inundation.

Figure 2.5 (2 sheets) shows design water surface profiles along Molong Creek for the full range of design flood events, while **Figure 2.6** shows the time of rise of floodwater at a number of major road crossings in the study area. **Table 2.2** sets out the design peak flood levels and corresponding gauge height on NSW SESs manually read Wellington Street stream gauge.

TABLE 2.2
DESIGN PEAK FLOOD LEVELS AND CORRESPONDING GAUGE HEIGHTS
MANUALLY READ WELLINGTON STREET STREAM GAUGE

Design Flood Event	Peak Flood Level (m AHD)	Gauge Height (m)
20% AEP	530.90	3.99
10% AEP	531.17	4.26
5% AEP	531.43	4.52
2% AEP	531.77	4.86
1% AEP	532.04	5.13
0.5% AEP	532.24	5.33
0.2% AEP	532.44	5.53
PMF	537.72	10.81

The key features of flooding along Molong Creek and its tributaries are as follows:

- Floodwater surcharges the banks of Molong Creek in flood events as frequent as 20% AEP, where it inundates the following roads:
  - Hill Street at its intersection with Gidley Street; and
  - Edward Street at its intersection with Thistle Street.
- Floodwater that surcharges the right (eastern) bank of Molong Creek commences to inundate existing development that is located on the western side of Betts Street and Euchareena Road in a 20% AEP flood.
- Flow in Molong Creek backs up the ungated piped drainage line in Riddell Street where it upwells out of the existing grated inlet pits that are located near its intersection with Watson Street in a 10% AEP flood. Floodwater that upwells out of the existing piped drainage system at this location flows in a northerly direction where it ponds in the existing trapped low points that are located in both Bank Watson streets near their intersection.
- Floodwater commences to surcharge the left (western) bank of Molong Creek and overtop the railway upstream of Euchareena Road where it discharges through existing development that is located on Bank Street in a 10% AEP flood. During flood events rarer than 10% AEP, about 20% of the total flow in Molong Creek surcharges the creek at this location and flows through the aforementioned development.
- A hillock on the right (eastern) overbank of Molong Creek immediately upstream of its confluence with Boree Hollow (refer PFL Q08 for location) causes a significant reduction in the width of the floodplain. The constriction imposed on flow by the hillock causes a rise in flood levels of about 0.7 m upstream of its location (refer **Figure 2.5**).
- **Figures 2.3** and **2.4** (3 sheets each) and **Figures B1.1** to **B1.6** of **Appendix C** show another key constriction on the Molong Creek floodplain is the reduction in the width of the floodplain extending for a distance of about 300 m downstream of the Molong Creek Railway Bridge.

- The peak PMF flow in Molong Creek is about ten times the corresponding peak 1% AEP flow.
- Peak flood levels along Molong Creek in the PMF are about 3.5 to 6 m higher than the corresponding 1% AEP flood levels.

The key features of Main Stream Flooding along Boree Hollow are as follows:

- Access between the NSW SES Molong headquarters, which is located on William Street, and the main parts of Molong will be cut when Hill Street becomes inundated in a 0.5% AEP flood.
- Floodwater surcharges Boree Hollow in a 20% AEP flood and inundates existing development at the following locations:
    - Upstream of the Riddell Street causeway, where floodwater flows in a north-easterly direction through the Council depot.
    - Downstream of Hill Street, where floodwater surcharges the banks of the watercourse where it inundates the rear of residential allotments that are located on Old Dairy Lane and Kite Street.
- The peak PMF flow in Boree Hollow is about ten times the corresponding peak 1% AEP flow.

The key features of Main Stream Flooding along Moss Hollow Creek are as follows:

- The low point in Market Street adjacent to its intersection with End Street is set at an elevation of about RL 583.0 m AHD, while the obvert of the Moss Hollow Creek culvert crossing is set at about RL 583.2 m AHD. As a result, floodwater commences to overtop Market Street before the culverts are pressurised. Floodwater that overtops Market Street at this location flows in an easterly direction through existing residential development, where it discharges to Molong Creek upstream of its confluence with Moss Hollow Creek.
- Floodwater surcharges the banks of the creek and inundates the land zoned *IN1 General Industrial* immediately downstream of Starrlea Road in a 20% AEP flood to depths of up to about 0.5 m.
- The peak PMF flow in Moss Hollow Creek is about 11 times the corresponding peak 1% AEP flow.

The key features of Major Overland Flow in the Pillans Park Drainage Line are as follows:

- The piped drainage elements beneath the road crossings of the Pillans Park Drainage Line have a capacity of less than 20% AEP, whereby the resulting surcharge flow discharges through adjacent residential development.
- Flow commences to surcharge the piped drainage system between Iceworks Lane and Watson Street in a 5% AEP storm event.
- Elevated tailwater levels in Molong Creek commence to cause a backwater in the culverts beneath the railway and the private access road off Marsden Street in a 20% AEP flood event, significantly impacting the capacity to drain the Pillans Park Drainage Line. Once the capacity of these culverts is restricted, floodwater surcharges the left (northern) bank of the Pillans Park Drainage Line between Watson Street and the industrial land that is located to the east of the railway, where it flows in a northerly direction on the eastern side of the railway.

- **T**he peak PMF flow in the Pillans Park Drainage Line is about ten times the corresponding peak 1% AEP flow.

The key features of Major Overland Flow in the remainder of the study area are as follows:

- In the instance when intense rain falls directly over Molong in the absence of elevated water levels in Molong Creek, ponding of Major Overland Flow would occur to maximum depths of about 0.4 m and 0.5 m for design storms with AEPs of 5% (1 in 20) and 1% (1 in 100), respectively at the following locations in the vicinity of the Molong CBD:
    - in Watson Street south of its intersection with Banks Street;
    - in Banks Street west of its intersection with Watson Street; and
    - in Hills Street near its intersection with Gidley Street.
    - Stormwater ponding in the road reserve at the above locations is shown to extend into adjacent commercial and residential development, albeit generally at reduced depths.

2.6 Economic Impacts of Flooding

The economic consequences of floods are discussed in the *Molong Flood Study*, which assessed flood damages to residential, commercial/industrial property and public buildings in areas affected by both Main Stream Flooding and Major Overland Flow in the study area. There were only limited data provided by respondents to the *Community Questionnaire* on historic flood damages to the urban sectors in the study area. Accordingly, it was necessary to use data on damages experienced as a result of historic flooding in other urban centres. The residential flood damages were based on the publication *Floodplain Risk Management Guideline No. 4, 2007* (**Guideline No. 4**) published by the Department of Environment and Climate Change (**DECC**) (now Department of Climate Change, Energy, the Environment and Water (**DCCEEW**)). Damages to industrial and commercial development, as well as public buildings were evaluated using data from previous flood risk management investigations in NSW.

It is to be noted that the principal objectives of the damages assessment were to gauge the severity of urban flooding likely to be experienced at Molong and also to provide data to allow the comparative economic benefits of various flood modification measures to be evaluated in **Chapter 3** of the report. It is not the intention to determine the depths of inundation or the damages accruing to individual properties, but rather to obtain a reasonable estimate of tangible damages experienced over the extent of the urban area in the town for the various design flood events. The estimation of damages using *Guideline No. 4* (in lieu of site specific data determined by a loss adjustor) also allows a uniform approach to be adopted by Government when assessing the relative merits of measures competing for financial assistance in flood prone centres in NSW. As such, the damage costs contained in the present study are indicative estimates only.

The floor levels of individual dwellings/buildings were estimated by adding the height of floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from LiDAR survey. The type of structure and potential for property damage were also assessed during the visual inspection. If a property was not accessible to undertake a visual inspection, the height of the floor was assumed to be 300 mm above the adjacent natural surface level.

The number of properties that are predicted to be flood affected (floodwater on the allotment) and "above-floor" inundated as a result of both Main Stream Flooding and Major Overland Flow in the study area for floods ranging between 20% AEP and the PMF is set out in **Tables 2.3**, while **Table 2.4** shows comparable data for Main Stream Flooding on Molong Creek only. Also set out in the **Tables 2.3** and **2.4** are the total flood damages that would be experienced. **Figures 2.2** and **2.3** show the indicative depth of above-floor inundation that would be experienced in individual properties during 1% AEP and PMF events, respectively, while **Figures B1.1** to **B1.6** in **Appendix C** show similar information for the 20%, 10%, 5%, 2%, 0.5% and 0.2% AEP storm events.

The 10% AEP flood event is considered to be the "threshold" for which the number of individual buildings that would experience above-floor inundation increases significantly at Molong. For example, a total of 36 buildings (24 commercial, six residential and six public buildings) would be subject to above-floor inundation in a 10% AEP, resulting in total flood damages of about $2.7 Million. The total number of buildings inundated above-floor level increases to about 94 (44 commercial, 41 residential and nine public buildings) in a 1% AEP flood event resulting in total flood damages of about $11.8 Million.

During a PMF event, 196 dwellings, 65 commercial/industrial type buildings and 17 public building would experience above-floor inundation, resulting in total flood damages of about $77.4 Million. The *Molong Flood Study* found that flooding from Molong Creek accounts for the majority of the commercial/industrial and public flood damages that are experienced at Molong, while it accounts for about 63% of the total residential flood damages.

For a discount rate of 7% pa and an economic life of 50 years, the *Present Worth Value* of total damages for all flood events up to 10% and 1% AEP at Molong due to both Main Stream Flooding and Major Overland Flow is about $4.7 Million and $12.0 Million, respectively, while the *Present Worth Value* of total damages for flooding purely from Molong Creek for all flood events up to 10% and 1% AEP is about $2.3 Million and $8.0 Million, respectively. Therefore, one or more schemes costing up to these amounts could be economically justified if they eliminated the specific sources of flood damages in the study area up to these two levels of flooding. While schemes costing more than this value would have a benefit/cost ratio less than 1, they may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility.

More specifically, the *Present Worth Value* of flood damages up to the 10% AEP and 1% AEP floods in the Molong CBD is $1.4 Million and $5.8 Million, respectively. These values represent the total amount that can be spent on measures which alleviate flood damages in the Molong CBD for all floods up to 10% and 1% AEP, respectively, while still being economically justifiable.

TABLE 2.3
FLOOD DAMAGES AT MOLONG
MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW

Design Flood Event (% AEP)	Residential			Commercial/Industrial			Public			Total Damage ($ Million)
	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	
	Flood Affected	Flood Above Floor Level		Flood Affected	Flood Above Floor Level		Flood Affected	Flood Above Floor Level		
20	21	3	0.64	10	7	0.27	4	4	0.14	1.05
10	34	6	1.17	25	24	1.21	11	6	0.31	2.69
5	51	18	2.44	37	35	2.76	11	7	0.38	5.58
2	63	31	3.91	41	39	4.23	12	9	0.55	8.69
1	68	41	5.00	46	44	6.04	12	9	0.74	11.78
0.5	77	48	5.82	49	48	7.3	12	10	0.90	14.02
0.2	79	55	6.83	51	49	8.56	12	11	1.07	16.46
PMF	256	196	35.28	66	65	35.24	18	17	6.86	77.38

TABLE 2.4
FLOOD DAMAGES AT MOLONG
MAIN STREAM FLOODING ON MOLONG CREEK ONLY

Design Flood Event (% AEP)	Residential			Commercial/Industrial			Public			Total Damage ($ Million)
	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	
	Flood Affected	Flood Above Floor Level		Flood Affected	Flood Above Floor Level		Flood Affected	Flood Above Floor Level		
20	4	1	0.11	6	5	0.17	4	4	0.14	0.42
10	10	3	0.46	25	24	1.21	8	6	0.26	1.93
5	22	13	1.56	36	34	2.56	8	7	0.33	4.45
2	28	19	2.41	39	37	3.78	9	8	0.48	6.67
1	34	25	3.15	44	42	5.25	9	8	0.63	9.03
0.5	37	29	3.73	46	46	6.39	9	8	0.76	10.88
0.2	40	35	4.57	48	47	7.41	9	9	0.91	12.89
PMF	151	146	28.04	62	62	31.34	14	14	4.63	64.01

2.7 Impact of Flooding on Critical Infrastructure and Vulnerable Development

Figure 2.7 (3 sheets) shows the location of vulnerable development and critical infrastructure relative to the extent of inundation resulting from the assessed design storm events, while **Table 2.5** over the page sets out the frequency of floods which would impact this type of development/ infrastructure.[2]

Community Assets

The majority of the sewage pumping stations remain flood free in a 0.2% AEP storm event, with the exception of the Thistle Street Pump Station (SS1) which is impacted by a 1% AEP event.

The major water supply assets at Molong are located on flood free land.

Several road crossings are also inundated by floodwater during storms that are more frequent than 20% AEP, further details of which are set out in **Section 2.8** below.

Emergency Services

While the majority of emergency services are located on land which lies above the 0.2% AEP flood, the Molong Ambulance Station, Molong NSW SES local unit and the Rural Fire Service (RFS) station are located land which would be inundated by the PMF. While the Molong Police Station is located on land that would be inundated during a 5% AEP flood event, it is understood that the NSW Government is in the process of relocating it to higher ground which would have a similar hydrologic standard as the other emergency services.

Vulnerable Development

While the majority of vulnerable type development in Molong is located either off the floodplain or would only be impacted by floods larger than 0.2% AEP (i.e. Molong Lodge, Molong Self-Care, Molong HealthOne and the Molong Medical Practice), the Molong Caravan Park is located on land that would be partially inundated during a 10% AEP flood event.

[2] Critical infrastructure has been split into two categories; community assets and emergency services.

TABLE 2.5
IMPACT OF FLOODING ON CRITICAL INFRASTRUCTURE AND VULNERABLE DEVELOPMENT LOCATED IN THE STUDY AREA[1,2]

Type	Development/Structure	Location Identifier[)]	Design Flood Event							
			20% AEP	10% AEP	5%AEP	2% AEP	1% AEP	0.5%	0.2%	PMF
Community Assets	Electricity Substation (South Street Substation)	-	NF	NF	NF	NF	NF	NF	NF	NF
	Telephone Exchange (Bundella Close Telephone Exchange)	-	NF	NF	NF	NF	NF	NF	NF	F
	Major Road Crossing and Identifier (Marsden Street)	RC01	NF	NF	NF	NF	NF	F	F	F
	Major Road Crossing and Identifier (Euchareena Road Bridge)	RC02	NF	NF	NF	NF	F	F	F	F
	Major Road Crossing and Identifier (Molong Creek Railway Bridge)	RC03	NF	NF	F	F	F	F	F	F
	Major Road Crossing and Identifier (Broken Hill Railway Bridge No.1)	RC04	NF	NF	NF	F	F	F	F	F
	Major Road Crossing and Identifier (Broken Hill Railway Bridge No. 2)	RC05	NF	NF	NF	NF	NF	NF	NF	F
	Major Road Crossing and Identifier (Wellington Street)	RC06	NF	NF	F	F	F	F	F	F
	Major Road Crossing and Identifier (Wellington Street)	RC07	F	F	F	F	F	F	F	F
	Major Road Crossing and Identifier (Riddell Street Causeway)	RC08	F	F	F	F	F	F	F	F
	Major Road Crossing and Identifier (Hill Street)	RC09	NF	NF	NF	NF	NF	F	F	F
	Major Road Crossing (Packham Drive)	RC10	NF	NF	NF	NF	NF	NF	NF	F
	Major Road Crossing (Quarry Road)	RC11	F	F	F	F	F	F	F	F
	Major Road Crossing and Identifier (Banjo Patterson Way)	RC12	NF	NF	F	F	F	F	F	F
	Major Road Crossing (Mitchell Highway)	RC13	F	F	F	F	F	F	F	F
	Major Road Crossing (Banjo Paterson Way)	RC14	NF	NF	NF	NF	NF	NF	F	F
	Major Road Crossing (Mitchell Highway)	RC15	NF	NF	NF	NF	NF	F	F	F
	Sewer System (Sewage Treatment Works)	SS3	NF	NF	NF	NF	NF	NF	NF	F
	Sewer System (Thistle Street Pump Station)	SS1	NF	NF	NF	F	F	F	F	F
	Sewer System (King Street Pump Station)	SS2	NF	NF	NF	NF	NF	NF	NF	NF
	Water Supply (Molong Water Reservoir)	WS1	NF	NF	NF	NF	NF	NF	NF	NF
	Water Supply (Molong Water Works)	WS2	NF	NF	NF	NF	NF	NF	NF	NF
Emergency Services	Ambulance Facility (Molong Ambulance Station)	-	NF	NF	NF	NF	NF	NF	NF	F
	Evacuation Centre (Molong RSL)	-	NF	NF	NF	NF	NF	NF	NF	NF
	F&R NSW Station (F&R Molong Fire Stat)	-	NF	NF	NF	NF	NF	NF	NF	NF
	NSW SES Station (Molong SES)	-	NF	NF	NF	NF	NF	NF	NF	F
	Police Station (Molong Police Station)	-	NF	F	F	F	F	F	F	F
	RFS Station (RFS Brigade Molong)	-	NF	NF	NF	NF	NF	NF	NF	F

Refer over for footnotes to table.

TABLE 2.5 (Cont'd)
IMPACT OF FLOODING ON VULNERABLE DEVELOPMENT AND CRITICAL INFRASTRUCTURE LOCATED IN THE STUDY AREA(1,2)

Type	Development/Structure	Location Identifier)	Design Flood Event							
			20% AEP	10% AEP	5%AEP	2% AEP	1% AEP	0.5%	0.2%	PMF
Vulnerable Development	Aged Care Facility (Molong Lodge)	AC1	NF	NF	NF	NF	NF	F	F	F
	Aged Care Facility (Prunus)	AC2	NF	NF	NF	NF	NF	NF	NF	NF
	Aged Care Facility (Molong Self-Care)	AC3	NF	NF	NF	NF	NF	NF	NF	F
	Caravan Park (Molong Caravan Park)	-	NF	F	F	F	F	F	F	F
	Child Care Facility (Cabonne Family Day Care)	CC1	NF	NF	NF	NF	NF	NF	NF	NF
	Child Care Facility (Molong Early Learning Centre)	CC2	NF	NF	NF	NF	NF	NF	NF	NF
	Educational Facility (Molong Central School)	EF1	NF	NF	NF	NF	NF	NF	NF	NF
	Educational Facility (St Joseph's Primary)	EF2	NF	NF	NF	NF	NF	NF	NF	NF
	Health Service (Molong Health Service)	H1	NF	NF	NF	NF	NF	NF	NF	NF
	Health Service (Molong Multi-Purpose Health)	H2	NF	NF	NF	NF	NF	NF	NF	NF
	Health Service (Molong HealthOne)	H3	NF	NF	NF	NF	NF	NF	NF	NF

1. Refer **Figure 2.7** (3 sheets) for location of vulnerable development and critical infrastructure.
2. "NF" = Infrastructure not impacted by flooding.
   "F" = Infrastructure impacted by flooding.

2.8 Hydrologic Standard of Existing Road and Rail Network

Both major and minor roads in the study area are vulnerable to inundation during storm events as frequent as 20% AEP. Identification of such roads is important to providing knowledge to NSW SES, identifying hazardous areas during floods and evacuation planning.

Floodwater originating from Molong Creek and its tributaries commences to inundate road crossings at the following locations:

- **Figure 2.6** shows that the road and rail crossings of Molong Creek commence to become inundated as follows:
    - The Molong Creek Railway Bridge (refer Peak Flood Level Location (**PFLL**) H03) commences to be overtopped in a 5% AEP flood.
    - The Broken Hill Railway Line commences to be overtopped in the vicinity of the Broken Hill Railway Bridge No. 1 (refer PFFL H04) in a 2% AEP flood.
    - The Euchareena Road Bridge (refer PFFL H02) commences to be overtopped in a 1% AEP flood.
    - The low point in Marsden Street that is located immediately to the east of the Marsden Street Bridge (refer PFFL H01) commences to be inundated during floods larger than 2% AEP flood, which cuts access between the eastern and western sides of Molong.
- **T**he road crossings of Boree Hollow commence to become inundated as follows:
    - The Riddell Street Causeway (refer PFFL H08) will be inundated during freshes in the watercourse.
    - The low level Williams Street crossing (refer PFFL H08) is inundated in a 20% AEP flood.
    - The Wellington Street crossing (refer PFFL H06) commences to be overtopped in a 5% AEP flood.
    - Hill Street (refer PFFL H09) commences to be overtopped in a 0.5% AEP flood.
- **T**he road crossings of Moss Hollow Creek commence to become inundated as follows:
    - The Starrlea Road causeway crossing is inundated during freshes in the creek.
    - The low level crossings at Quarry Road (refer PFFL H11) and End Street (refer PFFL H13) are inundated in a 20% AEP flood.
    - The low point in Market Street that is located adjacent to its intersection with End Street (refer PFFL H13) is inundated in a 20% AEP flood.
    - The Banjo Patterson Way Street crossing (refer PFFL H12) commences to overtop in a 5% AEP flood.
    - While the Packham Drive crossing (refer PFFL H10) remains flood free up to the PMF, floodwater originating from Moss Hollow Creek inundates the low point in the road approximately 50 m to the east in a 10% AEP flood.
- **T**he Mitchell Highway crossing of Foys Creek (refer PFFL H15) commences to be overtopped in a 0.5% AEP flood, while the Banjo Patterson Way crossing of Shingle Ridge Creek commences to be overtopped in a 0.2% AEP flood.
- The low level Shreeves Road crossing of Foys Creek will be inundated during freshes in the watercourse.

2.9 Potential Impacts of a Change in Hydraulic Roughness

An analysis was undertaken to assess the sensitivity of flood behaviour to potential changes in hydraulic roughness. **Figure 2.8** (6 sheets) shows the impact that a 20% increase in the "best estimate" hydraulic roughness values in the hydraulic model would have on flood behaviour for a 1% AEP flood event.

Peak 1% AEP flood levels along Molong Creek are typically increased in the range 50-200 mm, with increases of up to 240 mm show to occur in isolated areas. Increases in peak flood levels along the tributary arms of the three main flow paths and in other areas subject to Major Overland Flow are generally in the range 10 to 50 .

While the extent of land that would be affected by the abovementioned increases in peak flood levels does not increase significantly, the depth and frequency of inundation in existing development would increase as a result of an increase in the hydraulic roughness of the floodplain. Based on this finding, there would be merit in maintaining or even reducing the density of vegetation along Molong Creek when compared to existing levels where it runs through Molong (refer **Chapter 3** of this report for further discussion).

2.10 Potential Impacts of a Partial Blockage of Hydraulic Structures

The mechanism and geometrical characteristics of blockages in hydraulic structures and piped drainage systems are difficult to quantify due to a lack of recorded data and would no doubt be different for each system and also vary with flood events. Realistic scenarios would be limited to waterway openings becoming partially blocked during a flood event (no quantitative data are available on instances of blockage of the drainage systems which may have occurred during historic flood events).

A blockage assessment was undertaken as part of the *Molong Flood Study* based on the procedures set out in ARR 2019. Blockage factors of 25% and 50% were generally found to be applicable for the piped drainage lines within the urbanised parts of the study area, while blockage factors of 15% and 25% were generally found to be applicable for the footbridge crossings of the Main Drain and Major Overland Flow paths.[3]

Figure 2.9 shows the impact that a partial blockage of existing hydraulic structures would have on flood behaviour at Molong for a 1% AEP storm event, as well as the plan location and magnitude of the adopted blockage factors.

A partial blockage of the main road crossings of Molong Creek and its tributaries generally increases peak flood levels by a maximum of 50 mm, with the exception of the Marsden Street Bridge, where a partial blockage increases peak flood levels by up to 80 mm. The combined partial blockage of the Molong Creek Railway and Euchareena Road Bridges only increases peak flood levels in the Molong CBD by up to 40 mm.

While a partial blockage of the hydraulic structures along Banjo Paterson Way cause localised increases in peak flood levels of up to 400 mm, the affected area is relatively localised on confined to undeveloped land that is zoned either *R5-Large Lot Residential* or *RU1-Primary Production* under *Cabonne LEP 2012*. (e.g. in the immediate vicinity of its crossing of Shingle Ridge Creek).

[3] Note that an L_{10} value of 1.5 m was adopted for the blockage assessment.

A partial blockage of the piped drainage system in areas subject to Major Overland Flow is generally negligible, except along the Pillans Park Drainage Line where the blockage of the culvert in the vicinity of Iceworks Lane increases peak flood levels by up to 120 mm

As the design flood envelopes derived as part of the *Molong Flood Study* include the effects that a partial blockage of the existing hydraulic structures would have on flood behaviour at Molong, there isn't a need to factor these effects in the assessment of a suitable freeboard for future development (refer **Section 3.5.1.2** of this report for further discussion).

2.11 Potential Impacts of Future Urbanisation

Future urbanisation has the potential to increase the rate and volume of runoff conveyed by the various watercourses, as well as increase the frequency of surcharge of the local stormwater drainage system. It is also likely to result in changes to the existing drainage system. For example, while existing minor watercourses are likely to be retained and formalised in drainage reserves, piped drainage systems associated with urban subdivisions will result in significant amendments to existing overland flow paths leading to the watercourses.

As the existing Development Control Plan for Molong does not define the maximum permissible hard stand area within an individual allotment, a fraction impervious value of 20% was applied to the hydrologic model in areas zoned *R5 Large Lot* Residential, while a fraction impervious value of 80% was applied to areas zoned *R1 General Residential*, *B2 Local Centre*, *B5 Business Development* and *IN2 Light Industrial*.

Figure 2.10 shows the impact that future infill development could have on local catchment flood behaviour absent flooding on Molong Creek and its major tributaries in a 1% AEP storm event. Note that the assessment undertaken as part of the present study is of a broad-scale and strategic nature, and that more detailed site specific assessments would need to be undertaken as part of any future development.

Figure 2.10 shows that infill development in the urbanised parts of Molong has the potential to increase peak flood levels in existing development by between 10 and 50 mm in a 1% AEP storm event, with the following exceptions:

- in the lower reaches of the Pillans Park Drainage Line where infill development would increase the rate of flow surcharging the drainage line in the vicinity of Gidley Street resulting in an increase of up to 100 mm in peak 1% AEP flood levels in existing development;
- between Molong Cemetery Road and Banjo Patterson Way where peak flood levels will increase by up to 100 mm; and
- in East Molong where peak flood levels will increase by up to 200 mm between Marsden Street and Buckland Street.

2.12 Potential Impacts of Future Climate Change

DCCEEW recommends that the advice set out in Section 3.7.4 of its floodplain risk management guide *Incorporating 2016 Australian Rainfall and Runoff in studies* (OEH, 2019) be used as the basis for examining climate change in projects undertaken under the State Floodplain Management Program and the FRMM. The guideline recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities ranging between 10 and 30 per cent.

On current projections the increase in rainfalls within the service life of developments or flood management measures is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit which may apply near the end of the century. Under present day climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce about a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce about a 0.2% AEP event.

For the purpose of the present study, the impact 10% and 30% increases in design 1% AEP rainfall intensities would have on flooding behaviour was assessed by comparing the peak flood levels which were derived from the flood modelling for design events with AEP's of 1%, 0.5% and 0.2%.

Figures 2.11 and **2.12** show the increase in peak 1% AEP flood levels that would occur if rainfall intensities were to increase by 10% and 30% as a result of future climate change, respectively, while **Figure 2.13** shows the impact these potential changes would have on the extent of a 1% AEP flood event.

Impact of a 10% Increase in 1% AEP Rainfall Intensities

Peak flood levels along Molong Creek would be increased in the range 100-300 mm, while increases in peak flood levels of generally up to 100 mm are shown to occur along its major tributaries. Increases in peak 1% AEP flood levels generally of up to 50 mm would occur along the Major Overland Flow paths.

Impact of a 30% Increase in 1% AEP Rainfall Intensities

Peak flood levels along Molong Creek would be increased by up to 500 mm, while increases in peak flood levels of generally up to 300 mm are shown to occur along its major tributaries. Increases in peak 1% AEP flood levels generally of up to 100 mm would occur along the Major Overland Flow paths.

Figure 2.13 shows the increase in the extent of land that would be affected by floodwater should 1% AEP rainfall intensities increase by 10 or 30 per cent. The extent of land that would be inundated by floodwater should 1% AEP rainfall intensities increase by up to 30% is negligible due to the relatively steep sided nature of the floodplain adjacent to the relatively flat overbank areas.

Based on the above finding, consideration of the potential for future climate to significantly increase peak flood levels when assessing potential flood modification measures, as well as the freeboard requirements for future development (refer **Chapter 3** of this report for further discussion).

2.13 Flood Hazard Vulnerability and Hydraulic Categorisation of the Floodplain

2.13.1 General

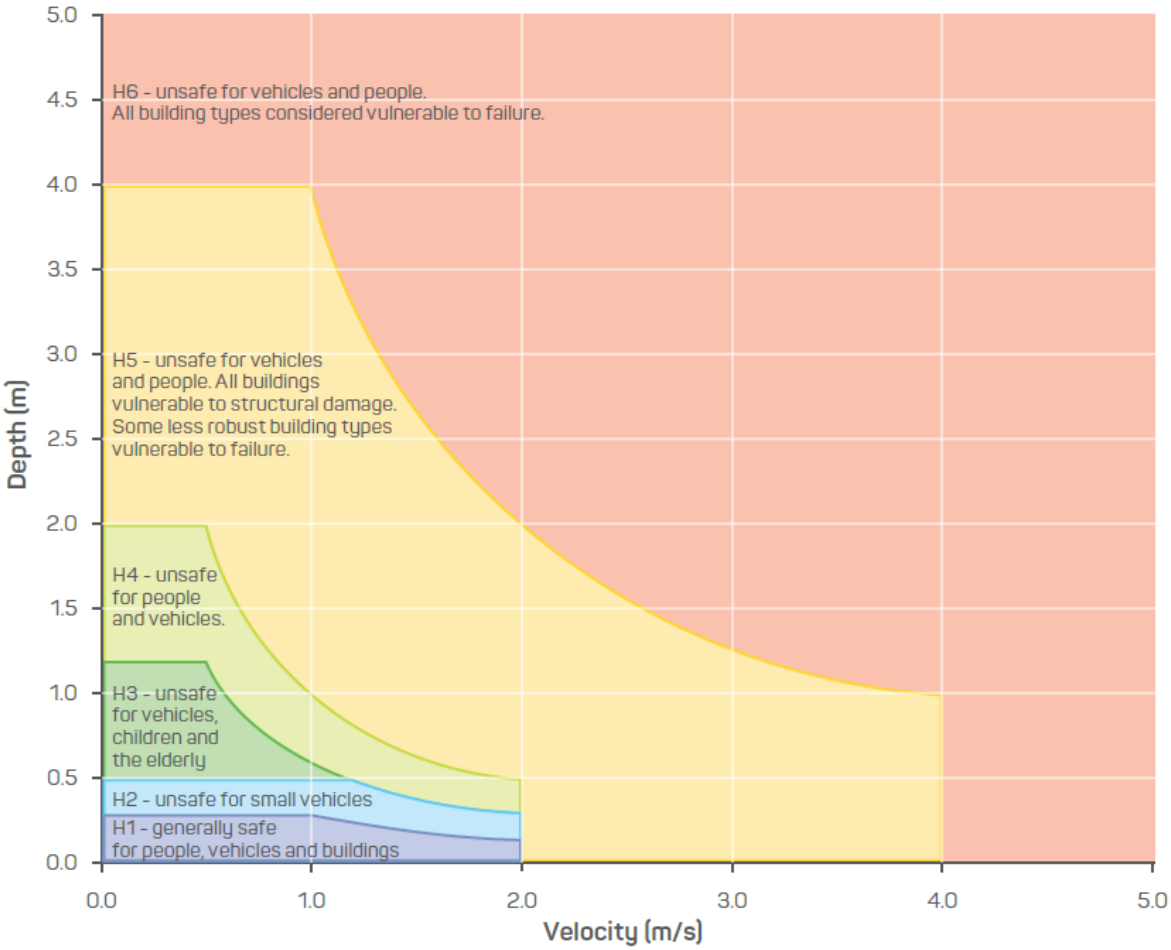
According to Appendix L of the FRMM, in order to achieve effective and responsible flood risk management, it is necessary to divide the floodplain into areas that reflect:

1. The impact of flooding on existing and future development and people. To examine this impact it is necessary to divide the floodplain into *"flood hazard vulnerability"* categories, which are provisionally assessed on the basis of the velocity and depth of flow. This task was undertaken as part of the present study where the floodplain was divided six flood hazard vulnerability zones. **Section 2.13.2** below provides details of the procedure adopted.

2. The impact of future development activity on flood behaviour. Development in active flow paths (i.e. *"floodways"*) has the potential to adversely re-direct flows towards adjacent properties. Examination of this impact requires the division of flood prone land into various *"hydraulic categories"* to assess those parts which are effective for the conveyance of flow, where development may affect local flooding patterns. Hydraulic categorisation of the floodplain was also undertaken in the *Flood Study* and was reviewed and updated in this present study. **Section 2.13.3** below summarises the procedure adopted.

2.13.2 Flood Hazard Vulnerability Categorisation

Flood hazard categories may be assigned to flood affected areas in accordance with the definitions contained in ARR 2019. Flood prone areas may be classified into six hazard categories based on the depth of inundation and flow velocity that relate to the vulnerability of the community when interacting with floodwater as shown in the illustration over the page which has been taken from ARR 2019.



Figures 2.14 and **2.15** (3 sheets each) show the *Flood Hazard Vulnerability Classification* based on the procedures set out in ARR 2019 for the 1% AEP and PMF flood events, respectively, while **Figures B1.7** and **B1.8** in **Appendix C** show the similar information for design floods with AEPs of 5% and 2%.

For floods up to 1% AEP in magnitude, H6 type flooding conditions are generally limited to the inbank area of Molong Creek, with large areas of H5 located on its overbank area and along its tributary arms. Due to the significant increase in the depth of inundation for a PMF event combined with the relatively steep sided nature of the floodplain, the majority of flood prone land is subject to H6 type flooding, with the remainder generally subject to H5 type flooding.

The majority of the Molong CBD is classified as H3, with isolated pockets of H4 in a 5% AEP flood event. The hazard classification in the Molong CBD generally increases to H4 with isolated pockets of H5 in a 2% AEP flood, with the extent of land classified as H5 increasing further in a 1% AEP flood.

It is important to note that upstream buildings have the effect of "shielding" downstream buildings from hazardous flooding conditions. Sensitivity analyses undertaken as part of the present study found that the extent of land classified as H5 in a 1% AEP increases in the vicinity of Bettes Street and the Molong CBD if the buildings are removed from the floodplain.

The flood hazard in the vicinity of existing development that is located on the western side of Betts Street and Euchareena Road is generally classified as H3 in a 5% AEP event, increasing to H4 in a 2% and 1% AEP flood.

Areas classified as H5 and H6 in a 1% AEP flood event are shown to be present in the vicinity of existing development at the following locations:

- on the left (western) overbank of Molong Creek in the vicinity of the Dr Ross Memorial Recreation Ground;
- in the vicinity of the intersection Thistle Street and Edward Street;
- on the left (western) and right (eastern) overbank of Boree Hollow between King Street and William Street;
- on the eastern side of Market Street to the south Moss Hollow Creek; and
- along the western kerb line of Baker Street where it runs between Loftus Street and Polaris Street.

The Major Overland Flow paths in the urbanised parts of Molong are generally classified as either H1 or H2 in a 1% AEP storm event, with the exception of areas where floodwater ponds on the upstream side of roads where it is generally classified as either H3 or H4.

2.13.3 Hydraulic Categorisation of the Floodplain

According to the FRMM, the floodplain may be subdivided into the following three hydraulic categories:

- Floodways;
- Flood storage; and
- Flood fringe.

Floodways are those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with obvious naturally defined channels. Floodways are the areas that, even if only partially blocked, would cause a significant re-distribution of flow, or a significant increase in flood level which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

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

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

Figures 2.18 to **2.21** show the division of the floodplain into floodway, flood storage and flood fringe areas for design floods with AEPs of 5%, 2% and 1%, as well as the PMF, while **Figures B1.9** and **B1.10** in **Appendix C** show the similar information for design floods with AEPs of 5% and 2%.

While floodway areas are generally confined to the road reserves in the vicinity of the Molong CBD in a 5% AEP flood, they commence to operate between the buildings in this area in a 2% AEP flood. A large portion of the Molong CBD is categorised as floodway in a 1% AEP flood, noting that sensitivity testing undertaking as part of the *Molong Flood Study* found that preventing flow from discharging through the Molong CBD increased peak flood levels on Molong Creek upstream of Euchareena Road Bridge by up to 0.3 m, indicating that this area is important for the conveyance of flood flows.

Flood storage areas are confined to the major ponding areas which are located on the upstream side of the road and railway embankments, as well as in the local farm dams that have been constructed to capture surface runoff in different parts of the study area.

2.14 Environmental Considerations

While Council presently maintains the density of vegetation within the inbank area of Molong Creek on an irregular and limited basis, observations made during the preparation of both the *Molong Flood Study* and the present study identified a number of large trees, several of which had been laid over by the recent floods.

During the public workshop that was held during the exhibition of the *Molong Flood Study*, one resident highlighted that the inbank area of Molong Creek where it runs through Molong has significant flora and fauna value and should not be disturbed as part of any future flood mitigation works.

2.15 Council's Existing Planning Instruments and Policies

2.15.1 General

The *Cabonne LEP 2012* is the principal statutory planning document used by Council for controlling development by defining zoning provisions, establishing permissibility of land use and regulating the extent of development in the Molong Shire Council local government area.

The Cabonne DCP No. 10 supplements *the Cabonne LEP 2012* by providing general information and detailed flood related guidelines and controls which relate to the decision making process.

2.15.2 Land Use Zoning – Molong Local Environmental Plan 2010

Figure 2.18 shows the zonings that are incorporated in *Cabonne LEP 2012* for the study area. The study area comprises a mixture of business (B2, B4 and B6), industrial (IN1), residential (R1 and R5), public recreation (RE1 and RE2), rural (RU1), special purpose (SP1 and SP2) and waterway (W2) based zonings.

2.15.3 Flood Provisions – Cabonne LEP 2012

Clause 5.21 of *Cabonne LEP 2012* entitled "*Flood planning*" outlines its objectives in regard to development of land that is located within the extent of the FPA. Clause 5.21 was inserted into *Cabonne LEP 2012* by the NSW Government on 14 July 2021 and unlike the wording in corresponding repealed clause, the FPL is not defined in clause 5.21.

Clause 5.21 states that development consent must not be granted unless the consent authority is satisfied that the development:

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

It also states that in deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters:

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

While the heading of clause 5.22 entitled "*Special flood considerations"* was inserted in *Cabonne LEP 2012* by the NSW Government on 14 July 2021, Council is awaiting the outcomes of the present study prior to making a decision on its possible adoption. It is noted that the new clause forms part of the updated *NSW Flood Prone Land Package* and has the following objectives:

- in relation to development with particular evacuation or emergency response issues (e.g. schools, group homes, residential care facilities, hospitals, etc.) to enable evacuation of land which lies above the FPL; and
- to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land that lies outside the FPA but within the extent of the PMF. The form of wording that would comprise Clause 5.22 is set out in **Section 3.5.1.4**.

While the recently inserted flood planning clause does not make reference to flood planning maps, it is noted that they are still contained in the *Cabonne LEP 2012*. It is recommended that these maps be removed from the *Cabonne LEP 2012* and updated flood mapping based on the findings of the present study be incorporated in the *Cabonne DCP 2012*.

2.15.4 Flood Related Development Controls

Cabonne DCP No. 10 has the stated objectives of:

(a) To provide more detailed controls for the assessment of applications on land affected by potential floods In [sic] *accordance with the provisions of Cabonne LEP 1991 (as amended).*

(b) To alert the community to the hazard and extent of land affected by potential floods.

(c) To inform the community of Council's policy in relation to the use and development of land affected by the potential floods in Molong.

(d) To reduce the risk to human life and damage to property caused by flooding through controlling development on land affected by potential floods.

It is noted that the document appears to have been approved by Council in a meeting that was held in 2003 and refers to a superseded version of *Cabonne LEP 2012*.

Cabonne DCP No. 10 states the following:

> *"The DCP applies to all development permissible with the consent of Council on land in Molong zoned 2(v) Village or Urban under Cabonne LEP 1991 that also forms part of the Possible Inundation Awareness zone or Flood Fringe as shown in Annexure 1.0."*

It is noted that the zones referred to in *Cabonne DCP No. 10* are not consistent with those set out in *Cabonne LEP 2012* and therefore it is not clear to what land the controls set out in the document apply. It is also noted that *Annexure 1.0* is not attached to the online version of the document, so the extent of the various flood affected areas are not defined.

In relation to the controls that apply to proposed development, *Cabonne LEP 2012* states the following:

> *"The development controls apply to all flood pone land (that is to the PMF flood). The type of controls have been graded relative to the severity and frequency of potential floods, having regard to the three following applicable categories:*
>
> - *Flood Inundation Awareness Zone: Greater then the 100-year ARI flood (plus 0.5m freeboard) and up to the PMF.*
> - *Flood Fringe: Up to and including the 100-year ARI flood (plus 0.5m freeboard) and outside the floodway.*
> - *Floodway: Up to and including the 100-year ARI flood (plus 0.5m freeboard) and within the floodway. The applicant should be aware that the 7(f) zone provides significant restrictions on development within the floodway under Cabonne LEP 1991.*
>
> *Annexure 5.0 outlines the controls relevant to the area to which this Policy applies for each of the above categories."*

It is noted that *Annexure 5.0* is not attached to the online version of the document, so the controls that apply to flood prone land are not defined.

Recommendations relating to the update of the approach set out in *Cabonne DCP No. 10* are set out in **Section 3.5.1.4**, while **Appendix D** of this report contains suggested wording for incorporation into the document.

2.16 Flood Warning and Flood Preparedness

The NSW SES is nominated as the principal combat and response agency for flood emergencies in NSW. NSW SES is responsible for the issuing of relevant warnings (in collaboration with BoM), as well as ensuring that the community is aware of the flood threat and how to mitigate its impact. The *Cabonne Shire Local Flood Plan* which is dated April 2013 covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures for all levels of flooding within the Cabonne LGA. *Cabonne Shire Local Flood Plan* is administered by the Cabonne Local Commander[4] who controls flood operations within the Cabonne LGA. NSW SES maintains a local headquarters on the western overbank of Borree Hollow at the corner of Riddell and Williams streets in Molong.

Volume 1 of *Cabonne Shire Local Flood Plan* entitled '*Cabonne Shire Flood Emergency Sub Plan*' includes sections on flood preparedness, response and recovery. Volume 1 follows the standard NSW SES template and is divided into the following sections:

- ***Introduction****;* this section of the document identifies the responsibilities of the NSW SES Local Commander and NSW SES members and supporting services such as the Police, BoM, Ambulance, Fire Brigades, Council, etc. It also identifies the importance for NSW SES and Council to coordinate the development and implementation of a public education program to advise the population of the flood risk.
- ***Preparedness****;* this section of the document deals with activities required to ensure the *Cabonne Shire Local Flood Plan* functions during the occurrence of the flood emergency. It also devotes considerable attention to flood alertness and emergency response.
- ***Response***; The NSW SES maintains an operation centre at the Local NSW SES Headquarters at the corner of Riddell and Williams streets. Response operations will commence on receipt of a BoM Flood Warning, Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for flash flooding; or when other evidence leads to an expectation of flooding within the council area.
- ***Recovery****,* involving measures to ensure the long term welfare for people who have been evacuated, recovery operations to restore services and clean up and de-briefing of emergency management personnel to review the effectiveness of the *Cabonne Shire Local Flood Plan.*

While Annex A in Volume 2 of the *Cabonne Shire Local Flood Plan* deals with the existing flood risk in the Cabonne LGA, it does not specifically make reference to Molong Creek which lies in the Macquarie Valley, as opposed to the Lachlan Valley in which the majority of the LGA is located.

Annex B in Volume 2 of the *Cabonne Shire Local Flood Plan* deals with the effects that flooding has on the community. In relation to the effects that flooding has on the community at Molong, the document states the following:

> *"MOLONG (2001 population 1,860), located on the Molong Creek, is subject to flooding of residential areas and shops. Major flooding can occur with very little warning. Much of the commercial area lies within the floodplain and overbank flow is known to have entered the shopping area on four occasions (the last in 1956, 1990 and 2005). In the flood event of November 2005 (estimated to be a 1:130 year*

[4] It is noted that the *Cabonne Shire Local Flood Plan* refers to the "Molong Local Controller" who has now been given the title "Cabonne Local Commander".

rain event) water depths of well over a metre were recorded in Bank, Watson, Hill and Gidley Streets and evacuations were necessary with at [sic] *total of twenty two houses being inundated. Stock needed to be raised in shops, with seven businesses being inundated causing significant damage and disruption.*

Betts Street, a residential area to the east of the railway line, is the first part of the town to be affected by flood waters. In the major flood event that occurred in November 2005, ten houses were inundated with water crossing the area of the railway line flowing down the Mitchell Highway towards Bank Street flooding the Caravan Park, Police and Ambulance Stations. The waterway area of the Railway Bridge is inadequate for flood flow during significant events.

Flood Levels at a property in Betts Street Molong from 1956 (3.92m Wellington St Bridge Gauge) to the floods in April 1990 (3.75m Wellington St Bridge Gauge) and August 1990 (4.35m Wellington St Bridge Gauge) were 530.73m, 529.38m and 530.00m AHD respectively and at another property 530.73m, 530.31m (top of patio), and 530.66m AHD.

Three dams exist upstream of Molong – Lake Canobolas, located approx. 31 kilometres upstream of Molong on Molong Creek, Molong Creek Dam, located approx. 19 kilometres south-east of Molong on Molong Creek, and Borenore Creek Dam located on Borenore Creek approx. 16 kilometres south-east of Molong. For more information on these dams refer to page A3.

'Somerton Park', which is about 1.5 kilometres downstream of Lake Canobolas, would be affected by a dam failure. No Dambreak Study to date has sufficiently evaluated the potential cascade dam failure scenario on Molong and from the December 2000 Dam Break Study the simulation showed that some houses in Molong would be affected by a dam break at Lake Canobolas that also triggered a dam break at Molong Creek Dam. However in the simulation no inundation heights were calculated so it is unknown how much the town is affected by this dam failure scenario."

NSW maintains three Flood Intelligence Cards for Molong Creek, details of which are set out in **Table 2.6**. By comparison with the design peak flood levels given in **Table 2.2**, it will be necessary to update the information contained in the *Molong (Wellington St) Flood Intelligence Card*. The consequences of flooding that are listed for the nominated design flood events should also be updated based on the findings of both the *Molong Flood Study* and the present study (refer **Chapter 3** of this report for further discussion).

TABLE 2.6
DETAILS OF NSW SES FLOOD INTELLIGENCE CARDS FOR MOLONG CREEK

Name	Bureau No.	Datum Type	Gauge Zero	Gauge Type	Gauge Location	Minor Flood Level	Moderate Flood Level	Major Flood Level	Class	Height (m)	Consequences
Molong Creek @ D/S Borenore Creek (421178)	563005	Local	Not Given	Automatic	15 km upstream of Molong Railway Bridge	Not Given	3.00	3.50	-	0.00	➢ *This gauge was installed by the DIPNR in August 2003 and may eventually be incorporated into a local flood warning system for Molong Creek by the BoM.*
Heifer Station Creek D/S (421154)	-	Assumed	3.213	Manual	On Common upstream of Cullinane's home.	Not Given	Not Given	Not Given	-	0.00	➢ *This gauge plate is part of the Molong Creek Water Users Association and is read on a monthly basis. The gauge is not particularly accessible especially at night and in bad weather.*
Molong (Wellington St) (10456)	-	AHD	526.905	Manual	East of the Wellington Street Bridge, Molong	Not Given	3.30	3.90	-	0.00	➢ *Bureau of Meteorology has produced a Flash Flood Directive for this gauge. Awaiting a new AWRC reference number. This gauge has been used since 1993 for Unit SOP and for flood intelligence.* ➢ **ARI: Average Recurrance* [sic] *Interval - the long-term average number of years between the occurence* [sic] *of a flood as big as, or larger than, the selected event. For example, floods reaching a height as great as, or greater than, the 100 year ARI flood will occur on average once every 100 years*
									-	3.00	➢ *Molong SES Unit HQ opens*
									-	3.25	➢ *31 August 1996 Peak Height.* ➢ *Flooding beginning to threaten town. South-west drains from Bank and Gidley streets were sandbagged to stop backflow from creek.*
									MOD	3.30	➢ *Moderate Flood Level.* ➢ *Flood water entered shopping area at floor level (in the November 2005 flood).*
									MOD	3.30	➢ *Peak Height. 20 July 2016.* ➢ *No additional consequences were noted for this peak*
									MOD	3.36	➢ *August 1998 Peak Height.* ➢ *Preventative mitigation measures were taken using sandbags but no flooding occurred.*
									MOD	3.40	➢ *Water surrounds ReadyMix plant and 2 houses in Betts St.*
									MOD	3.50	➢ *Backwater from creek over Hill St at Gidley St. Traffic movement causes damage through side wash. Check with Police re diverting traffic via Edward and Wellington Sts. Water rising in SWD at Bank and Watson Sts.*
									MOD	3.75	➢ *April 1990, Peak Height.* ➢ *Minor to moderate level flooding in Betts, Watson, Hill and Edward streets with about 10 houses flood affected. Water over the roads but no road closures.*
									MAJ	3.90	➢ *5% AEP (1 in 20 year ARI)*. Major Flood Level.* ➢ *Water over road;* o *0.7m at north end of Edward St;* o *0.3m at Hill and Gidley Sts;* o *0.3m at Watson and Banks Sts.* ➢ *Additional properties which may need assistance (e.g. do they experience yard/overfloor flooding?);* o *Betts St - South End - 6 houses and ReadyMix.* o *Hill St - 7 houses.* o *Euchareena Rd - Kinsella* ➢ *Police Station and cottages, Girl Guides, CWA, caravan park, Ambulance Stn, Motel, School Agricultural Site, J.Packham, J.Morphett, K.Boucher, Findlay Wilson and McMahons (where are these?).* ➢ *Note: Old telephone poles used for parking control near the soccer ground may become a hazard by floating down Betts St.*

Cont'd Over

TABLE 2.6 (Cont'd)
DETAILS OF NSW SES FLOOD INTELLIGENCE CARDS FOR MOLONG CREEK

Name	Bureau No.	Datum Type	Gauge Zero	Gauge Type	Gauge Location	Minor Flood Level	Moderate Flood Level	Major Flood Level	Class	Height (m)	Consequences
Molong (Wellington St) (10456)									MAJ	3.92	➢ *March 1956, Peak Height.* ➢ *Moderate level flooding in Betts, Watson, Hill and Banks streets with about 30 houses and 20 commercial premises flood affected.*
									MAJ	4.35	➢ *August 1990, Peak Height.* ➢ *Flooding occurred in Banks, Betts, Hill, Watson and Edwards streets with about 30 houses and 23 commercial properties flood affected. Water in Banks St up to 1m deep.*
									MAJ	4.50	➢ *20%* [sic] *AEP (1 in 50 year ARI*)* ➢ *Water over road:* o *1.0m at north end of Edward St;* o *0.5m at Hill and Gidley Sts;* o *0.5m at Bank and Watson Sts* ➢ *Additional properties which may need assistance (are they flooded?): 10 houses in Betts St; 1 house in Euchareena Rd; 1 house in Banks St; 5 houses in Gidley St. (17 houses); 25 commercial properties in Bank St.*
									MAJ	4.70	➢ *November 2005 Peak height.* ➢ *Fast flowing flood water, with high velocity.* ➢ *The following streets had people evacuated:* o *Betts St, 8 Houses* o *Hill St, 4 Houses* ➢ *The following streets were inundated, with estimates of water height:* o *Watson St, 2m* o *Edward St, north end (up to 1.5m)* o *Mitchell Highway (up to 1.5m) closed 3km east of Molong on* o *the route to Orange (Fairbridge Park).* ➢ *The railway line from Orange to Broken Hill was closed* ➢ *Flooding Statistics:* o *10-12 Houses flooded above floor level* o *20 Houses experienced yard flooding* o *30 Businesses experienced above floor flooding* o *Some farmland was flooded* o *4-5 Caravans in Molong Caravan Park affected by flooding* o *(Watson & Hill St)* o *Power was out in Molong for 2 days* o *The Police and Ambulance Stations were flooded.*
									MAJ	4.90	➢ *1% AEP (1 in 100 ARI*)* ➢ *Evacuation necessary from Hill, Gidley and Betts St.* ➢ *Water over road;* o *1.3m at north end of Edward St.* o *1.0m at Hill and Gidley Sts.* o *1.0m at Bank and Watson Sts.* ➢ *Additional properties which may need assistance (are they flooded?):* ➢ *1 house in Hill St; 2 houses in Gidley St; 4 commercial peroperties* [sic] *in Bank St.* ➢ *Upstream water will be approaching the Mitchell Hwy at Fairbridge Park.*

Cont'd Over

TABLE 2.6 (Cont'd)
DETAILS OF NSW SES FLOOD INTELLIGENCE CARDS FOR MOLONG CREEK

Name	Bureau No.	Datum Type	Gauge Zero	Gauge Type	Gauge Location	Minor Flood Level	Moderate Flood Level	Major Flood Level	Class	Height (m)	Consequences
Molong (Wellington St) (10456)									MAJ	6.4	➢ *3x100 year flow (1:5,000 ARI*).*
									MAJ	9.7	➢ *PMF (536.6mAHD)* ➢ *This is 5.8m above the 5% AEP (1 in 20 year ARI*) level at this point.* ➢ *A depth of 10.5m is indicated at Bank and Watson Sts.* ➢ *Additional properties which may need assistance;* o *4 houses in Shadforth St;* o *6 houses in Riddell St;* o *10 houses in Hill St;* o *5 houses in Kite St;* o *3 Houses in Market St;* o *9 commercial properties in Bank and Watson Sts.*

3 POTENTIAL FLOOD RISK MANAGEMENT MEASURES

3.1 Range of Available Measures

A variety of flood risk management measures can be implemented to reduce flood damages. They may be divided into three categories, as follows:

Flood modification measures change the behaviour of floods in regard to discharges and water surface levels to reduce flood risk. This can be done by the construction of levees, detention basins, channel improvements and upgrades of piped drainage systems in urban areas. Such measures are also known as "structural" options as they involve the construction of engineering works. Vegetation management is also classified as a flood modification measure.

Property modification measures reduce risk to properties through appropriate land use zoning, specifying minimum floor levels for new developments, voluntary purchase of residential property in high hazard areas, or raising existing residences in the less hazardous areas. Such options are largely planning (i.e. "non-structural") measures, as they are aimed at ensuring that the use of floodplains and the design of buildings are consistent with flood risk. Property modification measures could comprise a mix of structural and non-structural methods of damage minimisation to individual properties.

Response modification measures change the response of flood affected communities to the flood risk by increasing flood awareness, implementation of a flood warning system and the development of an emergency response plan for property evacuation.

3.2 Community Views

Comments on potential flood risk management measures were by way of the *Community Questionnaire*, which was distributed at the commencement of the study. The responses are summarised in **Appendix A** of this report. Question 8 in the *Community Questionnaire* outlined a range of potential flood management options and asked whether each respondent was in favour of the individual option or not. **Table 3.1** over the page sets out the responses that were received to Question 8 from the Molong community.

The issues identified by the responses to the *Community Questionnaire* support the objectives of the study as nominated in the attached *Community Newsletter,* and the activities nominated in the Study Brief. Of interest is that about one-third (22) of the respondents to the questionnaire were in favour of prohibiting all new development on land with any potential to flood. This was closely followed by 18 respondents who were in favour of Council prohibiting new development only in locations that are extremely hazardous and 15 respondents who were in favour of placing restrictions on developments which reduce the potential for flood damages.

While respondents were strongly in favour of the majority of the potential structural measures that were listed in the *Community Questionnaire*, the construction of permanent levees and detentions basins received the least positive response.

While the respondents were strongly in favour of the majority of the potential non-structural measures that were listed in the *Community Questionnaire*, a mostly negative response was given to providing funding or subsidies to raise houses above major flood level in low hazard areas and the flood proofing of individual properties.

TABLE 3.1
COMMUNITY VIEWS ON POTENTIAL FLOOD RISK MANAGEMENT MEASURES

Flood Management Measure	Classification	Respondent's Views		
		Yes	No	Don't Know
Management of vegetation along creek corridors to provide flood mitigation, stability, aesthetic and habitat benefits	Flood Modification Measure	52	0	0
Widening of watercourses		41	5	4
Construct detention basins		24	6	11
Construction of permanent levees/diversion banks to contain floodwaters		31	9	8
Improve stormwater drainage system		47	0	4
Upgrade culverts beneath roads/railways		43	0	3
Removal of floodplain obstructions		47	1	6
Voluntary purchase of the most severely affected flood-liable properties	Property Modification Measure	42	1	8
Provide funding or subsidies to raise houses above major flood level in low hazard areas		27	9	7
Flood proofing of individual properties by waterproofing walls, putting shutters across doors, etc.		20	11	10
Specify controls on future development in flood-liable areas (e.g. controls on extent of filling, minimum floor levels, etc.)		44	1	3
Provide a Planning Certificate to purchasers in flood prone areas, stating that the property is flood affected.		45	1	2
Ensuring all information about the potential risks of flooding is available to all residents and business owners		50	1	0
Improve flood warning and evacuation procedures both before and during a flood.	Response Modification Measure	48	0	0
Community education, participation and flood awareness programs		38	1	5
Ensuring all residents and business owners have Flood Action Plans - these outline WHAT people should do, WHERE they should go and WHO they should contact in a flood		47	0	3

3.3 Outline of Chapter

A range of potential risk flood management measures were examined at the strategic level of detail and where appropriate, tested for feasibility on a range of assessment criteria in **Chapter 4**. Following consideration of the results by the FRMC, selected measures were included in *Molong FRMP 2024* in **Chapter 5**.

The potential flood modifications that were assessed as part of this study include:

- improvements to the existing stormwater drainage system to reduce the impacts of local catchment flooding in the Molong CBD;
- the construction of a flood protection levee along the western bank of Molong Creek in combination with the lowering of its overbank area;
- the duplication of the Molong Creek Railway and Euchareena Road bridges;
- the provision of additional waterway area beneath the railway line north of the existing bridge crossing;
- the construction of a detention basin on the Pillans Park Drainage Line in combination upgrades to reaches of the existing trunk drainage line; and
- channel and flow diversion measures on Moss Hollow Creek immediately upstream of its crossing of Market Street.

Details of the assessed flood modification measures are set out in **Section 3.4** of this Chapter.

The property modification measures considered as part of this study include controls over future development, voluntary house purchase and raising (refer **Section 3.5** of this Chapter for details).

Response modification measures, such as improvements to emergency planning and responses and public awareness programs have also been considered, details on which are set out in **Section 3.6** of this Chapter.

3.4 Flood Modification Measures

3.4.1 Molong Creek Potential Flood Modification Measures

As the majority of the flood damages that are experienced in Molong occur as a result of floodwater which breaks the western bank of the watercourse upstream of the Euchareena Road Bridge and discharges through the Molong CBD, a scheme which reduces the frequency of this occurrence has merit.

While the Molong Flood Study demonstrated that both the Molong Creek Railway and Euchareena Road bridges increase peak flood levels upstream of their location, and hence the frequency that floodwater breaks the western bank of the creek, their upgrade alone would not provide a significant benefit in terms of a reduction in flood damages, for the reason that the narrowing of the channel downstream of the rail corridor also contributes to elevated flood levels at the location of the breakout. The cost to upgrade of the two bridges by way of providing additional spans would not be cheap and also requires significant earthworks to facilitate their widening.

Based on the above understanding, as staged approach to implementing a flood mitigation scheme which over time will improve the level of flood immunity afforded to the Molong CBD, while managing third party related impacts, as well as time and cost related constraints associated with its implementation.

Table 3.2 sets out the key features of the potential flood mitigation options (**PFMOs**) which were assessed as part of the present study, as well as a brief description of their impact on floods with AEPs of 10%, 5% and 1%. Also included in **Table 3.2** is the estimate capital cost to implement each of the assessed PFMOs.

Assessment Outcome

While the implementation of the PFMO1a and PFMO1b works would reduce the impact that local stormwater runoff has on existing development that is located along Watson and Banks streets, in order to reduce the impact that Main Stream Flooding has on existing development in the Molong CBD it would also be necessary to implement the PFMO2 and PFMO3 works. While further incremental improvements could be achieved in the level of flood protection afforded by the PFMO2 levee by implementing the PFMO4, PFMO5 and PFMO6 works, these would take a significant amount of time and capital investment to complete.

The implementation of the works comprising PFMO1a, PFMO1b, PFMO2 and PFMO3 would remove the impacts of Main Stream Flooding from the Molong CBD area for all floods up to 10% AEP, with the level of flood protection afforded to this area increasing to a minimum of 1% AEP following the implementation of the works comprising PFMO4, PFMO5 and PFMO6.

It is noted that the *Present Worth Value* of flood damages saved by removing flooding from the Molong CBD area for all floods up to the 10% AEP and 1% AEP are $1.4 Million and $5.8 Million, respectively. As the total cost of the measures required to provide a 10% AEP and 1% AEP level of protection to Molong CBD are estimated to be $9.7 Million[5] and $42.3 Million, their implementation cannot be justified on economic grounds (i.e. because their benefit cost ratios are less than 1).

That said, flooding of the Molong CBD on a relatively frequent basis is causing major disruption to the town and its people, so there is merit in implementing the assessed works, either in part or in full, providing an adequate source of funding can be found. Furthermore, the impacts of future climate change will increase the magnitude and frequency of flow which surcharges the western bank of Molong Creek, further increasing the impact that flooding from this source has on the Molong community.

Based on the above understanding, while the full suite of assessed measures has been included in *Molong FRMP 2024*, their design and construction has been split into the following five stages:

- **Stage 1** – Feasibility study and concept design of PFMO1a, PFMO1b, PFMO2, PFMO3, PFMO4, PFMO5 and PFMO6 (Estimated Cost = $0.6 Million).
- **Stage 2** – Detailed design and implementation of the works associated with PFMO1a, PFMO1b, PFMO2 and PFMO3 (Estimated Capital Cost = $11.2 Million).
- **Stage 3** – Detailed design and implementation of the works associated with PFMO4 (Estimated Capital Cost = $5.4 Million).
- **Stage 4** – Detailed design and implementation of the works associated with PFMO5 (Estimated Capital Cost = $20.5 Million).
- **Stage 5** – Detailed design and implementation of the works associated with PFMO6 (Estimated Capital Cost = $7.2 Million).

[5] Includes the estimated cost of undertaking a feasibility study and concept design of the full suite of measures.

TABLE 3.2
SUMMARY OF ASSESSED POTENTIAL FLOOD MODIFICATION MEASURES ON MOLONG CREEK

Potential Flood Modification Measure	Identifier	Key Features	Impact on Flood Behaviour	Key Findings	Estimated Capital Cost of Individual PFMO ($ Million)(1)	Estimated Cumulative Capital Cost of Assessed PFMOs ($ Million)
Molong CBD Stormwater Drainage Upgrade	PFMO1a	➢ The left hand side of **Figure 3.1**, sheet 1 shows the key features of the works associated with PFMO1a. ➢ Enlargement of the existing stormwater pipes in Watson Street and Banks Street. ➢ Provision of improved pit inlet capacity in both the Watson Street and Bank Street sags. ➢ Installation of motorised penstock gates on sections of pipe discharging to Molong Creek (2 off). ➢ Installation of flood gates on the outlet of two existing 450 mm diameter pipes discharging to Molong Creek at the intersection of Watson and Hills streets. ➢ Installation of a new length of 600 mm diameter pipe connecting the Riddell Street drainage line with upgraded system running north along eastern side of Watson Street (required to divert flow north when penstock gate is in its closed position). ➢ Installation of pump well, two off 1 m^3/s submersible pumps (one duty and one standby) and rising main on eastern side of Watson Street opposite Banks Street.	➢ Refer **Figure 3.1** (2 sheets) shows the impact that PFMO1a would have on flood behaviour under "flood gates open" and "flood gates closed" conditions, respectively. ➢ PFMO1a would significantly reduce the impact that local stormwater runoff has on existing commercial and residential development that is located along Watson Street and Banks Street in the Molong CBD during floods which do not surcharge the western bank of Molong Creek. ➢ PFMO1a would not reduce the impact that flooding has on existing development during floods which surcharge the western bank of Molong Creek.	➢ While PFMO1a would significantly reduce the impact that local stormwater runoff would have on flooding conditions in existing residential and commercial development that is located in the Molong CBD, it would not provide any flood mitigation benefits during floods which surcharge the western bank of Molong Creek. ➢ Based on the above understanding, in order to reduce the impact that Main Stream Flooding has on existing development in the Molong CBD it would be necessary to implement works which reduce the frequency and magnitude of flow which surcharges the western bank of Molong Creek.	3.7	3.7
Molong CBD Commercial Property Removal	PFMO1b	➢ Purchase and demolition of a select number of commercial buildings that are located adjacent to the sag in Banks Street.	➢ While the removal of a select number of commercial buildings adjacent to the low point in Banks Street would reduce both the depth and duration of local stormwater runoff that would otherwise pond above back-of-footpath levels in the road reserve, preliminary flood modelling indicates that it would have limited benefit in terms of reducing peak flood levels associated with Main Stream Flooding.	➢ As the removal of existing commercial buildings would provide limited flood mitigating benefits in regards Main Stream Flooding, the focus should be on reducing the blocking effects that the existing buildings have on local catchment runoff that presently ponds in the road reserve during intense rainfall events. ➢ Based on the above, there may be merit in purchasing and removing one or more commercial buildings that are located on the northern side of Bank Street adjacent to the sag in the road, as this would provide additional relief to stormwater that would otherwise pond above back-of-footpath levels in the road reserve. ➢ As the current flood modelling does not show excessive depths of inundation present in Banks Street as a direct result of local catchment runoff, further, more detailed investigations are required to confirm or otherwise the merits of this measure.	2.0	5.7

1. Refer over for footnotes.

Cont'd Over

TABLE 3.2 (Cont'd)
SUMMARY OF ASSESSED POTENTIAL FLOOD MODIFICATION MEASURES ON MOLONG CREEK

Potential Flood Modification Measure	Identifier	Key Features	Impact on Flood Behaviour	Key Findings	Estimated Capital Cost of Individual PFMO ($ Million)[(1)]	Estimated Cumulative Capital Cost of Assessed PFMOs ($ Million)
10% AEP Western Creek Bank Levee	PFMO2	➢ The left hand side of **Figure 3.3**, sheet 1 shows the key features of the works associated with PFMO2 in combination with PFMO1a. ➢ Construction of a 340 m (approx.) long reinforced concrete or block wall along the western boundary of the existing rail line extending north from the train station to the pedestrian level crossing. ➢ Installation of a removable barrier arrangement across the pedestrian and Euchareena Road level crossings. ➢ Construction of a 210 m (approx.) long reinforced concrete or block wall extending north from the Euchareena Road level crossing to the existing reinforced concrete deflection barrier that is located at the intersection of Watson and Hill streets. ➢ Construction of a 20 m (approx.) long reinforced concrete or block wall extending west from the existing reinforced concrete deflection barrier that is located at the intersection of Watson and Hill streets to the private access road which runs immediately to the west of the Molong Swimming Pool. ➢ Installation of a removable barrier arrangement across the aforementioned private access road. ➢ Construction of a 310 m (approx.) long reinforced concrete or block wall extending west from the aforementioned private access road where it would tie into high ground near the intersection of Hill Street and Edward Street. ➢ Rationalisation of the existing pipes discharging to Molong Creek along Hills Street to a single upgraded outlet pipe. ➢ Installation of a motorised penstock gate on the aforementioned upgraded reach of pipe. ➢ Note that the crest level of the abovementioned sections of levee have been set 0.1 m above peak 10% AEP flood levels so as to facilitate their overtopping during rarer floods. That said, the intent is to design the levee to allow it to be raised in the future once other flood modification measures have been constructed (refer below for further discussion).	➢ Refer **Figure 3.3** (2 sheets) shows the impact that PFMO2 would have on flood behaviour under "flood gates closed" conditions, noting that the assessment includes the works associated with PFMO1a. ➢ While PFMO2 would prevent flow from surcharging the western bank of Molong Creek for floods up to 10% AEP in magnitude, it would exacerbate flooding conditions in existing residential and commercial development that is located on the eastern side of the watercourse, noting that several houses in this area are subject to above-floor inundation during floods that are more frequent than 10% AEP. ➢ While PFMO2 would not impact flood behaviour during a 1% AEP flood event due to its relatively low level nature, adverse impacts would be experienced in existing development that is located on the eastern overbank of Molong Creek during a 5% AEP flood, even though the levee would be overtopped by floodwater and provide limited flood mitigation benefits to exiting development that is located in the Molong CBD.	➢ While PFMO2 in combination with PFMO1a would reduce the impact that both local stormwater runoff and Molong Creek floods up to 10% AEP would have on flooding conditions in existing residential and commercial development that is located in the Molong CBD, it would exacerbate flooding conditions in existing development that is located on the eastern side of Molong Creek. ➢ While the residential properties that would be adversely impacted by the works either form part of the current voluntary house purchase scheme for Molong, or the recommended voluntary house raising scheme, the acquisition/raising of these properties/houses will take time. ➢ Based on the above understanding, there is merit in undertaking other cost-effective works which are aimed at mitigating the impacts that the PFMO2 works would have on flooding conditions in these properties.	4.0	9.7

1. Refer over for footnotes.

Cont'd Over

TABLE 3.2 (Cont'd)
SUMMARY OF ASSESSED POTENTIAL FLOOD MODIFICATION MEASURES ON MOLONG CREEK

Potential Flood Modification Measure	Identifier	Key Features	Impact on Flood Behaviour	Key Findings	Estimated Capital Cost of Individual PFMO ($ Million)[(1)]	Estimated Cumulative Capital Cost of Assessed PFMOs ($ Million)
Partial Lower Molong Creek Overbank Works	PFMO3	➢ The left hand side of **Figure 3.4**, sheet 1 shows the key features of the works associated with PFM03 in combination with the other aforementioned PFMOs. ➢ Lowering of the eastern overbank of Molong Creek over a distance of about 500 m downstream of the Molong Railway Bridge, noting that the benched overbank area would be set a minimum 1.5 m above the existing invert level of the watercourse.	➢ Refer **Figure 3.4** (2 sheets) shows the impact that PFMO3 would have on flood behaviour under "flood gates closed" conditions, noting that the assessment includes the works associated with the aforementioned PFMOs. ➢ The works associated with PFMO3 would reduce upstream flood levels sufficient to offset the impact that the levee would otherwise have on flood behaviour in existing development that is located on the eastern side of Molong Creek.	➢ While the overbank works would mitigate the impacts that PFMO2 has on Main Stream Flooding in existing development, they are located on both railway and privately owned land, which would entail an approval process. ➢ To reduce the impact that the PFMO3 overbank works have on the operation of the privately owned land, batter slopes of 1V:10H have been adopted in its set out. ➢ The option of demolishing the Molong Swimming Pool and lowering the western overbank of Molong Creek as an alternative was assessed as part of the present study. However, it was found that these works were insufficient to mitigate the adverse impacts associated with the PFMO2 levee. ➢ The option of increasing the level of protection of the PFMO2 levee to 5% AEP in combination with the PFMO3 overbank works was also assessed as part of the present study. However, it was found that the reduction in peak flood levels attributable to the works were not sufficient to offset the blocking effects of the raised levee. ➢ Based on the above findings, it would be feasible to provide a 10% AEP level of flood protection to existing development that is located in the Molong CBD without needing to acquire/raise the properties that are located on the eastern side of Molong Creek.	1.5	11.2
Lower Molong Creek Overbank and Road/Levee Realignment Works	PFMO4	➢ The left hand side of **Figure 3.5**, sheet 1 shows the key features of the works associated with PFM04 in combination with the other aforementioned PFMOs. ➢ Realignment of the intersection of Watson and Hill streets ➢ Realignment of a 150 m length (approx.) of the PFMO2 levee to the eastern side of the realigned section of road and the rationalisation of the existing stormwater drainage system. ➢ Lowering of the western overbank of Molong Creek over a distance of about 200 m downstream of the Molong Railway Bridge, noting that the benched overbank area would be set a minimum 1.5 m above the existing invert level of the watercourse.	➢ Refer **Figure 3.5** (2 sheets) shows the impact that PFMO4 would have on flood behaviour under "flood gates closed" conditions, noting that the assessment includes the works associated with the aforementioned PFMOs. ➢ While the works associated with PFMO4 would result in a reduction in both the extent and depth of flooding that would be experienced in the Molong CBD during floods rarer than 10% AEP by lowering peak flood levels along Molong Creek, overtopping of the levee would still occur during a 5% AEP flood.	➢ While the works associated with PFMO4 would reduce the impact that flooding has on existing development that is located in the Molong CBD, it does not result in a significant increase in the level of protection of the PFMO2 levee. ➢ The option of increasing the level of protection of the PFMO2 levee to 5% AEP as part of the PFMO4 works was assessed as part of the present study. However, it was found that the reduction in peak flood levels attributable to the works were not sufficient to offset the blocking effects of the raised levee.	5.4	16.6

1. Refer over for footnotes.

Cont'd Over

TABLE 3.2 (Cont'd)
SUMMARY OF ASSESSED POTENTIAL FLOOD MODIFICATION MEASURES ON MOLONG CREEK

Potential Flood Modification Measure	Identifier	Key Features	Impact on Flood Behaviour	Key Findings	Estimated Capital Cost of Individual PFMO ($ Million)[1]	Estimated Cumulative Capital Cost of Assessed PFMOs ($ Million)
Mid-Molong Creek Overbank and Molong Railway Bridge Duplication Works	PFMO5	➢ The left hand side of **Figure 3.6**, sheet 1 shows the key features of the works associated with PFM05 in combination with the other aforementioned PFMOs. ➢ Lowering of the eastern and western overbank of Molong Creek where it runs between the Euchareena Road and Molong Rail bridges, noting that the benched overbank area would be set a minimum 1.5 m above the existing invert level of the watercourse. ➢ Construction of a new 36 m (approx.) long rail bridge immediately to the south of the existing structure.	➢ Refer **Figure 3.6** (2 sheets) shows the impact that PFMO5 would have on flood behaviour under "flood gates closed" conditions, noting that the assessment includes the works associated with the aforementioned PFMOs. ➢ The works associated with PFMO5 would increase the level of flood protection afforded by the PFMO2 levee to greater than 5% AEP, with significant reductions in peak flood levels also shown to occur at the 1% AEP level of flooding.	➢ While the increase in waterway area beneath the railway line would increase the level of protection of the PFMO2 levee to greater than 5% AEP, it would still be overtopped in a 1% AEP event. ➢ The option of increasing the level of protection of the PFMO2 levee to 1% AEP as part of the PFMO5 works was assessed as part of the present study. However, it was found that the reduction in peak flood levels attributable to the works were not sufficient to offset the blocking effects of the raised levee.	20.5	37.1
Upper Molong Creek Overbank and Euchareena Road Bridge Duplication Works	PFMO6	➢ The left hand side of **Figure 3.7**, sheet 1 shows the key features of the works associated with PFM06 in combination with the other aforementioned PFMOs. ➢ Lowering of the eastern overbank of Molong Creek where it runs between the extension of Dean Street and the Euchareena Road Bridge, noting that the benched overbank area would be set a minimum 1.5 m above the existing invert level of the watercourse. ➢ Construction of a new 30 m (approx.) long road bridge immediately to the east of the existing structure. ➢ Raising the crest height of the PFM02 levee along its full length to 0.1 m above the peak 1% AEP flood level in Molong Creek.	➢ Refer **Figure 3.7** (2 sheets) shows the impact that PFMO6 would have on flood behaviour under "flood gates closed" conditions, noting that the assessment includes the works associated with the aforementioned PFMOs. ➢ The works associated with PFMO6 would increase the level of flood protection afforded by the raised sections of the PFMO2 levee to greater than 1% AEP, with reduction in peak flood levels also shown to occur along the main arm of Molong Creek where it runs through Molong.	➢ The implementation of the PFMO6 works in combination with the other aforementioned PFMOs would provide a 1% AEP level of protection to existing development that is located in the Molong CBD.	7.2	44.3

1. Does not include the estimated $0.6 Million to undertake a feasibility study and prepare a detailed concept design of the various measures comprising the Molong CBD Flood Mitigation Scheme.

3.4.2 Moss Hollow Creek Potential Flood Mitigation Measures

Damaging flooding is experienced in several residential properties that are located on the eastern side of Market Street in the immediate vicinity of where Moss Hollow crosses the road corridor. While the existing transverse drainage structure is relatively large, floodwater surcharges the existing sag that is present in the road to its south, where it discharges in an easterly direction through the existing properties.

In order to prevent this breakout of flow it would be necessary to divert the floodwater which surcharges the sag in Market Street towards the existing transverse drainage structure. This would involve the upgrade of the existing channel where it runs along the western side of the road corridor in order to increase its capacity, as well as provide a diversion bund which would run along the western side of the road corridor immediately adjacent to the sag. Due to the close proximity of the channel to the road nearer the existing transverse drainage structure, it would also be necessary to extend the existing retaining structure further south. The above works have been denoted herein as the "**Moss Hollow Creek Drainage Improvements (PFMO7)**".

Assessment Outcome

As shown in **Figure 3.8**, while the Moss Hollow Creek Drainage Improvements (PFMO7) would significantly reduce the flooding that is presently experienced in the existing residential properties that are located on the eastern (downstream) side of the sag in Market Street, they would exacerbate flooding in an existing residential property that is located immediately adjacent to the outlet of the existing transverse drainage structure for floods as frequent as 10% AEP. Based on this finding, Moss Hollow Creek Drainage Improvements (PFMO7) are not recommended for inclusion in *Molong FRMP 2024*.

3.4.3 Pillans Park Drainage Line Potential Flood Mitigation Measures

Damaging flooding was experienced in existing residential development that is located adjacent to the Pillans Park Drainage Line during the intense rainfall that occurred in November 2022. There are also indications that parts of the drainage system are in structural decline and require rectification. In order to address these issues, Council engaged a local consulting firm to undertake an assessment of the condition of the existing drainage system and to also assess options for its upgrade. The findings of the assessment are set out in the report entitled "*Molong Urban Flooding Issues Investigation – Stage 1 Report*" (Premise, 2024).

The investigation assessed a range of measures, the various options associated with which were set out in Premise, 2024 as follows.

- **Section 1 – Smith Street to Norman Lane**
  - Option 1.1 – Two Metre Wide Easement with Underground Stormwater Infrastructure and Overland Flow Path
  - Option 1.2 – Two Metre Wide Easement with Underground Stormwater Infrastructure Only
- **Section 2 – Norman Lane to Lee Street**
  - Option 2 – Five Metre Wide Easement with Overland Flow Path
- **Section 3 – Lee Street to Wellington Street**
  - Option 3 – Six Metre Wide Easement with Overland Flow Path

- **Section 4 – Wellington Street Sag**
  - Option 4.1 – Upgrade Wellington Street Sag Stormwater Infrastructure
  - Option 4.2 - Additional Pipe Down Wellington Street
  - Option 4.3 - Raise Verge Along Lot Frontages and Create Spillway
- **Section 5 – Lot 1 In DP 124044 Detention Basin and Gidley Street Crossing**
  - Option 5.1 – Detention Basin in Lot 1 In DP 124044
  - Option 5.2 – Additional Pipe Down Gidley Street
- **Section 6 – Iceworks Lane & Centa-Pak Site**
  - Option 6.1 – Additional Stormwater Pipe Though the Centa-Pak Site
  - Option 6.2 – Additional Stormwater Pipe Up Iceworks Lane

Premise, 2024 recommended that general maintenance be undertaken to remove debris from kerb and culvert inlets within the catchment to allow the existing stormwater network to operate at its maximum capacity. It also recommended that a preliminary cost assessment be prepared to determine the financial viability of Council's preferred set of options, following confirmation of which, commission detailed ground survey, undertake a detailed hydraulic analysis and prepare the detailed design.

Council advised that due to the time required to obtain easements in private property, the following set of options are considered to provide the best outcome in terms of flood mitigation and drainage improvements in their absence:

- Option 1.2 – Two Metre Wide Easement with Underground Stormwater Infrastructure Only
- Option 2 – Five Metre Wide Easement with Overland Flow Path
- Option 3 – Six Metre Wide Easement with Overland Flow Path
- Option 4.1 – Upgrade Wellington Street Sag Stormwater Infrastructure
- Option 5.1 - Detention Basin in Lot 1 In DP 124044

The above set of options have been denoted herein as the "**Pillans Park Drainage Line Improvements (PFMO8)**".

Assessment Outcome

The works comprising the Pillans Park Drainage Line Improvements (PFMO8) were incorporated into the TUFLOW model that was developed as part of the *Molong Flood Study*. **Figure 3.9** shows the impact that the implementation of these works would have on flood behaviour for storms with AEPs of 10%, 5% and 1%.

While the implementation of the Pillans Park Drainage Line Improvements (PFMO8) would not remove flooding altogether from the residential development that borders the drainage line for storms as frequent as 10% AEP, they would reduce both the frequency and severity of flooding that is currently experienced in these properties during heavy rainfall events. It is noted that the works would remove above-floor flooding in a single dwelling during a 5% AEP storm event and a second dwelling during a 1% AEP storm event. Based on this finding, the Pillans Park Drainage Line Improvements (PFMO8) are recommended for inclusion in *Molong FRMP 2024*.

3.4.4 Vegetation Management

Management programs in creeks typically involve maintenance of batters, the removal of sediment, removal of dense vegetation and the clearance of flood debris after significant flow events. Clearance of debris within the stream corridor reduces the potential for future capture by the flow and blockage of culverts.

Given the potential for dense vegetation to slow the passage of flow and hence increase peak flood levels in Molong Creek and its major tributaries where they run through Molong, there is merit in Council implementing a more regimented program of managing the density of the riparian vegetation. For this reason, the development and implementation of a vegetation management plan has been included in *Molong FRMP 2024*.

3.5 Property Modification Measures

3.5.1 Controls over Future Development

3.5.1.1 Current Government Policy

The NSW Government has recently finalised reforms of the *NSW Flood Prone Land Package*. As part of the reform, the wording in the flood planning clause of all NSW Councils was updated on 14 July 2021. As part of the reform, Council will need to nominate the FPL or levels that it wishes to define the FPA and make alternative arrangements for making flood planning maps publicly available where previously solely reliant on LEP flood overlay maps. While the reforms also included an optional clause titled *special flood considerations* which applies to land which lies between the FPA and the extent of the PMF, Council chose not to include it in *Cabonne LEP 2012* at the time.

3.5.1.2 Considerations for Setting Freeboard Requirements

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

Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest and basement entrance levels, etc. Design variables that are typically incorporated in the derivation of freeboard typically comprise the following:

- increases in peak flood levels due to wind and wave action;
- uncertainties in the design flood level estimates due to the confidence limits associated with the design peak flow estimates, inaccuracies in the LiDAR survey data and possible variations in key parameters such as hydraulic roughness; and
- increases in peak flood levels due to future climate change.

Table 3.3 provides a summary of a joint probability analysis which was undertaken to assess the freeboard allowance which should be incorporated in the FPL for areas at Molong that are affected by Main Stream Flooding, noting the methodology for deriving the various components of the freeboard allowance is based on the approach set out in Public Works, 2010.

TABLE 3.3
SUMMARY OF FREEBOARD ANALYSIS
AREAS AFFECTED BY MAIN STREAM FLOODING

Design Variable	Probability of Occurrence/Level of Certainty	Maximum Allowance (m)	Joint Probability Allowance (m)
Wave Action	50%	0.20(1)	0.10
Uncertainties in Peak 1% AEP Flood Level Estimate			
- LiDAR survey data	100%	0.15	0.15
- Peak flow estimate	50%	0.30	0.15
Future Climate Change	50%	0.30	0.15
	TOTAL		**0.55**

1. Based on vehicle driven wave action

The maximum allowance for uncertainties in the peak 1% AEP flood level estimate is comprised of the following

- inaccuracies in the LiDAR survey data; and
- provision for a 10% increase in the best-estimate peak 1% AEP flow derived by comparison with the increase in peak flood levels associated with a 0.5% AEP flood event.

In regards the potential impacts of future climate change on flood behaviour at Molong, the *ARR Data Hub* gives the following interim climate change factors for Representative Concentration Pathways (**RCPs**) of 4.5 and 8.5 in the years 2050 and 2090:

Year	RCP 4.5	RCP 8.5
2050	7.1%	10.1%
2090	13.1%	22.8%

A flood with an AEP of 0.5% is commonly considered to be analogous to a flood that would result from a 10% increase in 1% AEP rainfall intensities. By comparison with the interim climate change factors, the adoption of the 0.5% AEP would provide a reasonable indicator of the potential for future climate change to impact peak 1% AEP flood levels at Molong.

While the joint probability analysis set out in **Table 3.3** indicates a freeboard slightly greater than the traditional value of 0.5 m may be appropriate, it is considered that the adoption of a value of 0.5 m for setting the FPL in areas affected by Main Stream Flooding would provide a reasonable level of flood protection to future development at Molong.

While the flood range in the major watercourses which traverse the study area is such that the traditional 0.5 m freeboard is appropriate for setting the FPL, its adoption in areas affected by Major Overland Flow would lead to the FPA extending onto land which would not experience damaging or hazardous flooding during a 1% AEP storm event, even allowing for all the variables which comprise freeboard.

Considerable reduction in the number of properties in Major Overland Flow areas classified as "flood affected" would result by the adoption of a threshold depth of inundation under 1% AEP conditions of 0.1 m as the criterion for defining area which would be subject to the majority of flood related development controls, compared with the traditional approach. Properties with depths of inundation 0.1 m or greater, or in a floodway (i.e. traversed by significant overland flows which may in some cases be less than 0.1 m in depth) would therefore be considered to lie within the FPA. Properties with depths of inundation under 1% AEP non-floodway conditions of less than 0.1 m would be classified as "Local Drainage" and, as such would be subject to controls such as the Building Code of Australia (**BCA**) requirements, rather than attracting a flood affectation notice. This approach is supported by the FRMM and would not adversely impact on Council's duty of care in regard to management of flood prone lands. The proposed categorisation of the floodplain, terminology and controls are shown on **Table 3.4**.

TABLE 3.4
PROPOSED CATEGORISATION OF THE FLOODPLAIN

Category	Proposed Terminology used to define inundation in the *Molong FRMS&P* report	Are Development Controls Required?	Is Section S10.7 Notification Warranted?
Main Stream Flooding	"Main Stream Flooding"	Yes	Yes
Local Overland Flooding - Local Drainage - Major Drainage	 "Local Drainage" "Major Overland Flow"	 No (ref. footnote 1). Yes (ref. footnote 2).	 No (ref footnote 1) Yes (ref footnote 3)

1. Inundation in Local Drainage areas is accommodated by the minimum floor level requirement of 0.15 m above finished surface level contained in the BCA and does not warrant a flood affectation notice in S10.7 Planning Certificates.
2. These are the deeper flooded areas with higher flow velocities. Development controls are specified in **Appendix D**.
3. Depth and velocity of inundation in Major Overland Flow areas are sufficient to warrant a flood affectation notice in S10.7 Planning Certificates. Inundation is classified as "flooding".

Figure D1.1 in **Appendix D** is an extract from the *Flood Planning Map* for Molong. The figure includes areas subject to both Main Stream Flooding and Major Overland Flow. The extent of the FPA (the area subject to flood related development controls) is shown in a solid mauve (Main Stream Flooding) and green (Major Overland Flow) colour in **Figure D1.1**, and has been defined as follows:

- In areas subject to Main Stream Flooding, the FPA is based on the traditional definition of the area that lies at or below by the 1% AEP plus 0.5 m freeboard.
- In areas subject to Major Overland Flow, the FPA is defined as the extent of areas which act as a floodway, as well as areas where depths of inundation exceed 0.1 m in a 1% AEP event.

Also shown in **Figures D1.1** is the extent of the *Special Flood Considerations Zone*, which is the area of land which lies between the extent of the FPA and the PMF, and where the Flood Hazard Vulnerability Classification in a PMF event is greater than H2.

3.5.1.3 Proposed Planning Controls for Molong

While *Cabonne DCP No. 10* deals with development on flood prone land at Molong, it is limited in its scope and is not consistent with current best flood risk management practice. As a result, it is recommended that Council review and update *Cabonne DCP No. 10* based on the findings of the present study, as well as the suggested wording that is set out in **Appendix D** of this report.

Annexures 2A and **2B** in **Appendix D** set out the graded set of flood related planning controls which have been developed for areas that are subject to Main Stream Flooding and Major Overland Flow, respectively, while **Figure D1.1** in **Appendix E** shows the areas where the graded set of flood related planning controls set out in **Annexures 2A** and **2B** apply in Molong.

Minimum habitable floor level (**MHFL**) requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on **Figure D1.1**. The MHFLs for residential land use types is the level of the 1% AEP flood event plus freeboard, whereas for commercial and industrial land use types the MHFL is to be as close to the 1% AEP flood level plus freeboard as practical, but no lower than the 5% AEP flood level plus freeboard. In situations where the MHFL is below the 1% AEP flood level plus freeboard, a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard.[6]

For areas outside the FPA shown on **Figure D1.1**, the MHFL for essential community facilities and utilities which are critical for flood response and recovery, as well as sensitive uses and facilities is the level of the PMF.

Figure D1.2 in **Appendix D** is an extract of the *Flood Planning Constraint Category Map* for the Cabonne LGA which respectively show the subdivision of the floodplain at Molong into the following four categories which have been used as the basis for developing the graded set of planning controls:

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the FPA where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the FPA but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in **Appendix D** of this report.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the FPA and the PMF where the Flood Hazard Vulnerability Classification in a PMF event is greater than H2. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes. This area is identical to the *Special Flood Considerations Zone* shown on **Figure D1.1**.

[6] Freeboard is equal to 0.5 m for development being assessed in areas affected by Main Stream Flooding and 0.3 m for development being assessed in areas affected by Major Overland Flow.

The derivation of the four FPCCs firstly involved the derivation of a number of sub-regions which were based on the nature of flooding at Molong, the sub-categories of which are set out in **Table 3.5**. These sub-regions were then combined, with the resulting extents further refined in order to improve the area over which each FPCC applied.

TABLE 3.5
KEY ELEMENTS COMPRISING FLOOD PLANNING CONSTRAINT CATEGORIES AT MOLONG

Flooding	FPCC	Sub-category	Constraint
Main Stream Flooding	1	a	1% AEP Main Stream Flooding (MSF) Floodway
		b	1% AEP MSF Flood Hazard Vulnerability Classification H6
	2	a	1% AEP MSF Flood Storage
		b	1% AEP MSF Flood Hazard Vulnerability Classification H5
		c	0.2% AEP MSF Flood Hazard Vulnerability Classification H5 and H6
		d	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Submerged) – *Only discreet areas that meet this criteria were included*
		e	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Elevated) – *Only discreet areas that meet this criteria were included*
	3	-	Flood Planning Area
	4	-	Extent of PMF where Flood Hazard Vulnerability Classification is H3 - H6
Major Overland Flow	1	-	1% AEP Floodway AND Flood Hazard Vulnerability Classification H4 - H6
	2	a	1% AEP Floodway AND Flood Hazard Vulnerability Classification H1 - H3
		b	1% AEP Flood Storage Area
		c	0.2% AEP Flood Hazard Vulnerability Classification H5 and H6
	3	-	Flood Planning Area
	4	-	Extent of PMF where Flood Hazard Vulnerability Classification is H3 - H6

3.5.1.4 Revision of Cabonne LEP 2012

Both *Molong FRMS 2024* and *Molong FRMP 2024* have been developed giving consideration to the following amended form of wording which automatically came into effect on 14 July 2021:

"6.2 Flood planning

(1) The objectives of this clause are as follows—

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause—

Considering Flooding in Land Use Planning Guideline means the *Considering Flooding in Land Use Planning Guideline* published on the Department's website on 14 July 2021.

flood planning area has the same meaning as it has in the Flood Risk Management Manual.

Flood Risk Management Manual means the *Flood Risk Management Manual*, ISBN 978-1-923076-17-4, published by the NSW Government in June 2023.

While Council chose not to include the optional new *special flood considerations* clause in *Cabonne LEP 2012* at the same time as the *flood planning* clause was automatically updated by the NSW Government, it is recommended that Council now look to include it as it will require consideration to be given to approving certain types of development on land that lies between the FPA and the PMF where the Flood Hazard Vulnerability Classification in a PMF event is greater than H2:

Special flood considerations

(1) The objectives of this clause are as follows—

(a) to enable the safe occupation and evacuation of people subject to flooding,

(b) to ensure development on land is compatible with the land's flood behaviour in the event of a flood,

(c) to avoid adverse or cumulative impacts on flood behaviour,

(d) to protect the operational capacity of emergency response facilities and critical infrastructure during flood events,

(e) to avoid adverse effects of hazardous development on the environment during flood events.

(2) This clause applies to—

(a) for sensitive and hazardous development—land between the flood planning area and the probable maximum flood, and

(b) for development that is not sensitive and hazardous development—land the consent authority considers to be land that, in the event of a flood, may—

(i) cause a particular risk to life, and

(ii) require the evacuation of people or other safety considerations.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development—

(a) will not affect the safe occupation and efficient evacuation of people in the event of a flood, and

(b) incorporates appropriate measures to manage risk to life in the event of a flood, and

(c) will not adversely affect the environment in the event of a flood.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause—

***Considering Flooding in Land Use Planning Guideline**—see clause 5.21(5).*

***flood planning area**—see clause 5.21(5).*

***Flood Risk Management Manual**—see clause 5.21(5).*

***probable maximum flood** has the same meaning as it has in the Flood Risk Management Manual.*

***sensitive and hazardous development** means development for the following purposes—*

(a) [list land uses]

Direction— Only the following land uses are permitted to be included in the list—

(a) boarding houses,

(b) caravan parks,

(c) correctional centres,

(d) early education and care facilities,

(e) eco-tourist facilities,

(f) educational establishments,

(g) emergency services facilities,

(h) group homes,

(i) hazardous industries,

(j) hazardous storage establishments,

(k) hospitals,

(l) hostels,

(m) information and education facilities,

(n) respite day care centres,

(o) seniors housing,

(p) sewerage systems,

(q) tourist and visitor accommodation,

(r) water supply systems

The steps involved in Council amending *Cabonne LEP 2012* following the finalisation and adoption of *Molong FRMS&P 2024* are:

1. Council Planning Staff consider the conclusions of *Molong FRMS&P 2024* and suggested amendments to *Cabonne LEP 2012*.
2. Council resolves to amend *Cabonne LEP 2012* in accordance with *Molong FRMS&P 2024.*
3. Council prepares a Planning Proposal in accordance with NSW Planning and Environment Guidelines. Planning Proposal submitted to NSW Planning and Environment in accordance with section 3.33 of the EP&A Act, 1979.
4. Planning Proposal considered by DCCEEW and determination made in accordance with section 3.34(2) of the EP&A Act, 1979 as follows:
   (a) whether the matter should proceed (with or without variation),
   (b) whether the matter should be resubmitted for any reason (including for further studies or other information, or for the revision of the planning proposal),
   (c) community consultation required before consideration is given to the making of the proposed instrument (the community consultation requirements),
   (d) any consultation required with State or Commonwealth public authorities that will or may be adversely affected by the proposed instrument,
   (e) whether a public hearing is to be held into the matter by the Planning Assessment Commission or other specified person or body,
   (f) the times within which the various stages of the procedure for the making of the proposed instrument are to be completed.
5. Planning Proposal exhibited for public comment.
6. Planning Proposal reviewed following public submissions and submissions from relevant State and Commonwealth authorities.
7. Final Local Environmental Plan with proposed amendments drafted.
8. Amending Local Environmental Plan made by the Minister and gazetted.

3.5.2 Potential Voluntary House Purchase Scheme

Removal of housing from high hazard floodway areas in the floodplain is generally accepted as a cost-effective means of correcting previous decisions to build in such areas. The voluntary purchase of residential property in hazardous areas has been part of the NSW Government's Floodplain Management Program for over 20 years, with the recently released *Guideline for the voluntary purchase scheme* (DCCEEW, 2024a) setting out the key eligibility criteria and funding requirements should a council wish to incorporate such a scheme into one of its flood risk management plans.[7]

Voluntary purchase is a recognised and effective flood risk management measure for existing residential properties in areas where:

- there are highly hazardous flood conditions from riverine or overland flooding and the principal objective is to remove people living in the properties and reduce the risk to life of residents and potential rescuers
- a property is located within a floodway and the removal of a building may be part of a floodway clearance program that aims to reduce significant impacts on flood behaviour elsewhere in the floodplain, by enabling the floodway to more effectively perform its flow conveyance function
- purchase of a property enables other flood mitigation works (such as channel improvements or levee construction) to be implemented because the property will impede construction or may be adversely affected by the works with impacts notable to be offset.

Prior to progressing to the purchase of a property that has been identified as being eligible under the scheme, it would first be necessary to undertake a scoping study, especially if the intention is for a council to apply for NSW Government grant funding. The study would involve discussions with each eligible and agreeable property owner, as well as a detailed assessment of each property to determine a priority order and costing for each.

Following the completion of the scoping study, the subject owner is notified that Council is prepared to purchase the property when the owner is ready to sell. Ultimately, the purchase price of the property is determined by independent valuers and the Valuer General, and by negotiation between Council and the owners, noting that valuations are not reduced due to the flood affected nature of the site.

After purchase, land is subsequently cleared and the site re-developed and re-zoned for public open space or some other flood compatible use. A further criterion applied by State Government agencies in assessing eligibility for funding is that the property must be in a high hazard floodway area, that is, in the path of flowing floodwaters where the depth and velocity at the peak of the flood are such that life could be threatened, damage of property is likely and evacuation difficult.

Assessment Outcome

Based on the findings of the *Molong Flood Study*, there are currently 18 houses that are located in high hazard floodway areas at Molong, six (6) on the eastern overbank and ten (10) on the western overbank of Molong Creek, one (1) on the western overbank of Boree Hollow and one (1) on the western overbank of Moss Hollow Creek. Based on an average sale price of $400,000, the purchase of all 18 properties is estimated to cost $7.2 Million.

[7] State government funding is only available for properties where the buildings were approved and constructed prior to 1986 when the original Floodplain Development Manual was gazetted. Properties built after this date should have been constructed in accordance with the principles in the manual.

While the purchase of these properties cannot be justified on economic grounds, there removal from the floodplain would significantly reduce risk to life during floods which surcharge the inbank area of Molong Creek and its major tributaries. As a result, the adoption of an expanded voluntary house purchase scheme for Molong is recommended for inclusion in *Molong FRMP 2024*, noting that it would first be necessary to undertake the aforementioned scoping study before proceeding with the voluntary acquisition of the affected properties.

3.5.3 Potential Voluntary House Raising Scheme

Voluntary house raising is recognised as an effective floodplain risk management measure for both riverine and overland flood conditions. It is generally undertaken to:

a) reduce the frequency of exposure to flood damage of the house and its contents and reduce the frequency of household disruption and associated trauma and anxiety; or

b) as a compensatory measure where flood mitigation works adversely affect a house, which is generally considered part of the mitigation work rather than a separate VHR scheme.

Voluntary house raising can be an effective strategy for existing properties in low flood hazard areas where mitigation works to reduce flood risk to properties are impractical or uneconomic, noting that it must form part of a broader floodplain risk management strategy for an area rather than as a stand-alone option, as it does not deal with issues such as risk to life. The recently released *Guideline for voluntary house raising schemes* (DCCEEW, 2024b) sets out the key eligibility criteria and funding requirements should a council wish to incorporate such a scheme into one of its flood risk management plans.

State government funding is only available for properties where the buildings were approved and constructed prior to 1986 when the original Floodplain Development Manual was gazetted, noting that houses built after this date should have been constructed in accordance with the principles in the manual.

Following the adoption of a voluntary house raising scheme as part of a flood risk management plan, the next step is for a council to undertake a scoping study, especially if the intention is to apply for NSW Government grant funding. The study is to include discussions with each eligible and agreeable property owner, as well as a detailed assessment of each property to determine a priority order and costing for each. Following the completion of the scoping study, the subject owner is notified that Council is prepared to cover the cost of raising the existing house to the FPL or higher.

Assessment Outcome

Based on the findings of the *Molong Flood Study*, there are 11 houses that would experience above-floor inundation as a result of Main Stream Flooding during a 1% AEP flood event that are not located in high hazard floodway areas. Of these, seven (7) are of brick veneer type construction, while the remaining four (4) are of timber frame type construction and therefore could be raised.

Based on an estimated $150,000 to raise a single timber frame house, the cost to raise the four houses in Molong is estimated to cost $0.6 Million. While the flood damages in the four houses for all floods up to the 1% AEP are less than this amount, there is merit in investigating the owner's willingness to have the floor level of their house raised to the FPL, thereby reducing future damages in the property.

Based on the above finding, the commissioning of a scoping study has been included in *Molong FRMP 2024*. A provision has also been included in Molong FRMP 2024 to raise the floor level of the four aforementioned dwellings to the FPL, noting that this would be subject to a favourable outcome of the scoping study.

3.6 Response Modification Measures

3.6.1 Severe Weather/Thunderstorm and Flood Warning System

Improvements to the flood warning and response procedures were strongly favoured by the community during the community consultation process. An effective flood warning system has three key components, i.e. a flood forecasting system, a flood warning broadcast system and a response/evacuation plan. All systems need to be underpinned by an appropriate public flood awareness program.

Presently warnings regarding the potential for flooding to occur at Molong are limited to BoMs *Severe Thunderstorm Warning* and *Severe Weather Warnings for Flash Flooding* alert services which are publicly available via the internet via the following links or on smart phones via free Apps such as Hazards Near Me which is linked to the Australian Warning System:

- http://www.bom.gov.au/nsw/warnings/
- https://hazardwatch.gov.au/

As both residential and commercial development in parts of Molong is subject to damaging flash-type flooding, there is merit in implementing an effective location-based messaging system which warns both residents and business owners of:

a) the potential for flood producing rain to be experienced over the Molong Creek catchment and also directly over the town, and

b) the potential for damaging flooding to occur as a result of rising water levels in Molong Creek at the location of the Downstream Borenore Creek stream gauge and also in town.

While Council would first need to commission an investigation to assess the feasibility of implementing such a scheme at Molong, it is envisaged that it would comprise the following as a minimum:

- The installation of telemetered stream gauge on the western bank of Molong Creek a short distance downstream of the Marsden Street Bridge (**Downstream Marsden Street Bridge stream gauge**).
- A location-based text messaging service that alerts subscribers to:
  a) the issuing of a Severe Weather or Thunderstorm Warning from the Bureau of Meteorology;
  b) the exceedance of the pre-determined water level alerts on both the Downstream Borenore Creek and Downstream Marsden Bridge stream gauges.

It is envisaged that the Molong Post Office and Orange Airport rain gauges, as well as the other gauges which form part of BoM's FWN would be used to alert residents and businesses owners of the potential for flood producing rain to be experienced over the Molong Creek catchment and also directly over the town.

It order to determine the pre-determined trigger levels on the Downstream Borenore Creek stream gauge, it will be necessary to extend the hydraulic model that was developed as part of the Molong Flood Study to a location upstream of the gauge site. The extended model would then be used to derive a stage versus discharge relationship, which would then be used to determine key trigger levels on the stream gauge.

The cost to investigate and design the system an integrated severe weather/thunderstorm and flood warning system for Molong is estimated to be about $50,000, whilst its implementation is estimated to cost about $300,000.

3.6.2 Improved Emergency Planning and Response

As mentioned in **Section 2.16**, the *Cabonne Shire Local Flood Plan* provides detailed information regarding preparedness measures, conduct of response operations and coordination of immediate recovery measures for all levels of flooding.

NSW SES should ensure information contained in this report on the impacts of flooding on urban development, as well as recommendations regarding flood warning and community education are used to update Volume 2 of the *Cabonne Shire Local Flood Plan*. Volume 2 should include the following sections:

1 – The Flood Threat includes the following sub-sections:

1.1 Land Forms and River Systems – ref. **Sections 2.1** and **2.2** of the report for information on these topics.

1.4 Characteristics of Flooding – Indicative extents of inundation for the 1% AEP and PMF events and the typical times of rise of floodwaters at key locations on the major watercourses are shown on **Figures 2.3**, **2.4** and **2.6**. The location of vulnerable development and critical infrastructure relative to the flood extents is shown on **Figure 2.7**.

1.5 Flood History – Recent flood experience at Molong is discussed in **Section 2.3** of the report.

1.6 Flood Mitigation Systems – Section 2.4 of the report provides background to the history of flood risk management at Molong.

1.7 Extreme Flood Events – The PMF was modelled and the indicative extent and depth of inundation presented on **Figure 2.4**.

2 – Effects on the Community

Information on the properties affected by the 1% AEP design flood are included in this report (**Figure 2.3**). As floor level data used in this assessment were estimated from the LiDAR survey and "drive by" survey they are indicative only. While fit for use in estimating the economic impacts of design floods, the data should not be used to provide specific details of the degree of flood affectation of individual properties.

Figure 2.6 shows stage hydrographs at road and rail crossings of various watercourses and drainage lines at Molong, the locations of which are shown on **Figures 2.3** and **2.4**.

Figure 2.7 shows the location of vulnerable development and critical infrastructure at Molong relative to the flood extents of between 20 and 0.2% AEP, as well as the PMF. Refer **Section 2.7** for details of affected infrastructure.

Figures 3.10, **3.11** and **3.12** show the flood emergency response planning classifications for the 5% and 1% AEP flood events, as well as the PMF, respectively, based on the definitions set out in the *Floodplain Risk Management Guideline – Flood Emergency Response Classification of Communities* (DECC, 2007).

3.6.3 Public Awareness Programs

Community awareness and appreciation of the existing flood hazards in the floodplain would promote proper land use and development in flood affected areas. A well-informed community would be more receptive to requirements for flood proofing of buildings and general building and development controls imposed by Council. Council should also take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplains of the flood risk.

One aspect of a community's preparedness for flooding is the "flood awareness" of individuals. This includes awareness of the flood threat in their area and how to protect themselves against it. The overall level of flood awareness within the community tends to reduce with time, as memories fade and as residents move into and out of the floodplain. The ability to access free location-based severe weather and thunderstorm warnings via the internet or smart phone via would therefore represent a major opportunity for improving flood warning and preparedness times for people living in the flood effected areas of Molong.

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

- displays at Council offices using the information contained in the present study and photographs of historic flooding in the area;
- talks by NSW SES officers with participation by Council and longstanding residents with first-hand experience of flooding in the area; and
- preparation of a *Flood Information Brochure* which could be prepared by Council with the assistance of NSW SES containing both general and site-specific data and distributed with rate notices.

The community should also be made aware that a flood greater than historic levels or the flood planning level can, and will, occur at some time in the future.

4 SELECTION OF FLOOD RISK MANAGEMENT MEASURES

4.1 Background

FRMM requires a Council to develop a Flood Risk Management Plan based on balancing the merits of social, environmental and economic considerations which are relevant to the community. This chapter sets out a range of factors which need to be taken into consideration when selecting the mix of works and measures that should be included in *Molong FRMP 2024*.

The community will have different priorities and, therefore, each needs to establish its own set of considerations used to assess the merits of different measures. The considerations adopted by a community must, however, recognise the State Government's requirements for flood risk management as set out in FRMM and other relevant policies. A further consideration is that some elements of *Molong FRMP 2024* may be eligible for subsidy from State and Federal Government sources and the requirements for such funding must, therefore, be taken into account.

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

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

4.2 Ranking of Measures

A suggested approach to assessing the merits of various measures is to use a subjective scoring system. The chief merits of such a system are that it allows comparisons to be made between alternatives using a common "currency". In addition, it makes the assessment of alternatives "transparent" (i.e. all important factors are included in the analysis). The system does not, however, provide an absolute "right" answer as to what should be included in *Molong FRMP 2024* and what should be left out. Rather, it provides a method by which Council can re-examine the measures and if necessary, debate the relative scoring given to aspects of *Molong FRMP 2024*.

Each measure is given a score according to how well the measure meets the considerations discussed above. In order to keep the scoring simple, the following system is proposed:

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

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

Based on considerations outlined in this chapter, **Table 4.1** presents a suggested scoring matrix for the measures reviewed in **Chapter 3**. This scoring has been used as the basis for prioritising the components of *Molong FRMP 2024*.

4.3 Summary

Table 4.1 indicates that there are good reasons to consider including the following elements into *Molong FRMP 2024*:

- An update of the *Cabonne LEP 2012* to allow better management of the floodplain.
- Improved planning controls through the update of *Cabonne DCP No. 10* to incorporate the recommendations set out in this report.
- Incorporation of the catchment specific information on flooding impacts contained in this study in NSW SES Response Planning and Flood Awareness documentation for the study area.
- Improved public awareness of flood risk in the community.
- The investigation, design and implementation of an integrated severe weather/thunderstorm and flood warning system for Molong.
- The commissioning of a Voluntary House Purchase and Raising Scoping Study.
- The voluntary purchase of up to 18 residential properties that are located in high hazard floodway areas and the potential raising of up to four dwellings to the FPL.
- The investigation and concept design of the Molong Creek Flood Mitigation Scheme.
- The detailed design and staged construction of the Molong Creek Flood Mitigation Scheme.
- The concept design of the Pillans Park Drainage Line Improvements.
- The detailed design and staged construction of the Pillans Park Drainage Line Improvements.
- Development and implementation of a *Vegetation Management Plan* which deals specifically with Molong Creek where it runs through Molong (*Molong Creek at Molong Vegetation Management Plan*).

TABLE 4.1
ASSESSMENT OF POTENTIAL FLOOD RISK MANAGEMENT MEASURES FOR INCLUSION IN MOLONG FLOOD RISK MANAGEMENT PLAN 2024

Measure	Impact on Flooding/ Reduction in Flood Risk	Community Acceptance	Technical Feasibility	Planning Objectives	Environ. Impacts	Economic Justification	Financial Feasibility	Extreme Flood	Government Policies and TCM Objectives	Score
Flood Modification										
Molong Creek Flood Mitigation Scheme (PFMO1a, PFMO1b, PFMO2 and PFMO3)	+1	+2	+2	+1	0	-1	+1	0	+1	+7
Molong Creek Flood Mitigation Scheme (PFMO4, PFMO5 and PFMO6)	+2	+2	+1	+2	0	-2	-1	0	+2	+6
Pillans Park Drainage Line improvements (PFMO7)	+1	+2	+2	+1	0	+1	+1	0	+1	+9
Moss Hollow Creek Drainage Improvements (PFMO8)	-1	0	+1	0	+1	+1	+1	0	0	+3
Molong Creek at Molong *Vegetation Management Plan*	+1	+2	+2	+2	+2	+2	+2	0	+2	+15
Property Modification										
Inclusion of *Special Flood Considerations* clause in *Cabonne LEP 2012*	+2	+2	+2	+2	0	0	0	+2	+2	+12
Controls over Future Development (via update of *Cabonne DCP No. 10*)	+2	+2	+2	+2	0	0	0	+1	+2	+12
Voluntary House Purchase Scheme	+2	+2	+2	+2	0	-1	0	+2	+2	+11
Voluntary House Raising Scheme	+1	-2	+1	+1	0	-2	-2	0	+1	-2
Response Modification										
Severe Weather/Thunderstorm and Flood Warning System	+2	+2	+2	+2	0	+2	+2	+1	+2	+15
Improved Emergency Planning and Response	+2	+1	+2	+2	0	0	0	+2	+2	+11
Public Awareness Programs	+2	+1	+2	+2	0	0	0	+1	+2	+10

5 MOLONG FLOOD RISK MANAGEMENT PLAN 2024

5.1 The Flood Risk Management Process

The *Molong Flood Risk Management Study 2024 (**Molong FRMS 2024**)* and *Molong Flood Risk Management Plan* (***Molong FRMP 2024***) have been prepared as part of a Government program to mitigate the impacts of major floods and reduce the hazards in the floodplain. *Molong FRMP 2024* which is set out in this Chapter has been prepared as part of the Flood Risk Management Process in accordance with NSW Government's Flood Prone Land Policy.

The first steps in the Flood Risk Management Process involved the collection of flood related data and the preparation of a contemporaneous set of flood models which were then used to more accurately define the nature of flooding at Molong. The findings of the investigation are set out in the *Molong Flood Study* which was completed in early 2024 (Lyall & Associates, 2024). The findings of the *Molong Flood Study* formed the basis of the preparation of both *Molong FRMS 2024* and *Molong FRMP 2024*.

5.2 Purpose of the Plan

The overall objectives of *Molong FRMS 2024* were to assess the impacts of flooding, review policies and measures for management of flood affected land and to develop *Molong FRMP 2024* which:

- Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding and establishes a program and funding mechanism for *Molong FRMP 2024*.
- Proposes amendments to Cabonne Council's existing policies to ensure that the future development of flood affected land in the study area is undertaken so as to be compatible with the flood hazard and risk.
- Ensures *Molong FRMP 2024* is consistent with NSW State Emergency Services (**NSW SES's**) local emergency response planning procedures.
- Ensures that *Molong FRMP 2024* has the support of the community.

5.3 The Study Area

The study area for *Molong FRMP 2024* applies to areas that are zoned business (B2, B4 and B6), industrial (IN1), residential (R1 and R5), public recreation (RE1 and RE2), rural (RU1), special purpose (SP1 and SP2) and waterway (W2) at Molong. The study deals with the following two types of flooding:

- **Main Stream Flooding** which occurs when floodwater surcharges the inbank area of Molong Creek, Reedy Creek, Boree Hollow, Moss Hollow Creek and Foys Creek. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater but can include shallower and slower moving floodwater on the overbank of the aforementioned watercourses.
- **Major Overland Flow**, which is experienced during periods of heavy rain and is generally characterised by relatively shallow and slow-moving floodwater that is conveyed overland in an uncontrolled manner toward the abovementioned watercourses.

Figure 1.1 is a location plan, while **Figure 2.1** shows the extent of the catchments which contribute to flow in Molong Creek at the location of two WaterNSW operated stream gauges that are located on the watercourse, and at its confluence with the Bell River. **Figure 2.2** (3 sheets) shows details of the existing stormwater drainage system in the urbanised parts of Molong.

5.4 Community Consultation

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

- The delivery of a *Community Newsletter and Questionnaire* to residents and business owners in the study area which sort the community's view on a range of potential flood risk management measures. **Appendix A** of this report summarises the responses that were received to the *Community Questionnaire*.
- The public exhibition of the draft *Molong FRMS* and *Molong FRMP 2024*.

Meetings were also held with the Flood Risk Management Committee to discuss the findings of *Molong FRMS 2024* and also the recommended set of measures set out in *Molong FRMP 2024*.

While respondents to the *Community Questionnaire* were strongly in favour of the majority of the listed structural measures, the construction of permanent levees and detentions basins received the least positive response. While respondents were also strongly in favour of the majority of the listed non-structural measures, a mostly negative response was given to providing funding or subsidies to raise houses above major flood level in low hazard areas and the flood proofing of individual properties.

5.5 Existing Flood Behaviour

The main breakouts of flow which cause the most damage/disruption to existing residential and commercial development at Molong occur at the following four locations:

- Along the right (eastern) bank of Molong Creek upstream of the Molong Creek Railway Bridge, where floodwater inundates existing development that is located on the western side of Betts Street and Euchareena Road
- From the left (western) bank of Molong Creek upstream of the Euchareena Road Bridge, where floodwater overtops the railway and flows generally in a northerly direction through existing residential and commercial development in the Molong CBD. Prior to floodwater overtopping the railway, water backs up the ungated piped drainage in Riddell Street where it upwells out of the grated stormwater pits that are located near its intersection with Watson Street where it then flows in a northerly direction and ponds in the existing low points that are located in Bank and Watson streets near their intersection.
- The right (eastern) bank of Moss Hollow Creek where floodwater overtops Market Street flows in an easterly direction through existing residential development, where it discharges to Molong Creek upstream of its confluence with Moss Hollow Creek.
- Along the Pillans Park Drainage Line where the piped drainage system has a capacity of less than 20% (1 in 5) AEP, whereby the resulting surcharge flow discharges through adjacent residential development.

Figures 2.3 and **2.4** (6 sheets each) show the indicate extent and depth of above-ground inundation at Molong, as well as the indicative depth of above-floor inundation in existing residential, commercial/industrial and publicly owned properties for the 1% AEP and PMF events, respectively. **Appendix B** of this report contains several photos showing flood behaviour that was observed in parts of Molong during floods that occurred in February 1928, March 1956, November 2005, July 2016, January 2020, November 2021 and November 2022.

Figure 2.5 (2 sheets) shows design water surface profiles along the main arm of Molong Creek, while **Figure 2.6** (3 sheets) shows the time of rise of floodwater at key locations along the road and rail network at Molong.

Figure 2.7 (3 sheets) shows the indicate extent of flooding at Molong for floods of between 20% AEP and the PMF event, respectively. The locations of key community assets, emergency services and vulnerable type development are also shown on the figure.

5.6 Existing Flood Mitigation Measures

While Cabonne Council has installed flood gates on the outlets of several pipes which control local catchment runoff discharging directly to the Molong CBD, the absence of a flood gate on the pipe which controls local catchment runoff in Riddell Street resulted in backwater flooding from Molong Creek during the rising limb of the November 2022 flood.

While Council presently maintains the density of vegetation within the inbank area of Molong Creek on an irregular and limited basis, observations made during the preparation of both the *Molong Flood Study* and the present study identified a number of large trees, several of which had been laid over by the recent floods.

Cabonne Council has implemented a voluntary house purchase scheme whereby four dwellings that were located on the eastern overbank of Molong Creek have been removed from the floodplain, while the voluntary purchase of a further two were in progress at the time of writing.

While a telemetered stream gauge was installed downstream of the confluence of Molong and Borenore creeks in 2002 based on the recommendations set out in Bewsher Consulting, 1999, there is currently no linkage between recorded water levels and the corresponding consequences of flooding at Molong.

Development Control Plan No. 10 which is titled "*Flood Prone Land in Molong*" and dated 2003 (**Cabonne DCP No. 10**) supplements the *Cabonne Local Environmental Plan 2012 (**Cabonne LEP 2012***) by providing general information, as well as detailed flood related guidelines and controls for development that is proposed on flood prone land at Molong.

5.7 Economic Impacts of Flooding

Table 5.1 over the page shows the number of properties that would be flooded to above-floor level and the damages experienced in residential and commercial/industrial development, as well as public buildings at Molong as a result of both Main Stream Flooding and Major Overland Flow in the study area as a whole, while **Table 5.2** shows similar damage related data associated with only Main Stream Flooding on Molong Creek.

The 10% AEP flood event is considered to be the "threshold" for which the number of individual buildings that would experience above-floor inundation increases significantly at Molong, with the majority of flood damages occurring as a result of floodwater which breaks out of Molong Creek and discharges through the Molong CBD. While the flood damages assessment that was undertaken as part of the *Molong Flood Study* did not separately quantify the impact that Major Overland Flow has on commercial development that is located in the Molong CBD, anecdotal evidence indicates that significant damage and disruption is caused when intense rain is experienced directly over Molong.

For a discount rate of 7% pa, the *Present Worth Value* of total damages for all flood events up to the 1% AEP flood at Molong due to both Main Stream Flooding and Major Overland Flow is about

$12.0 Million. Therefore, one or more schemes costing up to this amount could be economically justified if they eliminated damages in the study area for all flood events up to this level of flooding.

In the case of the Molong CBD, the *Present Worth Value* of total damages for all flood events up to the 10% and 1% AEP floods is about $1.4 Million and $5.8 Million, respectively. Therefore, one or more schemes costing up to these amounts could be economically justified if they eliminated damages in the Molong CBD for all flood events up to these two levels of flooding.

While schemes costing more than the abovementioned values would have a benefit/cost ratio less than 1, they may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility.

TABLE 5.1
ECONOMIC IMPACTS OF FLOODING IN STUDY AREA
MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW

Design Flood Event (% AEP)	Properties Flooded Above-Floor Level						Total Flood Damages
	Residential		Commercial/Industrial		Public		
	No.	$ Million	No.	$ Million	No.	$ Million	$ Million
20%	3	0.64	7	0.27	4	0.14	1.05
10%	6	1.17	24	1.21	6	0.31	2.69
5%	18	2.44	35	2.76	7	0.38	5.58
2%	31	3.91	39	4.23	9	0.55	8.69
1%	41	5.00	44	6.04	9	0.74	11.78
0.5%	48	5.82	48	7.3	10	0.90	14.02
0.2%	55	6.83	49	8.56	11	1.07	16.46
PMF	196	35.28	65	35.24	17	6.86	77.38

TABLE 5.2
ECONOMIC IMPACTS OF FLOODING IN STUDY AREA
MAIN STREAM FLOODING ON MOLONG CREEK ONLY

Design Flood Event (% AEP)	Properties Flooded Above-Floor Level						Total Flood Damages
	Residential		Commercial/Industrial		Public		
	No.	$ Million	No.	$ Million	No.	$ Million	$ Million
20%	1	0.11	5	0.17	4	0.14	0.42
10%	3	0.46	24	1.21	6	0.26	1.93
5%	13	1.56	34	2.56	7	0.33	4.45
2%	19	2.41	37	3.78	8	0.48	6.67
1%	25	3.15	42	5.25	8	0.63	9.03
0.5%	29	3.73	46	6.39	8	0.76	10.88
0.2%	35	4.57	47	7.41	9	0.91	12.89
PMF	146	28.04	62	31.34	14	4.63	64.01

5.8 Structure of Molong Flood Risk Management Plan

A summary of *Molong FRMP 2024* proposed for the study area along with broad funding requirements for the recommended measures are shown in **Table S1** at the commencement of the *Molong FRMS 2024* report. The measures will over time achieve the objectives of reducing the flood risk to existing and future development for the full range of floods.

Molong FRMP 2024 is based on the following mix of measures which have been given a provisional priority ranking according to a range of economic, social, environmental and other criteria that are set out in **Table 4.1** of the *Molong FRMS* report:

- **Measure 1** – Include special flood considerations clause in the *Cabonne LEP 2012*.
- **Measure 2** – Improvements to planning and development controls for future development in flood prone areas via updates of *Cabonne DCP No. 10*.
- **Measure 3** – Improvements to emergency response planning.
- **Measure 4** – Increase public awareness of the risks of flooding in the community.
- **Measure 5** – Investigation and design of an integrated severe weather/thunderstorm and flood warning system for Molong.
- **Measure 6** – Implementation of an integrated severe weather/thunderstorm and flood warning system for Molong.
- **Measure 7** – Commissioning of a *Voluntary House Purchase and Raising Scoping Study*
- **Measure 8** – Voluntary purchase of up to 18 residential properties and the raising of up to four dwellings to the FPL.
- **Measure 9** - Investigation and concept design of the Molong CBD Flood Mitigation Scheme (denoted Phase 1 of the scheme).
- **Measure 10** – Detailed design and construction of Potential Flood Modification Options (PFMOs) 1a, 1b, 2 and 3 of the Molong CBD Flood Mitigation Scheme (denoted Phase 2 of the scheme).
- **Measure 11** – Detailed design and construction of PFMOs 4, 5 and 6 of the Molong CBD Flood Mitigation Scheme (denoted Phase 3 of the scheme).
- **Measure 12** – Investigation and concept design of the Pillans Park Drainage Line Improvements.
- **Measure 13** – Detailed design and construction of the Pillans Park Drainage Line Improvements.
- **Measure 14** - Development and implementation of the *Molong Creek at Molong Vegetation Management Plan*.

5.9 Planning and Development Controls

The results of *Molong FRMS 2024* indicate that an important measure for Council to adopt in the floodplain would be strong flood risk management planning applied consistently by all of its branches.

5.9.1 Revision of Cabonne Local Environmental Plan 2012

Clause 5.21 of *Cabonne LEP 2012* entitled "Flood planning" outlines its objectives in regard to development of land which lies within the Flood Planning Area (**FPA**). The wording in the flood planning clause was updated on 14 July 2021 as part of recent reforms that have been implemented by the NSW Government.

While the wording of the *flood planning* clause was automatically updated on 14 July 2021, Council chose not to include a new *special flood considerations* clause that also formed part of the recent reform package. Based on the findings of *Molong FRMS*, it is recommended that Council now look to include this additional clause in *Cabonne LEP 2012* (**Measure 1**), noting that its objectives are:

a) in relation to development with particular evacuation or emergency response issues (e.g. group homes, residential care facilities, etc.), to enable evacuation of land subject to flooding in events exceeding the flood planning level; and

b) to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land which lies between the FPA and the extent of the PMF. Wording in relation to this new clause is given in **Section 3.5.1.4** of the *Molong FRMS 2024* report.

5.9.2 Cabonne Development Control Plan No. 10

The recommended approach to managing future development in the study area uses the concepts of *flood hazard* and *hydraulic categorisation* to develop controls for future development in flood prone land (**Measure 2**). **Figure D1.1** in **Appendix D** of the *Molong FRMS 2024* report are extracts from the *Flood Planning Map* relating to the study area. The extent of the FPA has been defined as follows:

- In areas subject to Main Stream Flooding, the FPA is based on the traditional definition of the area inundated by the 1% AEP plus 0.5 m freeboard.
- In areas subject to Major Overland Flow, the FPA is defined as the extent of floodway areas, as well as areas where depths of inundation in a 1% AEP event exceed 0.1 m.

It is proposed that properties are located either partially or wholly within the extent of the FPA would be subject to S10.7 flood affectation notification and planning controls graded according to flood hazard and hydraulic categorisation. **Annexures 2A** and **2B** in **Appendix D** set out the graded set of flood related planning controls which apply to development in areas that are affected by Main Stream Flooding and Major Overland Flow, respectively. **Figure D1.1** shows the areas where the graded set of flood related planning controls set out in **Annexures 2A** and **2B** apply to Molong.

Minimum habitable floor level (**MHFL**) requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on **Figure D1.1** The MHFLs for residential land use types is the level of the 1% AEP flood event plus freeboard, whereas for commercial and industrial land use types the MHFL is to be as close to the 1% AEP flood level plus freeboard as practical, but no lower than the 5% AEP flood level plus freeboard. In situations where the MHFL is below the 1% AEP flood level plus freeboard, a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard.[8]

[8] Freeboard is equal to 0.5 m for development being assessed in areas affected by Main Stream Flooding and 0.3 m for development being assessed in areas affected by Major Overland Flow.

Figure D1.2 in **Appendix D** of the *Molong FRMS* report are extracts of the *Flood Planning Constraint Category Map* relating to the study area. The figures show the subdivision of the floodplain into the following four categories which have been used as the basis for developing the graded set of planning controls:

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the FPA where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the FPA but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this DCP.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the FPA and the PMF where the Flood Hazard Vulnerability Classification in a PMF event is greater than H2. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes. This area is identical to the *Special Flood Considerations Zone* shown on the **Flood Planning Map** (refer below for further details).

A *Special Flood Considerations Zone* has also been included which relates to areas where the flood risk is considered to be high enough to require additional controls to be applied to future development that is located on land that lies between the FPA and the PMF. It has been defined as the extent of land that lies between the FPA and the PMF where the flood hazard vulnerability classification during a PMF event would be H3 or higher. The extent of the *Special Flood Considerations Zone* is shown on the Flood Planning and Flood Planning Constraint Category Maps. The additional controls in this area relate to the safe and timely evacuation of people who would be occupying the floodplain at the time of a flood event and only apply in areas categorised as FPCC4.

5.10 Improvements to Emergency Response Planning and Community Awareness

Two measures are proposed in *Molong FRMP 2024* to improve emergency response planning and community awareness to the threat posed by flooding.

Measure 3 involves the update by NSW SES of the *Cabonne Shire Local Flood Plan* using information on flooding patterns, times of rise of floodwaters and flood prone areas identified in the *Molong FRMS 2024* report. Figures have been prepared showing indicative extents of flooding, high hazard areas, expected rates of rise of floodwaters in key areas and locations where flooding problems would be expected. **Section 3.6.2** references the locations of key data within the *Molong FRMS* report.

Council should also take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplains of the flood risk (included as **Measure 4** of *Molong FRMP 2024*). This information could be included in a *Flood Information Brochure* to be prepared by Council with the assistance of NSW SES containing both general and site-specific data and distributed with the rate notices. The community should also be made aware that a flood greater than historic levels or the planning level can, and will, occur at some time in the future. *Molong FRMP 2024* should be publicised and exhibited at community gathering places to make residents aware of the measures being proposed.

5.11 Implementation of Severe Weather/Thunderstorm and Flood Warning System

Measure 5 comprises the investigation and design of an integrated severe weather/thunderstorm and flood warning system for Molong, while **Measure 6** involves its implementation. As both residential and commercial development in parts of Molong is subject to damaging flash-type flooding, there is merit in implementing an effective location-based messaging system which warns both residents and business owners of the potential for flood producing rain to be experienced over Molong, as well as potential damaging flooding as a result of rising water levels in Molong Creek. The cost to investigate and design the system is estimated to be about $50,000, whilst its implementation is estimated to cost about $300,000.

5.12 Voluntary House Purchase and Raising Schemes

While Council currently administers a voluntary house purchase scheme for Molong, it is principally focussed on acquiring existing residential properties that are located on the eastern overbank of Molong Creek along both Betts Street and Euchareena Road. As *Molong FRMS 2024* found that there are a total of 18 existing dwellings that are located in high hazard floodway areas, several of which are located on the eastern overbank of Molong Creek, and on the floodplains of both Boree Hollow and Moss Hollow Creek, there is merit in expanding the scheme to include these additional properties. Based on the average sale price of $400,000 for a single residential property in Molong, the purchase of all 18 properties is estimated to cost $7.2 Million.

Molong FRMS 2024 found that there are currently 11 houses that would experience above-floor inundation as a result of Main Stream Flooding during a 1% AEP flood event that are not located in high hazard floodway areas. Of these, seven (7) are of brick veneer type construction and therefore could not be raised, while the remaining four (4) are of timber frame type construction and therefore could be raised. Based on this finding, *Molong FRMS 2024* recommended that the feasibility of implementing a house raising scheme which includes these four dwellings be investigated. Based on an estimated $150,000 to raise a single timber frame house, the cost to raise the four houses in Molong is estimated to cost $0.6 Million.

The commissioning of a scoping study associated with the expansion of the existing voluntary house purchase scheme and the implementation of a voluntary house raisings scheme for Molong forms **Measure 7**, while the purchase of up to 18 residential properties and the raising of up to four dwellings forms **Measure 8** of *Molong FRMP 2024*.

5.13 Flood Modification Works

Molong FRMS 2024 found that a significant reduction in flood damages can be achieved in the Molong CBD through the implementation of the following flood modification measures:

a) The upgrade of the existing stormwater drainage system in the Molong CBD (denoted PFMO 1a in *Molong FRMS 2024*). (Estimated Capital Cost - $3.7 Million)

b) The purchase and demolition of commercial buildings adjacent to the sag in Banks Street which would be aimed at reducing both the depth and duration of local stormwater runoff which would other pond above back-of-footpath levels in the road reserve (PFMO1b). (Estimated Capital Cost - $2.0 Million)

c) The construction of a levee along the western bank of Molong Creek extending from a location upstream of the Euchareena Road bridge to a location downstream of the Molong Creek Railway Bridge which would prevent the breakout of floodwater from the watercourse for all floods up to 10% AEP in magnitude (PFMO2). (Estimated Capital Cost - $4.0 Million)

d) The lowering of the western overbank of Molong Creek over a distance of about 500 m downstream of the Molong Creek Railway Bridge (PFMO3). (Estimated Capital Cost - $1.5 Million)

e) The realignment of Watson Street and Hill Street at their intersection, the realignment of a 150 m section of the aforementioned levee and the lowering of the eastern overbank of Molong Creek over a distance of about 200 m downstream of the Molong Creek Railway Bridge (PFMO4). (Estimated Capital Cost - $5.4 Million)

f) The duplication of the existing Molong Creek Railway Bridge on the western overbank of Molong Creek in combination with the lowering of its overbank area where it runs between the Euchareena Road Bridge and the railway corridor (PFMO5). (Estimated Capital Cost - $20.5 Million)

g) The duplication of the existing Euchareena Road Bridge on the eastern overbank of Molong Creek in combination with the lowering of its eastern overbank area where it runs between the extension of Dean Street and the road crossing. (Estimated Capital Cost - $7.2 Million)

The above suite of measures is denoted the "**Molong CBD Flood Mitigation Scheme**" in *Molong FRMS 2024* and is estimated to cost $42.8 Million to implement, inclusive feasibility and concept design costs.

Due to the significant time and costs associated with implementing the full suite of measures comprising the Molong CBD Flood Mitigation Scheme, there would be merit in staging their design and construction as follows:

- **Phase 1** – Undertaking of a feasibility study and the preparation of a detailed concept design of the various measures comprising the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $0.6 Million)
- **Phase 2** – Preparation of the detailed design and implementation of PFMO1a, PFMO1b, PFMO2 and PFMO3 of the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $11.2 Million)
- **Phase 3** – Preparation of the detailed design and implementation of PFMO4, PFMO5 and PFMO6 of the Molong CBD Flood Mitigation Scheme. (Estimated Cost - $33.1 Million)

The implementation of Phases 1 and 2 of the Molong CBD Flood Mitigation Scheme would cost about $11.7 Million and would prevent about $1.4 Million in flood damages in present worth terms, resulting in a benefit/cost ratio of about 0.12. Similarly, the implementation of Phase 3 of the Molong CBD Flood Mitigation Scheme would cost about $33.1 Million and would prevent about $4.4 Million in additional flood damages in present worth terms, resulting in a benefit/cost ratio of about 0.13.

While the implementation of the Molong CBD Flood Mitigation Scheme cannot be justified on pure economic grounds (i.e. because its benefit/cost ratio is less than 1), it would provide significant social benefit as it would reduce the frequency that floodwater breaks out of Molong Creek and impacts both residential and commercial development that is located in the immediate vicinity of the Molong CBD. The implementation of the Phase 2 works would also reduce impact that Major Overland Flow has on the commercial properties that are located in the Molong CBD. Based on these findings, it is considered that the Molong CBD Flood Mitigation Scheme has sufficient merit to be included in *Molong FRMP 2024* (**Measures 9**, **10** and **11**).

In addition to the flooding that is experienced in the Molong CBD, damaging flooding is also experienced in existing residential development that is located along the Pillans Park Drainage Line Council recently commissioned a study that investigation various options for upgrading select reaches of the drainage line, as well as the construction of a flood detention basin in land that is currently vacant. Council's preferred set of measures are denoted herein as the "**Pillans Park Drainage Line Improvements (PFMO8)**". Council has estimated the cost to design and implement the Pillans Park Drainage Line Improvements at $1.3 Million. While the flood modelling that was undertaken as part of *Molong FRMS 2024* does not show a significant reduction in both the extent and depth of inundation attributable to the Pillans Park Drainage Line Improvements, its implementation would formalise several elements of the drainage system that are in dis-repair in combination with reducing the frequency and severity of localised flooding. The concept design of the Pillans Park Drainage Line Improvements forms **Measure 12**, while its detailed design and construction forms **Measure 13** of *Molong FRMP 2024*.

Molong FRMS 2024 concluded that there is merit in developing and implementing a v*egetation management plan* which deals specifically with the reach of Molong Creek that runs through Molong (***Molong Creek at Molong Vegetation Management Plan***) (**Measure 14**).

5.14 Implementation Program

The steps in progressing the flood risk management process from this point onwards are:

1. Consider public comment, modify the document if and as required, and submit to Council.
2. Council adopts *Molong FRMP 2024*.
3. Assistance for funding qualifying projects included in *Molong FRMP 2024* may be available upon application under the Commonwealth and State funded floodplain management programs, currently administered by the Department of Climate Change, Energy, the Environment and Water.
4. As funds become available from Government agencies and/or Council's own resources, implement the measures in accordance with the established priorities.

Molong FRMP 2024 should be regarded as a dynamic instrument requiring review and modification over time. The catalysts for change could include new flood events and experiences, legislative change, alterations in the availability of funding, reviews of Council's planning strategies and importantly, the outcome of some of the studies proposed in this report as part of *Molong FRMP 2024*. In any event, a thorough review every ten years is warranted to ensure the ongoing relevance of *Molong FRMP 2024*.

6 GLOSSARY OF TERMS

TERM	DEFINITION
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, for a flood magnitude having five per cent AEP, there is a five per cent probability that there would be floods of greater magnitude each year.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood (**PMF**) event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* shows the extent of land on which flood related development controls apply.
Flood Planning Constraint Category 1 (FPCC 1)	Comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding
Flood Planning Constraint Category 2 (FPCC 2)	Comprises areas which lie below the *Flood Planning Level* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
Flood Planning Constraint Category 3 (FPCC 3)	Comprises areas which lie below the *Flood Planning Level* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
Flood Planning Constraint Category 4 (FPCC 4)	Comprises the area which lies above the *Flood Planning Level* but within the extent of the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes.
Flood Planning Level (FPL)	Flood levels selected for planning purposes, as determined by the relevant adopted flood risk management study and plan, or as part of a site specific study In the absence of an adopted flood risk management study and plan for a particular location, the FPL is defined as the peak 1% AEP flood level plus the addition of a 0.5 m freeboard.

TERM	DEFINITION
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding a particular flood chosen as the basis for the *Flood Planning Level* is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the *Flood Planning Level*.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Local Drainage	Land on an overland flow path where the depth of inundation during the 1% AEP storm event is less than 0.1 m.
Main Stream Flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major Overland Flow	Where the depth of overland flow during the 1% AEP storm event is greater than 0.1 m.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.

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APPENDIX A

COMMUNITY CONSULTATION

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ATTACHMENTS

A1. INTRODUCTION

At the commencement of the present study, the Consultants prepared a *Community Newsletter* and a *Community Questionnaire*, both of which were distributed by Council to the residents and business owners in Molong (refer to **Attachment A1**). A media release was also prepared that introduced the project and encouraged the community to provide input to the study by responding to the Community Questionnaire.

The purpose of the *Community Newsletter* was to introduce the objectives of the study and set the scene on flooding conditions so that the community would be better able to respond to the *Community Questionnair*e and contribute to the study process.

The *Newsletter* contained the following information:

- A plan showing the extent of the study area.
- A statement of the objectives of *Molong FRMS&P 2024*; namely the development of a strategy for reducing the flood risk and minimising the long-term impact of flooding on the community.
- Advising that the draft *Molong Flood Study* that was placed on exhibition in January and February 2024 and that a public information session would be held on 1 February 2024 in Molong.

The *Community Questionnaire* was structured with the objectives of:

- Determining residents' and business owners' attitudes to controls over future development in flood liable areas.
- Inviting community views on possible flood management options which could be considered for further investigation in *Molong FRMS 2024* and possible inclusion in the resulting *Molong FRMP 2024*.
- Obtaining feedback on any other flood related issues and concerns which the residents and business owners cared to raise.

This **Appendix** to the *Molong FRMS&P 2024* report discusses the responses to the nine questions that were included in the *Community Questionnaire* and comments made by respondents.

Chapter A2 deals with the residents' and business owners' views on the relative importance of classes of development over which flood-related controls should be imposed by Council.

Chapter A3 identifies residents' and business owners' views on the suitability of the various options which could be considered in more detail in *Molong FRMS 2024.*

Chapter A4 discusses the best methods by which the community could provide feedback to the consultants over the course of the study.

Chapter A5 summarises the findings of the community consultation process.

A2 RESIDENT PROFILE AND FLOOD AWARENESS

A2.1 General

Residents were requested to complete the *Community Questionnaire* and return it to the Consultants by 16 February 2024. The deadline was extended to include any submissions that were received after this date. The Consultants received 57 responses in total out of about 600 that had been distributed, a response rate of about 10%.

The Consultants have collated the responses, which are shown in graphical format in **Attachment A2**.

A2.2 Respondent Profile

The first four questions of the *Community Questionnaire* canvassed resident information such as whether the respondent was a resident or business owner, length of time at the property, the type of property (e.g. house, unit/flat).

Of the 57 responses, 51 were residents, nine were business owners (four of whom were also residents) and one was a tenant (**Question 2**).

The length of time respondents had been at the address was found to be varied, with approximately 28% of respondents having lived at the residence for between '1-5 years', 39% for '5 to 20 years', and 33% for 'more than 20 years' (**Question 3**).

The majority of respondents occupied residential type property (**Question 4**), which included houses (45 respondents), villas/townhouses (1) and units/flats/apartments (6). Two responses received were concerned with property which is vacant land. Six respondents owned non-residential type property, which included industrial units (1), warehouse or factory (1) and shops/commercial premises (4). Note that some responses were included in more than one property classification type.

A2.3 Controls over Development in Flood Prone Areas

The respondents were asked to rank from 1 to 6 the classes of development which they consider should receive protection from flooding (**Question 5**). Rank 1 was the most important and rank 6 the least.

The classes in decreasing order of importance to respondents ranged from:

- commercial/business type development.
- residential property;
- vulnerable residential (e.g. aged persons accommodation);
- essential community facilities (e.g. schools, evacuation centres); and
- Minor developments and editions
- New subdivisions

The above priority listing is not typical of other urban centres in rural NSW and is likely a result of the significant impact that flooding has on the CBD of Molong, noting that residential type development was a close second in the rankings. These results provide a guide as to the type of development that should be the focus of the present study.

In **Question 6**, respondents were asked about the level of control Council should place on new development to minimise flood-related risks. The community was strongly in favour of prohibiting new development on land with potential to flood (22), closely followed by prohibiting new development only in locations that are extremely hazardous (18) and placing restrictions on developments which reduce the potential for flood damage (15). Two respondents favoured not providing any advice.

Respondents were also asked in **Question 7** what notifications Council should give about the flood affectation of individual properties. The community was strongly in favour of advising existing residents (30) and prospective purchasers (37) of the known potential flood threat, while 7 respondents favoured only advising those who enquire to Council about the known potential flood risk. One respondent favoured not providing any notification. .

A3 POTENTIAL FLOOD MANAGEMENT MEASURES

The respondents were asked for their opinion on potential flood management measures which could be evaluated in *Molong FRMS 2024* (and if found to be feasible included in *Molong FRMP 2024*), by ticking a "yes" or "no" to the eleven potential options identified in **Question 8**.

The options comprised a range of *structural flood management measures* (e.g. programs by Council to manage vegetation in the creek system to maintain hydraulic capacity; widening of watercourses; construction of detention basins; improving the stormwater system; levees to contain floodwaters, as well as various *non-structural management measures* (e.g. voluntary purchase of residential properties in high hazard areas; raising floor levels of houses in low hazard areas; flood related controls over new developments; improvements to flood warning and evacuation procedures; community education on flooding; flood advice certificates). The options were not mutually exclusive, as *Molong FRMP 2024* could, in theory, include all of the options set out in the *Community Questionnaire*, or indeed, other measures nominated by the respondents or the FRMC.

The most popular structural measures were the management of vegetation along the creek corridor (52), improving the stormwater system in the town (47), removal of floodplain obstructions (47), upgrade of culverts under roads and railway (43) and widening of watercourses (41). Less favoured was the construction of levees/diversion banks (31) and detention basins (24).

Of the non-structural measures, ensuring all information is about the potential risks of flooding is available to all residents and business owners (50), improvement of flood warning and evacuation procedures (48), ensuring all residents and business owners have a Flood Action Plan (47), provision of a Planning Certificate to purchasers in flood prone areas (45), specifying controls on future development in flood-prone areas (44) and voluntary purchase of the most severely flood-liable properties (42) all received strong support. A mostly negative response was given to providing funding or subsidies to raise houses above major flood level in low hazard areas (27) and the flood proofing of individual properties (20).

A4 INPUT TO THE STUDY AND FEEDBACK FROM THE COMMUNITY

In **Question 9,** residents were asked for their view on the best methods of their providing input to the Study and feedback to the Consultants over the course of the investigation. Articles in the local media (newspaper, radio and TV) and via Council's website were the most popular methods, followed by information via the FRMC.

ATTACHMENT A1

COMMUNITY NEWSLETTER
AND QUESTIONNAIRE

MOLONG FLOOD RISK MANAGEMENT STUDY AND PLAN

COMMUNITY NEWSLETTER

Cabonne Council has engaged consultants to prepare both a *Flood Study* and *Flood Risk Management Study and Plan* for the township of Molong. The studies are jointly funded by Council and the NSW Department of Planning and Environment and aims to build community resilience towards flooding through informing better planning of development, emergency management and community awareness. Council has established a Flood Risk Management Committee which is comprised of relevant council members, state government agencies and community representatives.

The purpose of the *Flood Study* is to define the impact that flooding has on the urbanised parts of Molong for a range of storm events. **Figure 1** over shows the extent of the study area.

The *Flood Study* is nearing completion and the community is invited to review and comment on the draft report which will be placed on public exhibition at Council's offices in Molong between **08 January 2024** and **29 February 2024**. The draft report will also be available via Council's website (https://www.cabonne.nsw.gov.au/Council/Public-Notices/Draft-Molong-Flood-Study/).

A public information session will be held at the Cabonne Community Centre in Molong between **5.30pm** and **8.30 pm** on **Thursday 1 February 2024** where the Consultants will be available to answer any questions that you may have about the *Flood Study*.

Following the public exhibition period, the Consultants will consider the feedback from the exhibition process and embark on the next phase of the study - the preparation of the *Flood Risk Management Study and Plan*.

The aim of the *Flood Risk Management Study and Plan* is to assist Council in refining strategic plans for mitigating and managing the effects of existing flood risk (associated with existing development on flood prone land), future flood risk (associated with any new development on flood prone land) and continuing flood risk (the risk remaining in both existing and future development areas after floodplain risk management measures are implemented).

Have Your Say on Flood Risk Management

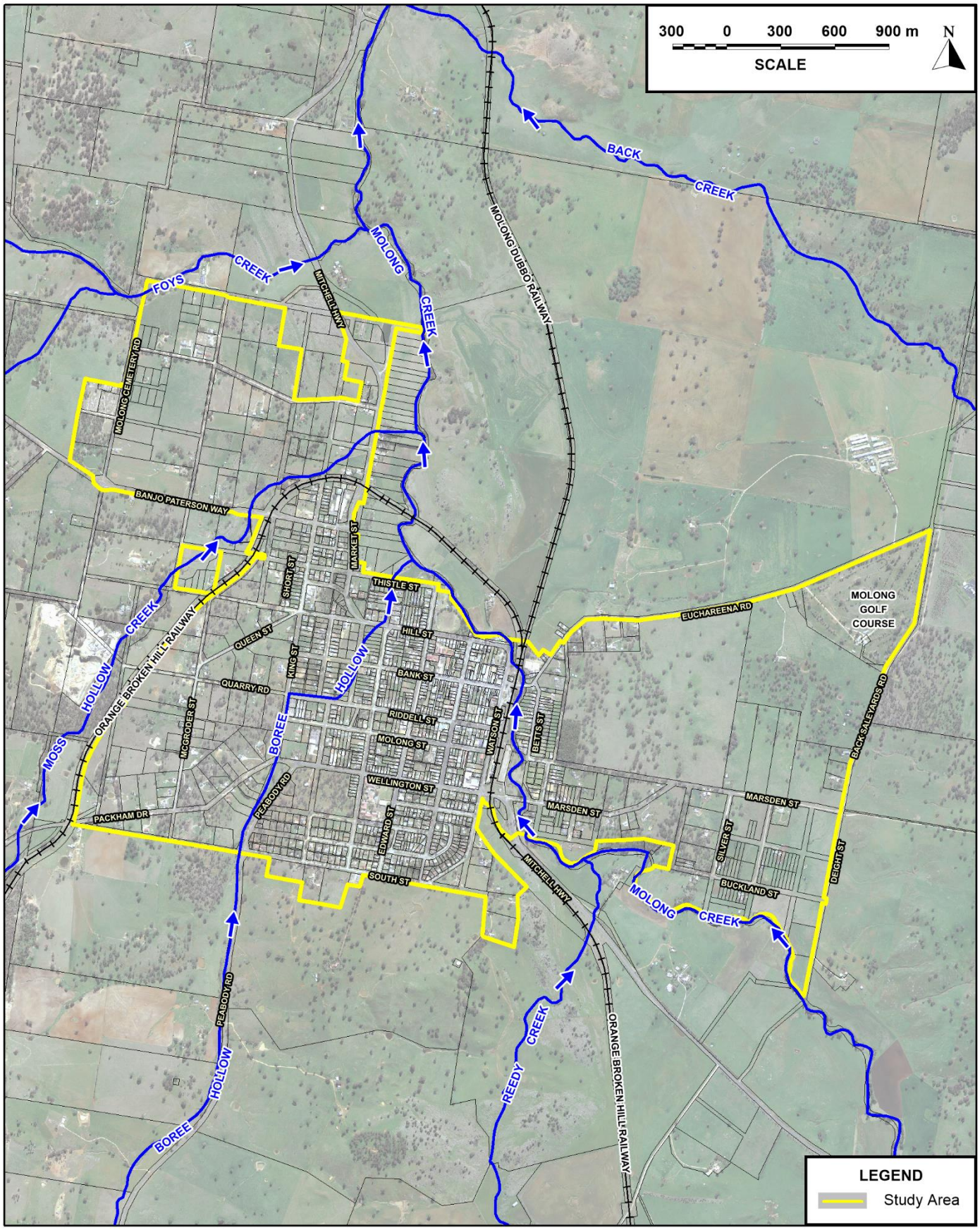
An important step in the preparation of the *Flood Risk Management Study and Plan* for Molong is to appraise what flood related issues are important to the community. The attached **questionnaire** has been provided to residents and businesses to assist the Consultant in gathering this important information. All information provided will remain confidential and for use in this study only. Please return the completed Questionnaire to Council's offices or email a scanned copy to the email address below by **Friday 16 February 2024**.

Contact: Cabonne Council

Matthew Christensen | Deputy General Manager – Cabonne Infrastructure
Phone: (02) 6392 3200
Email: Council@cabonne.nsw.gov.au

Australia's Food Basket
CABONNE COUNCIL

STUDY AREA


300 0 300 600 900 m
SCALE
N
BACK CREEK
MOLONG DUBBO RAILWAY
MOLONG CREEK
FOYS CREEK
MITCHELL HWY
MOLONG CEMETERY RD
BANJO PATERSON WAY
MARKET ST
SHORT ST
THISTLE ST
HILL ST
QUEEN ST
KING ST
BANK ST
QUARRY RD
RIDDELL ST
MOLONG ST
WELLINGTON ST
SOUTH ST
EDWARD ST
WATSON ST
BETTS ST
MARSDEN ST
EUCHAREENA RD
MOLONG GOLF COURSE
BACK SALEYARDS RD
SILVER ST
DEIGHT ST
BUCKLAND ST
MOLONG CREEK
MOSS HOLLOW CREEK
ORANGE BROKEN HILL RAILWAY
MCGRODER ST
PACKHAM DR
BOREE HOLLOW
PEABODY RD
PEABODY RD
BOREE HOLLOW
REEDY CREEK
ORANGE BROKEN HILL RAILWAY
MITCHELL HWY
LEGEND
Study Area

MOLONG FLOOD RISK MANAGEMENT STUDY AND PLAN

COMMUNITY QUESTIONNAIRE

This questionnaire is part of the *Molong Flood Risk Management Study and Plan*, which is currently being prepared by Cabonne Council with the financial support of the NSW Department of Planning and Environment. Your responses to the questionnaire will help us determine the flood issues that are important to you.

Please return your completed questionnaire in the reply paid envelope provided by **Friday 16 February 2024**. No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers
Reply Paid 85163
NORTH SYDNEY NSW 2060

1. Your Details

a) Name (Optional):_____

b) Address:_____

c) Phone Number (Optional):_____

d) Email (Optional): _____

About your property

2. Please tick as appropriate:

- ☐ I am a resident
- ☐ I am a business owner
- ☐ Other (please specify ____)

3. How long have you been at this address?

- ☐ 1 year to 5 years
- ☐ 5 years to 20 years
- ☐ More than 20 years (… years)

4. What is your property?

- ☐ House
- ☐ Villa/Townhouse
- ☐ Unit/Flat/Apartment
- ☐ Vacant land
- ☐ Industrial unit in larger complex
- ☐ Stand alone warehouse or factory
- ☐ Shop
- ☐ Community building
- ☐ Other (_____)

Your attitudes to Council's development controls

5. Please rank the following development types according to which you think are the most important to protect from floods

(1=highest priority to 6=least priority)

Development Type	Rank
Commercial/Business	
Residential	
Vulnerable residential development (e.g. aged persons accommodation)	
Essential community facilities (e.g. schools, evacuation centres)	
Minor developments and additions	
New subdivisions	

6. What level of control do you consider Council should place on new development to minimise flood-related risks?

(Tick only one box)

(In addition to being favoured by the Community, these options would also need to comply with legislation)

- ☐ Prohibit all new development on land with any potential to flood
- ☐ Prohibit all new development only in those locations that would be extremely hazardous to persons or property due to the depth and/or velocity of floodwaters, or evacuation difficulties
- ☐ Place restrictions on developments which reduce the potential for flood damage (e.g. minimum floor level controls or the use of flood compatible building materials)
- ☐ Advise of the flood risks, but allow the individual a choice as to whether they develop or not, provided steps are taken to minimise potential flood risks
- ☐ Provide no advice regarding the potential flood risks or measures that could minimise those risks
- ☐ Don't know

7. What notifications do you consider Council should give about the potential flood affectation of individual properties?

(Tick one or more boxes)

- ☐ Advise every resident and property owner on a regular basis of the known potential flood threat
- ☐ Advise only those who enquire to Council about the known potential flood threat
- ☐ Advise prospective purchasers of property of the known potential flood threat.
- ☐ Provide no notifications
- ☐ Other (please specify below)

_____

_____

_____

_____)

Your opinions on floodplain risk management measures

8. Below is a list of possible options that may be looked at to try to minimise the effects of flooding in the study area.

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

Option	Yes	No	Don't Know
Management of vegetation along creek corridors to provide flood mitigation, stability, aesthetic and habitat benefits			
Widening of watercourses			
Construct detention basins			
Construction of permanent levees/diversion banks to contain floodwaters			
Improve stormwater drainage system			
Upgrade culverts beneath roads/railways			
Removal of floodplain obstructions			
Voluntary purchase of the most severely affected flood-liable properties			
Provide funding or subsidies to raise houses above major flood level in low hazard areas.			
Flood proofing of individual properties by waterproofing walls, putting shutters across doors, etc.			
Specify controls on future development in flood-liable areas (e.g. controls on extent of filling, minimum floor levels, etc.)			
Provide a Planning Certificate to purchasers in flood prone areas, stating that the property is flood affected.			
Ensuring all information about the potential risks of flooding is available to all residents and business owners			
Improve flood warning and evacuation procedures both before and during a flood.			
Community education, participation and flood awareness programs.			
Ensuring all residents and business owners have Flood Action Plans - these outline WHAT people should do, WHERE they should go and WHO they should contact in a flood			

Other Information

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

- ☐ Council's website
- ☐ Articles in local newspaper
- ☐ Through Council's Floodplain Management Committee
- ☐ Other (please specify) _____

10. If you wish us to contact you so you can provide further information, please provide your details below:

Name: _____

Address: _____

_____

Phone: _____

Email: _____

Who can I contact for further information?

Cabonne Council
Matthew Christensen | Deputy General Manager – Cabonne Infrastructure
Phone: (02) 6392 3200
Email: Council@cabonne.nsw.gov.au

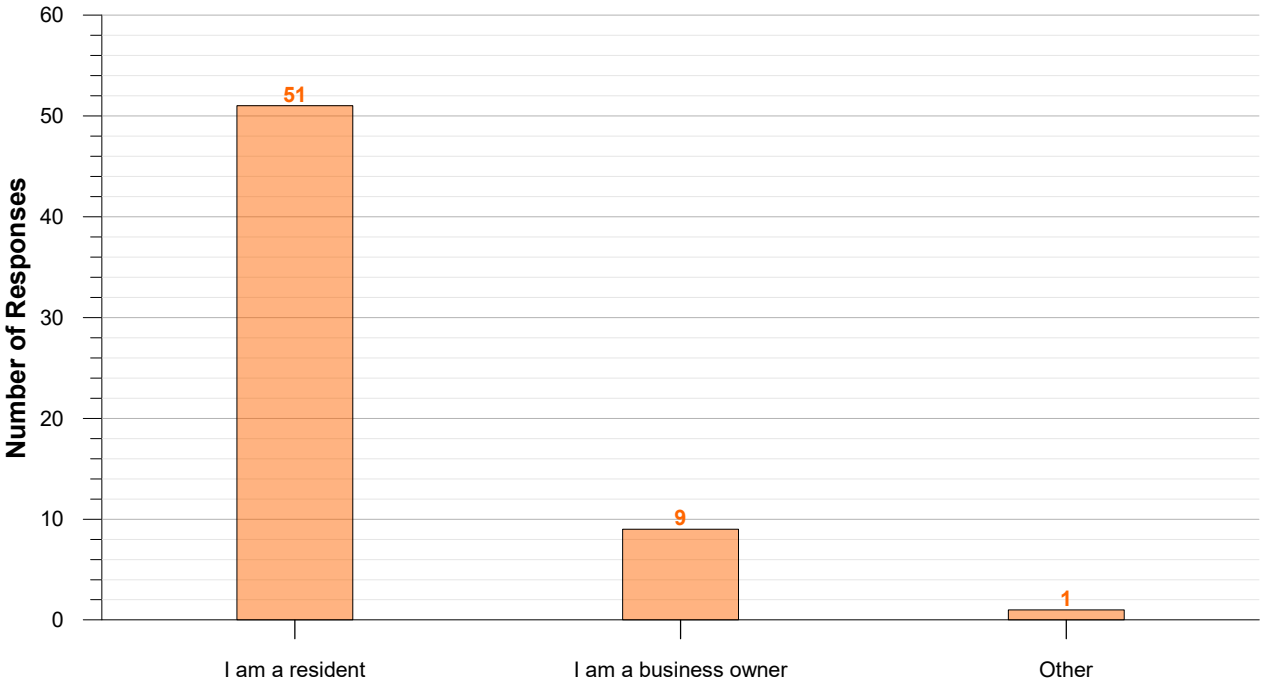
COMMENTS

Please write any additional comments here:

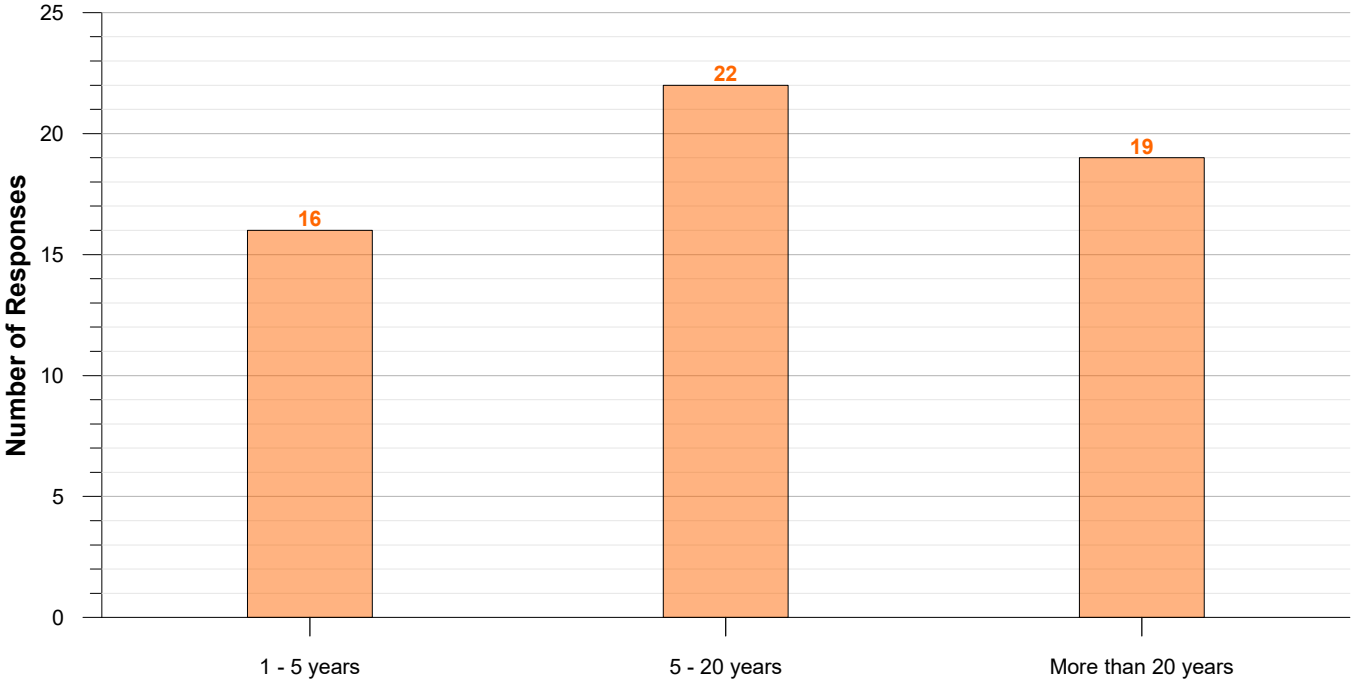
ATTACHMENT A2

RESPONSES TO COMMUNITY QUESTIONNAIRE

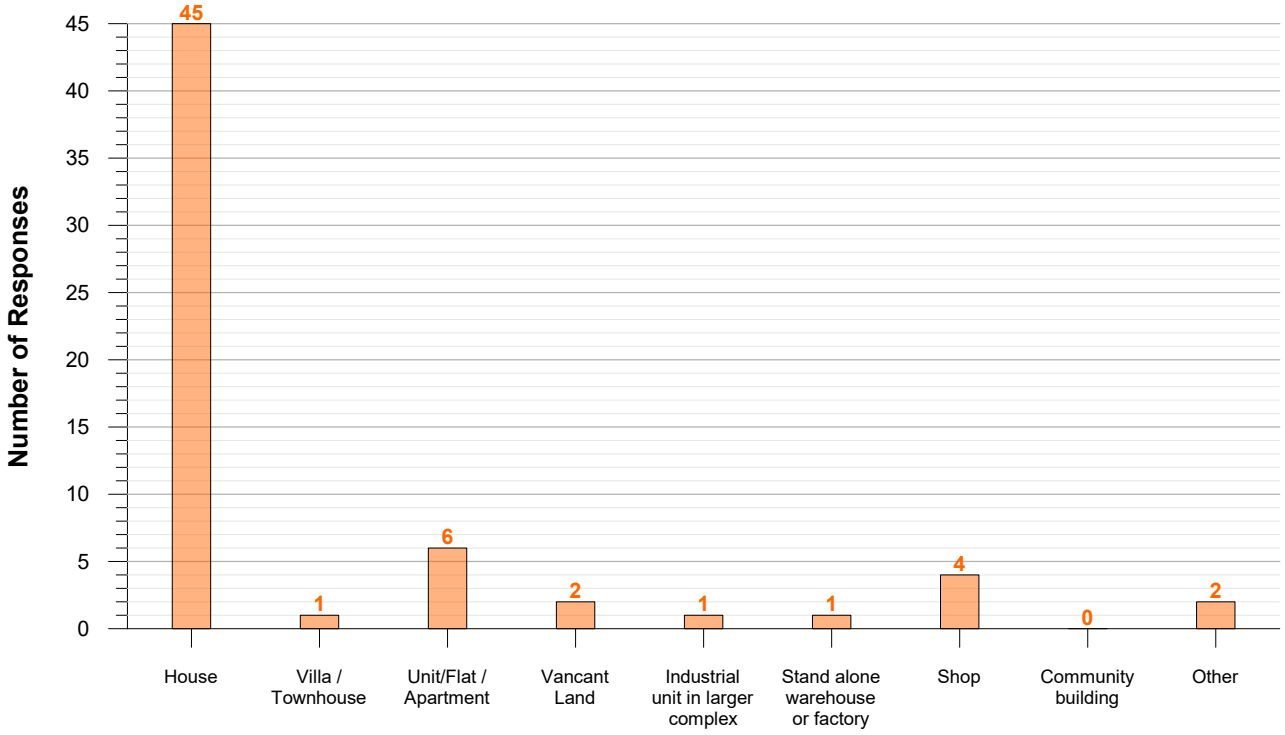
Q2. Occupier Status



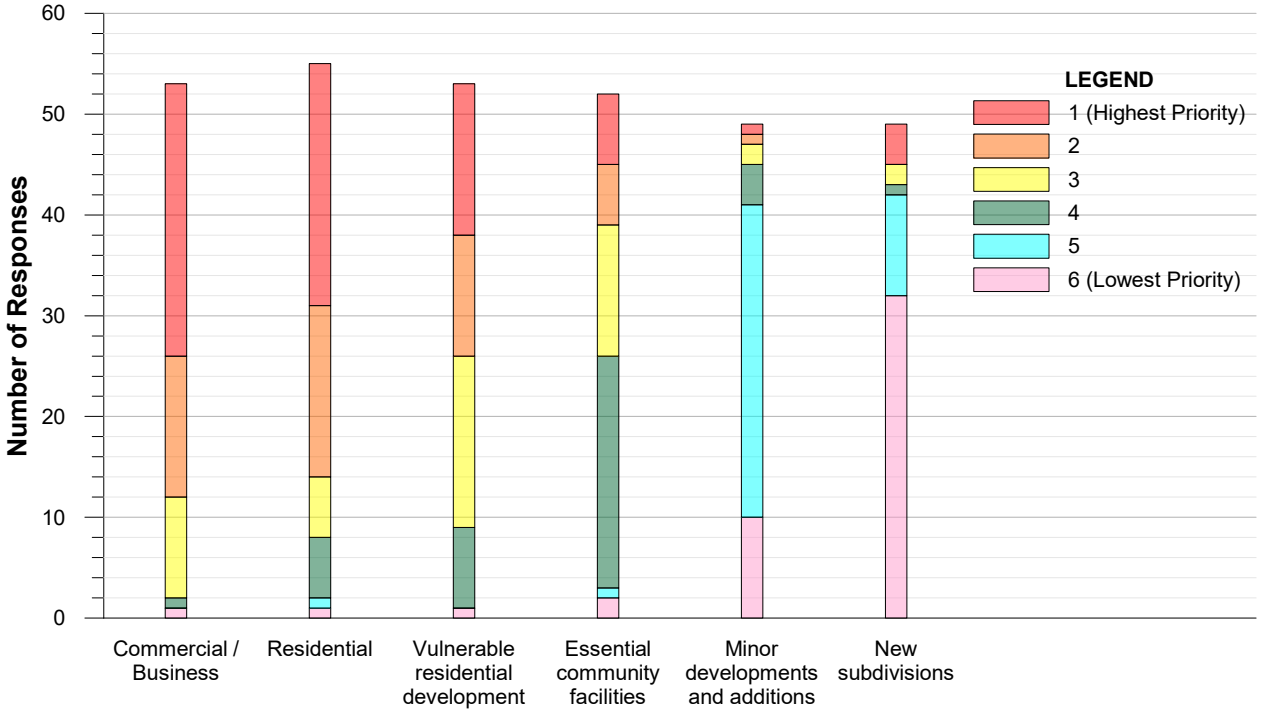
Q3. How long have you been at this address?



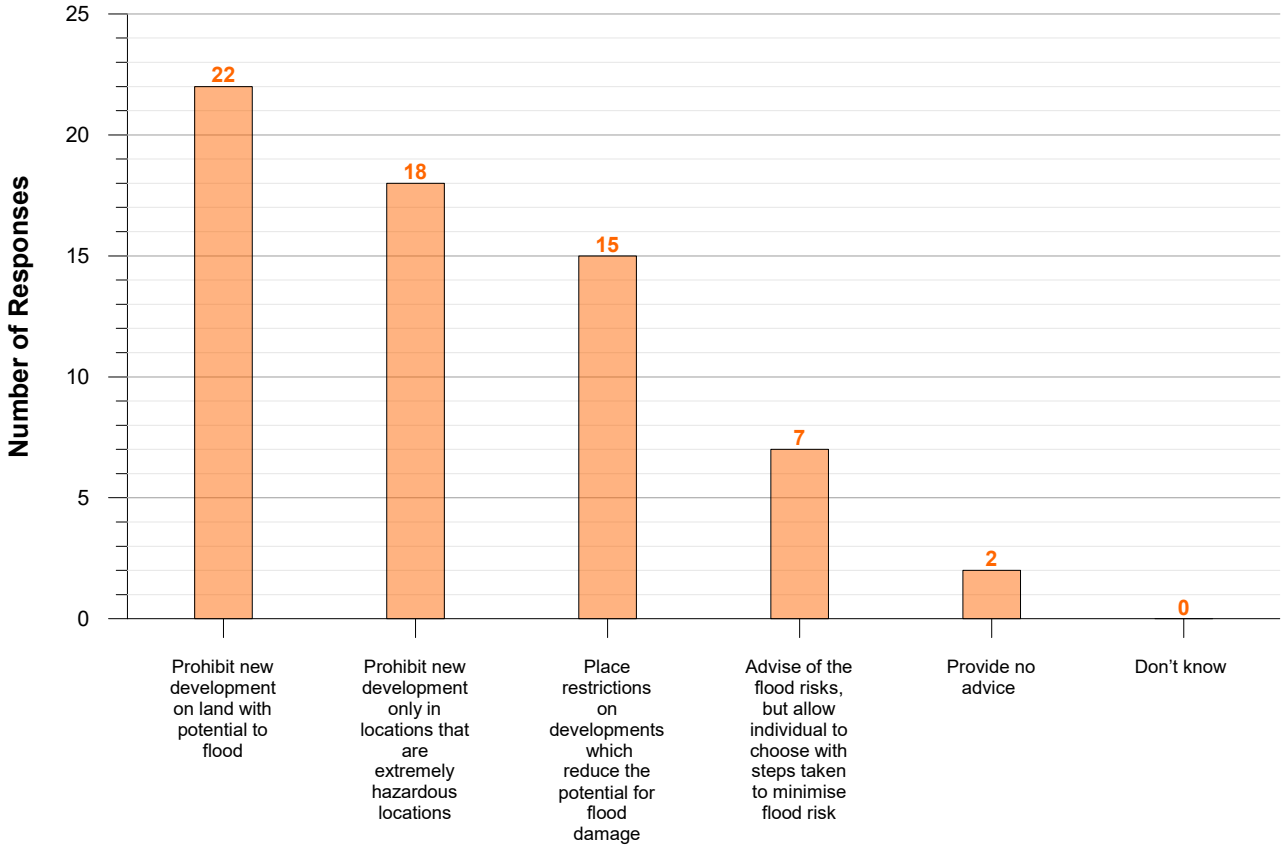
Q4. What is your property?



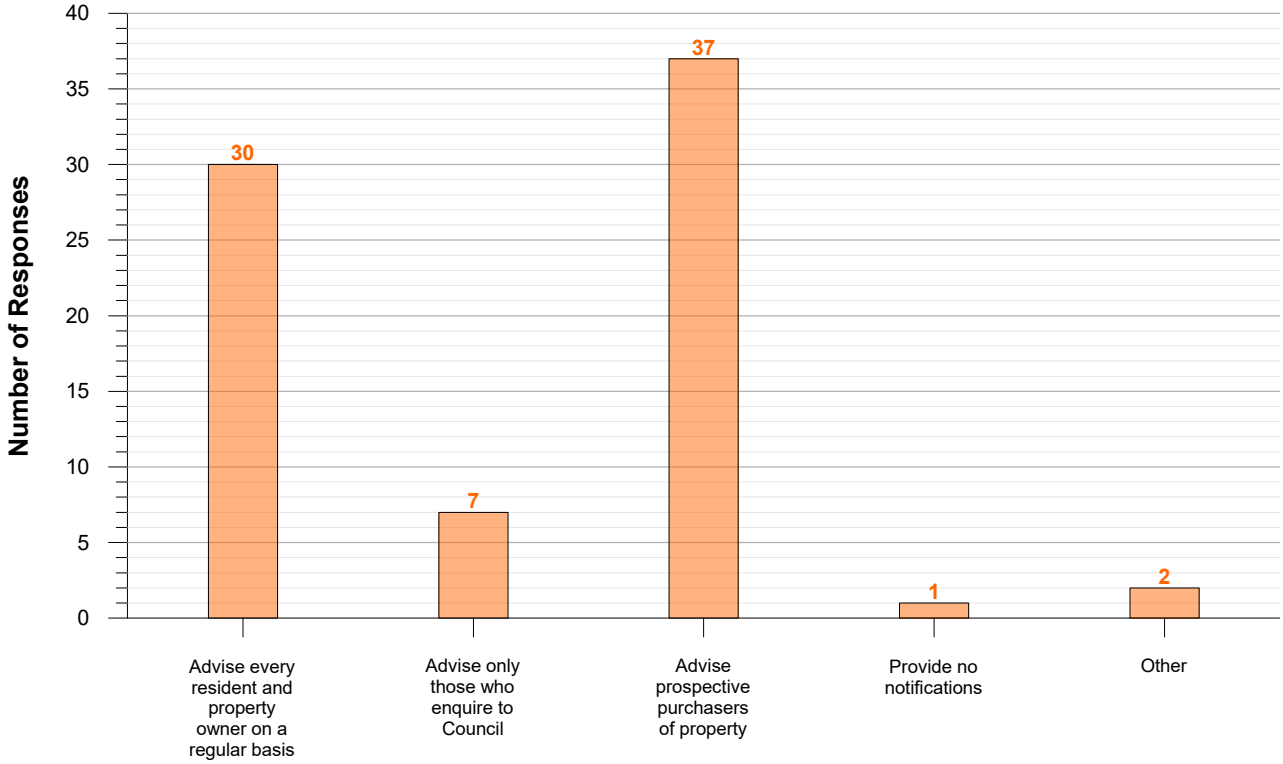
Q5. Rank of flood protection importance



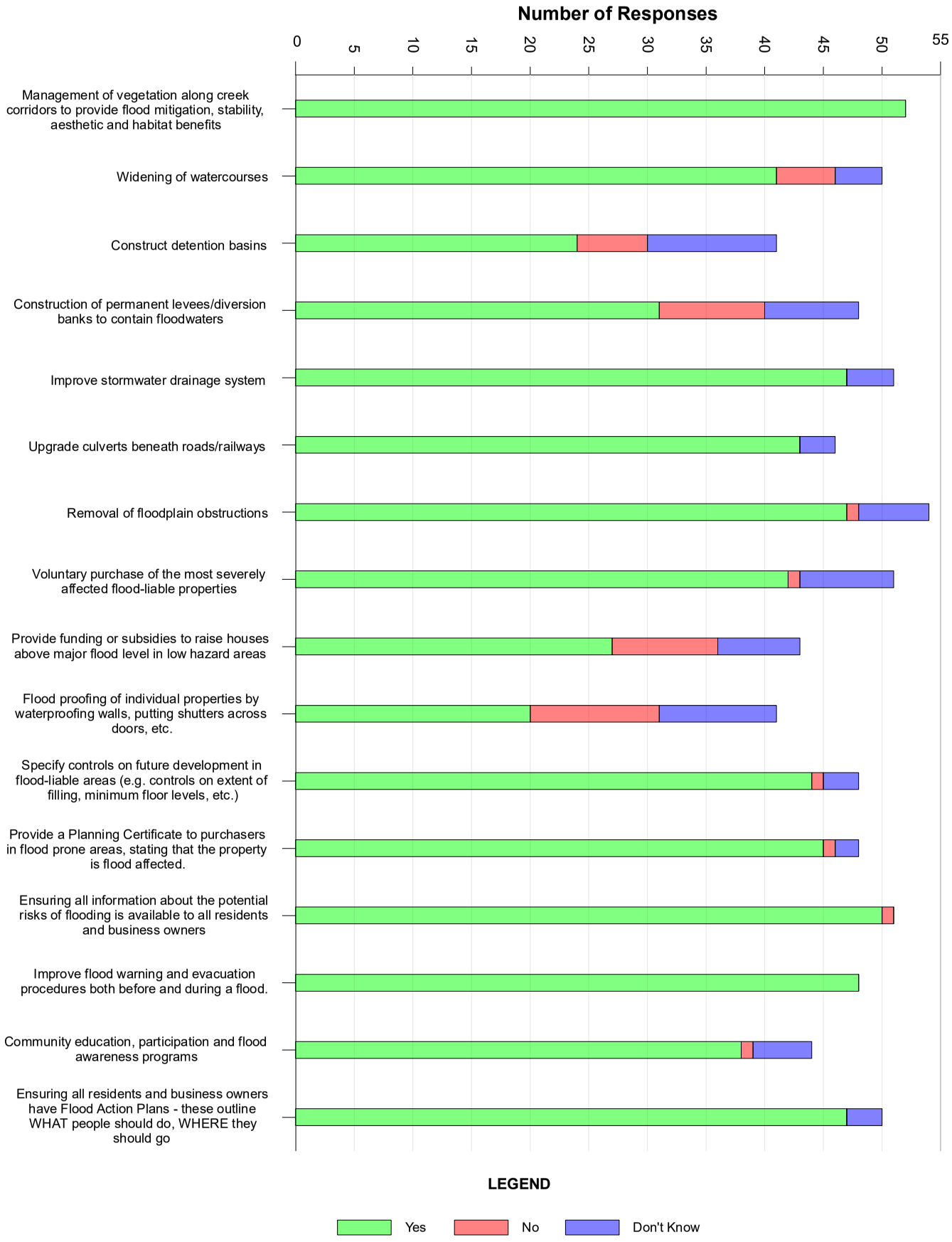
Q6. What level of control do you consider Council should place on new development to minimise flood related risks?



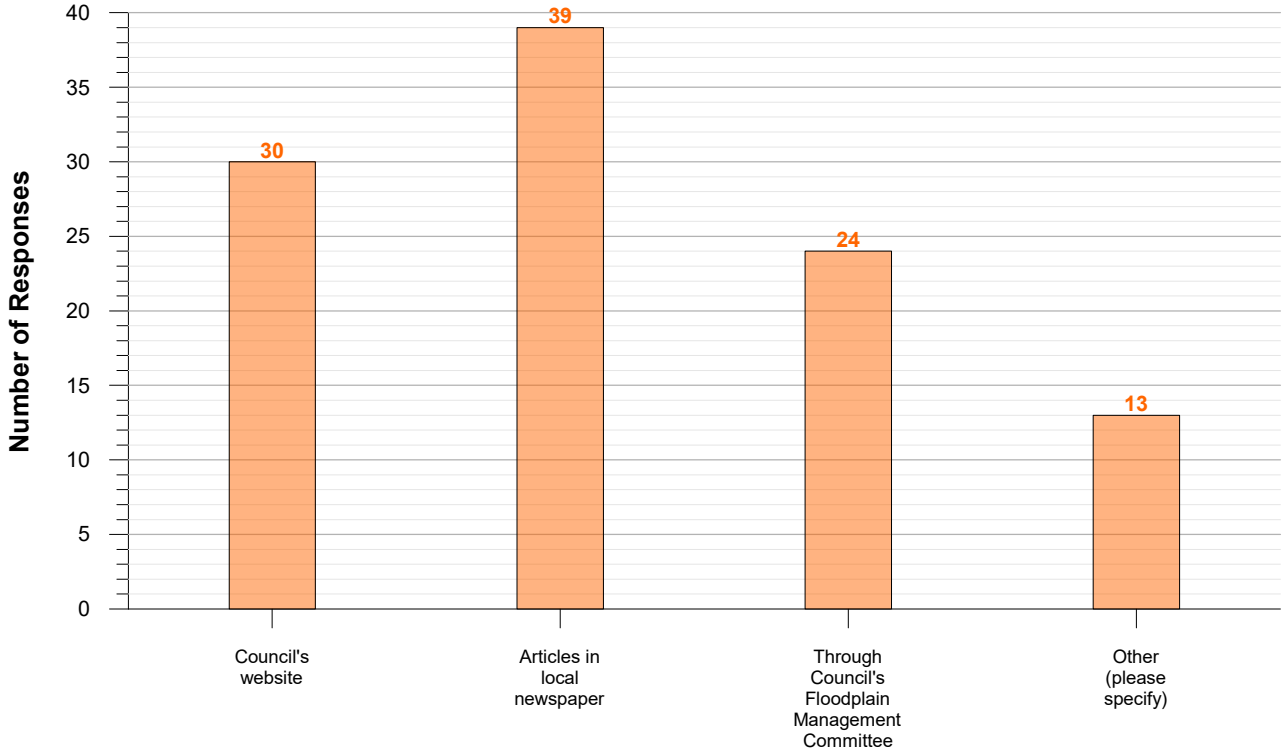
Q7. What notifications should Council give the potential flood affection of individual properties?



Q8. Options to minimise the effects of flooding at Molong



Q9. The best way to get input and feedback from the local community about the results and proposals from this study



APPENDIX B

PHOTOGRAPHS SHOWING OBSERVED FLOOD BEHAVIOUR AT MOLONG

8 NOVEMBER 2005

(Source: growMOLONG, 2019)

Plate B1.1 – (unknown time) Upstream side of Molong Creek Railway Bridge.

Plate B1.2 – (unknown time) Looking north along Watson Street from its intersection with Riddell Street.

Plate B1.3 – (unknown time) Floodwater overtopping the railway line to the east of the intersection of Watson Street and Riddell Street.

Plate B1.4 – (time unknown) Looking north along Railway from the old Mitchell Highway rail overpass.

Plate B1.5 – (time unknown) Looking north from the old water tank that is located adjacent to the intersection of Watson Street and Wellington Street.

8 NOVEMBER 2005

(Source: growMOLONG, 2019)

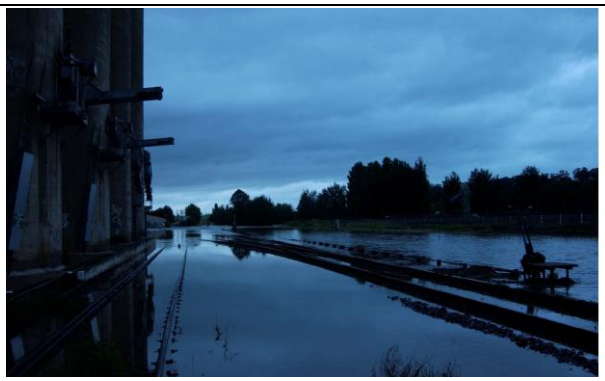


Plate B1.6 – (unknown time) Looking north along Railway adjacent to grain silos.

Plate B1.7 – (unknown time) Looking west along Molong Creek from Hunter Caldwell Park.

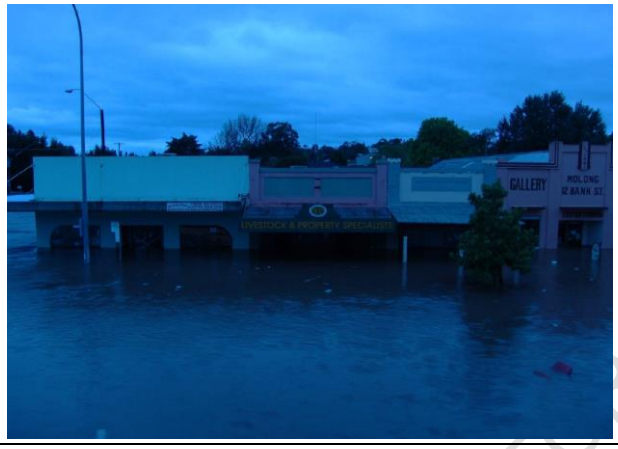


Plate B1.8 – (unknown time) Bank Street immediately west of its intersection with Watson Street.

Plate B1.9 – (unknown time) Looking east along Euchareena Road from its intersection with Watson Street.

Plate B1.10 – (unknown time) Looking west along Bank Street from its intersection with Watson Street.

Plate B1.11 – (unknown time) Watson Street at its intersection with Bank Street.

8 NOVEMBER 2005

(Source: growMOLONG, 2019)

Plate B1.12 – (unknown time) Looking west along Bank Street from its intersection with Watson Street.

Plate B1.13 – (unknown time) Looking north across Hill Street at its intersection with Gidley Street.

Plate B1.14 – (unknown time) Looking north along laneway adjacent to supermarket.

Plate B1.15 – (unknown time) Betts Street.

Plate B1.16 – (unknown time) Looking east along the Molong Creek floodplain to the north of Thistle Street.

Plate B1.17 – (unknown time) Longing north along Molong Creek from Hunter Caldwell Park.

8 NOVEMBER 2005

(Source: growMOLONG, 2019)

Plate B1.18 – (unknown time) Debris build up on the upstream side of the Molong Creek Railway Bridge.

Plate B1.19 – (unknown time) Looking east along Molong Creek floodplain upstream of Broken Hill Railway.

20 JULY 2016

Plate B2.1 – (Photo taken at 13:00 hours) William Street crossing of Boree Hollow.

Plate B2.2 – (Photo taken at 13:00 hours) Broken Hill Railway Bridge No. 1 crossing of Molong Creek.

Plate B2.3 – (Photo taken at 14:00 hours) Looking north along left bank of Molong Creek downstream of Molong Creek Railway Bridge.

Plate B2.4 – (Photo taken at 14:00 hours) Looking south along left bank of Molong Creek upstream Marsden Street Bridge.

Plate B2.5 – (Photo taken at 14:00 hours) Looking east at downstream side of Molong Creek Railway Bridge.

26 JANUARY 2020

Plate B3.1 – (unknown time) Floodwater that surcharged Pillans Park Drainage Line at Pillans Park flowing in a northerly direction along the eastern side of Edward Street.

26 NOVEMBER 2021

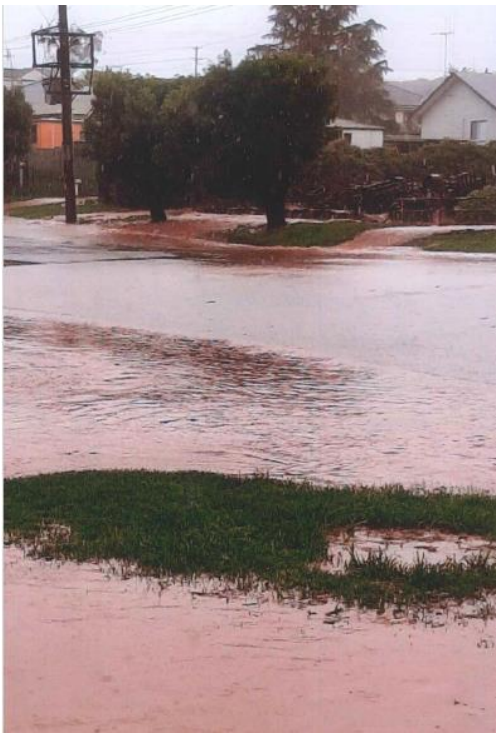


Plate B4.1 – (unknown time) Floodwater surcharging Pillans Park Drainage Line onto Gidley Street.

Plate B4.2 – (time unknown) Floodwater discharging to property on southern side of Gidley Street.

Plate B4.3 – (Photo taken at 15:35 hours) Lee Street crossing of Pillans Park Drainage Line.

Plate B4.4 – (Photo taken at 15:35 hours) Pillans Park Drainage Line downstream of Lee Street.

26 NOVEMBER 2021

Plate B4.5 – (time unknown) Norman Lane crossing of Pillans Park Drainage Line.

Plate B4.6 – (Photo taken at 14:20 hours) Looking east along Riddell Street at Boree Hollow.

Plate B4.7 – (Photo taken at 14:50 hours) Looking east along Hill Street at its intersection with Gidley Street.

Plate B4.8 – (Photo taken at 16:35 hours) Looking north along Market Street in the vicinity of its intersection with End Street.

Plate B4.9 – (Photo taken at 16:50 hours) Looking north along Molong Creek floodplain upstream of Broken Hill Railway.

Plate B4.10 – (Photo taken at 17:30 hours) Looking east along Bank Street.

26 NOVEMBER 2021

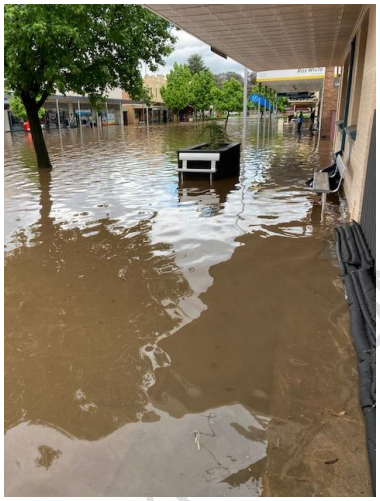
Plate B4.11 – (time unknown) Looking west along Boree Hollow at intersection of King Street and Riddell Street.

Plate B4.12 – (time unknown) Aerial view of Boree Hollow crossing of Riddell Street adjacent to Council Depot.

Plate B4.13 – (time unknown) Looking north along Molong Creek at Marsden Street bridge.

Plate B4.14 – (time unknown) Aerial view of floodwater ponding in Banks Street.

Plate B4.15 – (time unknown) Looking north along Molong Creek at Euchareena Road bridge.

26 NOVEMBER 2021	
	
Plate B4.16 – (Photo taken at 18:00 hours) Floodwater ponding in Bank Street.	**Plate B4.17** – (Photo taken at 18:00 hours) Floodwater ponding in Bank Street.

13-14 NOVEMBER 2022

Plate B5.1 – (Photo taken at 23:30 hours) Floodwater discharging to property on southern side of Gidley Street.

Plate B5.2 – (Photo taken at 00:40 hours) Floodwater ponding in Hill Street at its intersection with Gidley Street.

Plate B5.3 – (Photo taken at 01:20 hours) Floodwater ponding in Bank Street.

Plate B5.4 – (Photo taken at 01:20 hours) Floodwater ponding in Bank Street.

Plate B5.5 – (unknown time) Looking south along Watson Street from its intersection with Bank Street.

Plate B5.6 – (unknown time) Looking north along Watson Street from its intersection with Bank Street.

13-14 NOVEMBER 2022

Plate B5.7 – (time unknown) Floodwater ponding in Bank Street at its intersection with Watson Street.

Plate B5.8 – (Photo taken at 05:30 hours [approx.]) Looking south across Molong Creek immediately downstream of Gamboola Weir.

Plate B5.9 – (Photo taken at 05:40 hours) Floodwater ponding in Bank Street.

Plate B5.10 – (Photo taken at 05:45 hours) Floodwater ponding in Hill Street at its intersection with Gidley Street.

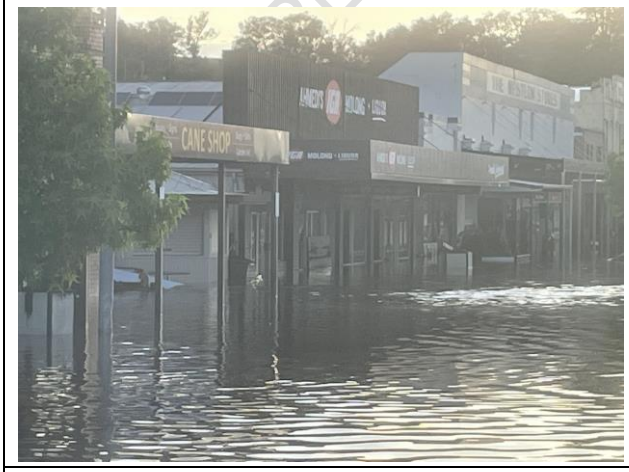


Plate B5.11 – (Photo taken at 06:15 hours) Floodwater ponding in Bank Street.

Plate B5.12 – (Photo taken at 06:45 hours) Floodwater ponding in Bank Street.

13-14 NOVEMBER 2022

Plate B5.13 – (Photo taken at 07:00 hours) Floodwater ponding in Hill Street at its intersection with Gidley Street.

Plate B5.14 – (Photo taken at 14:30 hours) Debris left behind at the intersection of Watson Street and Hill Street.

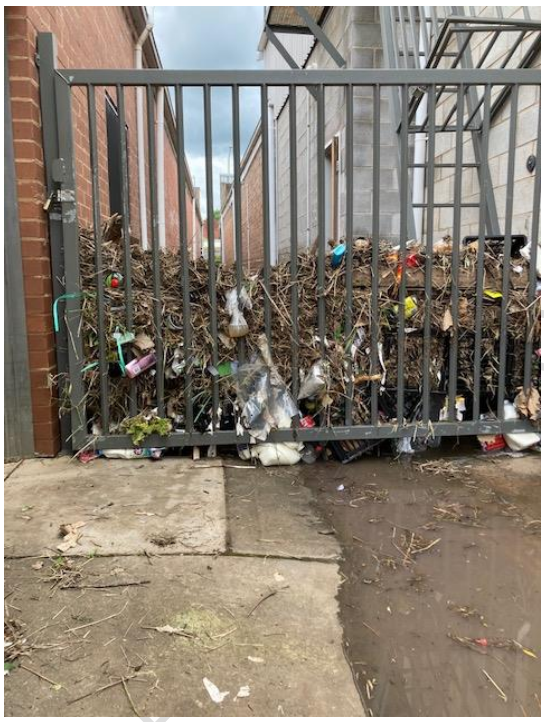


Plate B5.15 – (Photo taken at 14:30 hours) Debris build-up on gate between Molong Post Office and Supermarket.

Plate B5.16 – (Photo taken at 14:30 hours) Looking north across Molong Creek immediately downstream of the swimming pool.

13-14 NOVEMBER 2022

Plate B5.17 – (time unknown) Debris build-up on upstream side of Molong Creek Railway Bridge.

Plate B5.18 – Extract of Molong Express showing build-up of debris on upstream side of Molong Creek Railway Bridge.

Plate B5.19 – (time unknown) Debris build-up on Molong Creek Railway Bridge.

DATE NOT KNOWN

Plate B6.1 – Old Molong Creek Railway Bridge crossing of Molong Creek.

APPENDIX C

FIGURES SHOWING DESIGN FLOOD BEHAVIOUR AT MOLONG (BOUND IN VOLUME 2)

APPENDIX D

SUGGESTED WORDING FOR INCLUSION IN CABONNE DEVELOPMENT CONTROL PLAN

TABLE OF CONTENTS

FIGURES
(BOUND IN VOLUME 2)

D1.1 Introduction

This section of the DCP sets out specific controls to guide development of flood liable land. The approach to managing future development that is subject to flooding supports the findings of a series of location specific floodplain risk management studies and plans that have been prepared as part of the NSW Government's program to mitigate the impact of major floods and reduce the associated hazards in the floodplain.

D1.2 Objectives in Relation to Flood Risk Management

a) To minimise the potential impact of development and other activity upon the aesthetic, recreational and ecological value of the waterway corridors.

b) To increase public awareness of the hazard and extent of land affected by all potential floods, including floods greater than the 1% Annual Exceedance Probability (AEP) flood and to ensure essential services and land uses are planned in recognition of all potential floods.

c) To inform the community of Council's controls and policy for the use and development of flood prone land.

d) To reduce the risk to human life and damage to property caused by flooding through controlling development on land affected by potential floods.

e) To provide detailed controls for the assessment of applications lodged in accordance with the *Environmental Planning and Assessment Act 1979* on land affected by potential floods.

f) To provide different guidelines, for the use and development of land subject to all potential floods in the floodplain, which reflect the probability of the flood occurring and the potential hazard within different areas.

g) To apply a "merit-based approach" to all development decisions which takes account of social, economic and ecological considerations.

h) To control development and other activity within each of the individual floodplains within the LGA having regard to the characteristics and level of information available for each of the floodplains, in particular the availability of floodplain risk management studies and plans prepared in accordance with the *Flood Risk Management Manual*, issued by the NSW Government.

i) To deal equitably and consistently with applications for development on land affected by potential floods, in accordance with the principles contained in the *Flood Risk Management Manual*.

D1.3 Procedure for Determining What Controls Apply to Proposed Development

The procedure Council will apply for determining the specific controls applying to proposed development in flood liable areas is set out below. Upon enquiry by a prospective applicant, Council will make an initial assessment of the flood affectation and flood levels at the site using the following procedure:

- Assess whether the development is located on flood liable land from the **Flood Planning Map**.
- Determine which set of prescriptive flood related planning controls apply to the development from the **Flood Planning Map** (i.e. Main Stream Flooding or Major Overland Flow).

- Identify the category of the development from **Schedule1: Land Use Categories.**
- Determine the appropriate flood level at the site from the results of the location specific flood or floodplain risk management study.
- Determine which part of the floodplain the development is located in from the **Flood Planning Constraint Category Map**.
- Confirm that the development conforms with the relevant performance criteria, as well as the prescriptive controls set out in either **Schedule 2A** for Main Stream Flooding affected areas and **Schedule 2B** for Major Overland Flow affected areas.

With the benefit of this initial information from Council, the applicant will:

- Prepare the documentation to support the Development Application according to the requirements of **Section D1.9**.

A survey plan showing natural surface levels over the site will be required as part of the Development Application documentation. Provision of this plan by the applicant at the initial enquiry stage will assist Council in providing flood related information.

D1.4 Land Use Categories

The policy recognises twelve different types of land use for which a graded set of flood related controls apply. They are included in **Schedule 1: Land Use Categories**.

D1.5 Flood Planning Constraint Categories

For those floodplains where Council has adopted a flood or floodplain risk management study, the identified flood liable land has been divided into the following four *Flood Planning Constraint Categories* (**FPCCs**):

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the *Flood Planning Area* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the *Flood Planning Area* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this DCP.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the *Flood Planning Area* and the Probable Maximum Flood (**PMF**) where the Flood Hazard Vulnerability Classification in a PMF event is greater than H2. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes. This area is identical to the *Special Flood Considerations Zone* shown on the **Flood Planning Map**.

D1.6 Development Controls

The development controls have been graded relative to the severity and frequency of potential floods, having regard to the FPCCs determined by the relevant Floodplain Risk Management Study and Plan or, if no such study or plan exists, Council's interim considerations.

The objectives of the development controls are:

a) To require developments with high sensitivity to flood risk to be designed so that they are subject to minimal risk.

b) To allow development with a lower sensitivity to the flood hazard to be located within the floodplain, provided the risk of harm and damage to property is minimised.

c) To minimise the intensification of the high flood risk areas, and if possible, allow for their conversion to natural waterway corridors.

d) To ensure design and siting controls required to address the flood hazard do not result in unreasonable social, economic or environmental impacts.

e) To minimise the risk to life by ensuring the provision of reliable access from areas affected by flooding.

f) To minimise the damage to property arising from flooding.

g) To ensure the proposed development does not expose existing development to increased risks associated with flooding.

The performance criteria which are to be applied when assessing a proposed development are:

a) The proposed development should not result in any significant increase in risk to human life, or in a significant increase in economic or social costs as a result of flooding.

b) The proposal should only be permitted where effective warning time and reliable access is available to an area free of risk from flooding, consistent with any relevant Flood Plan or flood evacuation strategy.

c) Development should not significantly increase the potential for damage or risk to other properties either individually or in combination with the cumulative impact of development that is likely to occur in the same floodplain.

d) Procedures would be in place, if necessary, (such as warning systems, signage or evacuation drills) so that people are aware of the need to evacuate and are capable of identifying the appropriate evacuation route.

e) Development should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (e.g. by unsympathetic house–raising) or by being incompatible with the streetscape or character of the locality.

The prescriptive controls which apply to development that is proposed on land affected by Main Stream Flooding and Major Overland Flow are set out in **Schedules 2A** and **2B**, respectively.

D1.7 Proposals to Modify Flood Planning Constraint Categories

In certain situations it may be feasible to modify existing flood behaviour through engineering works which in turn would enable the extent of the FPCCs to be modified at a particular location. Proposals to modify an FPCC at a particular location would need to be supported by a detailed flooding investigation, further details of which are set out in **Section D1.9** below. Proposals would also need to demonstrate consistency with the flood related objectives and performance criteria of both the *Cabonne Local Environmental Plan 2012* and the DCP.

D1.8 Special Requirements for Fencing

The objectives are:

a) To ensure that fencing does not result in the obstruction of the free flow of floodwater.

b) To ensure that fencing does not become unsafe during floods so as to threaten the integrity of structures or the safety of people.

c) To ensure fencing is to be constructed in a manner which does not significantly increase flood damage or risk on surrounding land.

The performance criteria which are to be applied when assessing proposed fencing are:

a) Fencing is to be constructed in a manner that does not affect the flow of floodwater so as to detrimentally increase flood affection on surrounding land.

b) Fencing must be certified by an engineer specialising in hydraulic engineering stating that the proposed fencing would be constructed so as to withstand the force of floodwater, or collapse in a controlled manner to prevent the impediment of floodwater.

The prescriptive controls which apply to any proposed fencing on land designated FPCC 1 and FPCC 2 are:

a) An applicant will need to demonstrate that the fence (new or replacement fence) would not create an impediment to the flow of floodwater. Fences must satisfy the following:

- comprise pool/louvre type fencing or a collapsible hinged type fence structure;
- configured so as to allow floodwaters to equalise on both sides of the fence; and
- configured so as to minimise entrapment of flood debris.

D1.9 Explanatory Notes on Lodging Applications

The following steps must be followed in the lodgement of a development application:

a) Check the proposal is permissible in the zoning of the land by reference to any applicable environmental planning instruments.

b) Consider any other relevant planning controls of Council (e.g. controls in any other relevant part of the DCP.

c) Check whether your property is located either partially or wholly within the Flood Planning Area or Special Flood Considerations Zone, as defined on the **Flood Planning Map**.

d) Determine which set of prescriptive flood related planning controls apply to the development from the **Flood Planning Map**.

e) Determine which FPCC applies to the developable portion of your property by reference to the **Flood Planning Constraint Category Map**. Enquire with Council regarding existing flood risk mapping or whether a site–specific assessment may be warranted. A property may be located in more than one FPCC and the assessment must consider the controls that apply in each.

f) Determine the land use category relevant to the development proposal, by firstly confirming how it is defined by the relevant environmental planning instrument and secondly by ascertaining the land use category from **Schedule 1: Land Use Categories**.

g) Assess and document how the proposal will achieve the performance criteria for proposed development and associated fencing set out in **Sections D1.6** and **D1.8**.

h) Check if the proposal will satisfy the prescriptive controls for different land use categories in different FPCCs, as specified in either **Schedule 2A** or **Schedule 2B**.

i) If the proposal does not comply with the prescriptive controls, determine whether the performance criteria are nonetheless achieved.

j) Illustrations provided in this plan to demonstrate the intent of development controls are diagrammatic only. Proposals must satisfy all relevant controls contained in this plan and associated legislation.

k) The assistance of Council staff or an experienced engineer or planner may be required at various steps in the process to ensure that the flood risk management related requirements of this Plan are fully and satisfactorily addressed.

Note that compliance with all the requirements of this DCP does not guarantee that an application will be approved.

Information required with an application to address this plan is as follows:

a) Applications must include information which addresses all relevant controls listed above, and the following matters as applicable.

b) Applications for alterations and additions (see either **Schedule 2A** or **Schedule 2B**) to an existing dwelling on flood liable land must be accompanied by documentation from a registered surveyor confirming existing floor levels.

c) Development applications affected by this plan must be accompanied by a survey plan showing:

   i. The position of the existing building/s or proposed building(s);

   ii. The existing ground levels to Australian Height Datum around the perimeter of the building and contours of the site; and

   iii. The existing or proposed floor levels to Australian Height Datum.

d) Applications for earthworks, filling of land and subdivision shall be accompanied by a survey plan (with a contour interval of 0.25 m) showing relative levels to Australian Height Datum.

e) Where an existing catchment based flood study is not available, a flood study using a fully dynamic one or two dimensional computer model may be required. For smaller developments an existing suitable flood study may be used if available (e.g. it contains sufficient local detail), or otherwise a flood study prepared in a manner consistent with the latest edition of *Australian Rainfall and Runoff* and the *Floodplain Development Manual*, will be required and the following information must be submitted in plan form:

   i. water surface contours;

   ii. velocity vectors;

   iii. velocity and depth product contours;

   iv. delineation of flood risk precincts relevant to individual floodplains; and

   v. show both existing and proposed flood profiles for the full range of events for total development including all structures and works (such as revegetation/ enhancements).

   This information is required for both pre–developed and post–developed scenarios.

f) Where the controls for a particular development proposal require an assessment of structural soundness during potential floods, the following impacts must be addressed:

   i. hydrostatic pressure;

   ii. hydrodynamic pressure;

   iii. impact of debris; and

   iv. buoyancy forces.

   Foundations need to be included in the structural analysis.

D1.10 Glossary of Terms

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

TERM	DEFINITION
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, for a flood magnitude having five per cent AEP, there is a five per cent probability that there would be floods of greater magnitude each year.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood (**PMF**) event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* shows the extent of land on which flood related development controls apply in a given area, noting that other areas may exist which are not mapped but where flood related development controls apply.
Flood Planning Constraint Category 1 (FPCC 1)	Comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding
Flood Planning Constraint Category 2 (FPCC 2)	Comprises areas which lie below the *Flood Planning Level* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
Flood Planning Constraint Category 3 (FPCC 3)	Comprises areas which lie below the *Flood Planning Level* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
Flood Planning Constraint Category 4 (FPCC 4)	Comprises the area which lies above the *Flood Planning Level* (**FPL**) but within the extent of the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes. This area is identical to the *Special Flood Considerations Zone* shown on the *Flood Planning Map*.
Flood Planning Level (FPL)	Flood levels selected for planning purposes, as determined by the relevant adopted floodplain risk management study and plan, or as part of a site specific study In the absence of an adopted floodplain risk management study and plan for a particular location, the FPL is defined as the peak 1% AEP flood level plus the addition of a 0.5 m freeboard.

TERM	DEFINITION
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding a particular flood chosen as the basis for the *Flood Planning Level* is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the *Flood Planning Level*.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Local Drainage	Land on an overland flow path where the depth of inundation during the 1% AEP storm event is less than 0.1 m.
Main Stream Flooding	The covering of normally dry land by water that has escaped or been released from the normal confines of any lake, river, creek or other natural watercourse (whether or not altered or modified) or any reservoir, canal or dam.
Major Overland Flow	Where the depth of overland flow during the 1% AEP storm event is greater than 0.1 m.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
Special Flood Considerations Zone	Comprises the area where the flood risk is considered to be high enough to require additional controls to be applied to future development that is located on land which lies outside the FPA. The additional controls in this area relate to the safe and timely evacuation of people who would be occupying the floodplain at the time of a flood event and only apply in areas categorised as FPCC4.

SCHEDULE 1
LAND USE CATEGORIES

Land Use Category	Subdivision	LEP Land Uses
Critical Uses and Facilities	*Community facilities which may provide an important contribution to the notification or evacuation of the community during flood events.*	Health services facility; Electricity generating works; Emergency services facility.
Sensitive Uses and Facilities	*Uses which involve vulnerable members of the community;* *Uses which may cause pollution of a watercourse or town water supply;* *Uses which if affected, would significantly affect the ability of community to return to normal after flood event;*	Bio-solids treatment facility; Cemeteries; Child care centre; Correctional centre; Heavy industrial storage establishment; Heavy industries; Highway service centre; Group home; Passenger transport facilities; Respite day care centre; Schools; Seniors housing; Service Stations; Sewage treatment plant; Veterinary hospital; Waste or resource management facility; Water treatment facility.
Subdivision	*Subdivision of land which involves* *the creation of new allotments, with* *potential for further development;*	Camping grounds; Caravan parks; Eco-tourist facilities; Home business/ child care/occupations; Residential accommodation (excluding Group Home and Seniors housing); Tourist and visitor accommodation.
Residential		Attached dwellings Dwelling hours Multi dwelling housing Residential flat buildings Semi-detached dwellings Shop top housing
Commercial and Industrial		Amusement centre; Commercial premises (excluding Market); Crematorium; Depots; Entertainment facility; Freight transport facilities; Function centre; General industries; Industrial retail outlet; Industrial training facility; Light industries; Mortuaries;

		Place of public worship; Public administration building; Recreation facility (indoor & major); Registered club; Research station; Restricted premises; Sex services premises; Storage premises; Transport depots; Truck depots; Warehouse or distribution centre; Wholesale suppliers; Vehicle body repair workshops; Vehicle repair stations;
Recreation and Non-Urban		Agriculture (excluding intensive livestock agriculture); Animal boarding and training establishment; Boat sheds; Charter & tourism boating facilities; Car park; Community facility; Extractive industry; Forestry; Jetties; Market; Open cut mining; Recreation area; Recreation facility (outdoor).
Alterations and additions		Residential development: i. An addition or alteration to an existing dwelling of not more than 50m² to the habitable floor area which existed at the date of commencement of this Plan; ii. The construction of an outbuilding with a maximum floor area of 30m² or Rebuilt dwellings which substantially reduce flood risk having regard to property damage and personal safety; or iii. A change of use which does not increase flood risk having regard to property damage and personal safety. iv. Alterations and additions: i. An addition to existing premises of not more than 10% of the floor area which existed at the date of commencement of this DCP; ii. Rebuilding of a development which substantially reduces the extent of flood effects to the existing development; iii. A change of use which does not increase flood risk having regard to property damage and personal safety; or iv. Subdivision which does not involve the creation of new allotments with potential for further development.

SCHEDULE 2A
PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAIN STREAM FLOODING

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1)							Flood Planning Constraint Category 2 (FPCC 2)							Flood Planning Constraint Category 3 (FPCC 3)							Flood Planning Constraint Category 4 (FPCC 4)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A1	A2 A4				A2	A5	A1	A2 A4				A2	A5	A1	A2 A4	A3	A3					
Building Components						B2	B2				B2	B2	B2	B2				B2	B2	B2	B2	B3	B3					
Structural Soundness						C2	C2				C2	C2	C3	C2				C2	C2	C3	C2	C4	C4					
Flood Affectation						D1	D1			D1	D1	D1	D1	D2			D1	D1	D1	D1	D2							
Emergency Response						E4	E2 or E3			E4 E5	E3 E4	E3 E4	E4	E2 or E3			E4 E5	E2 E4	E2 E4	E4	E2 or E3	E2 or E3	E2 E4	E4 E5	E2 E4	E2 E4		E2 E4
Management and Design						F2 F3	F2 F3			F1	F2	F2 F3 F4	F2 F3	F2 F3			F1	F2	F2 F3 F4	F2	F2 F3	F2 F3	F2 F3 F4	F1	F2	F2 F3 F4	F2	F2
Stormwater						G2	G2			G1 G2	G1 G2	G1 G2	G2	G2			G1 G2	G1 G2	G1 G2	G2	G2	G1	G1					
Parking and Driveway Access						H2 H4 H6 H7	H6 H7 H8			H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8			H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8	H3	H3					

	Not Relevant		Unsuitable Land Use

SCHEDULE 2B
PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAJOR OVERLAND FLOW

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1)							Flood Planning Constraint Category 2 (FPCC 2)							Flood Planning Constraint Category 3 (FPCC 3)							Flood Planning Constraint Category 4 (FPCC 4)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A1	A2 A4				A2	A5	A1	A2 A4	A3	A3		A2	A5	A1	A2 A4	A3	A3					
Building Components						B1	B1				B1	B1	B1	B1	B3	B3		B1	B1	B1	B1	B3	B3					
Structural Soundness						C1	C1				C1	C1	C1	C1	C4	C4		C1	C1	C1	C1	C4	C4					
Flood Affectation						D1	D1			D1	D1	D1	D1	D2														
Emergency Response						E1	E1			E5					E2 or E3	E2 E4	E5					E2 or E3	E2 E4					
Management and Design						F2	F2			F1 F3	F2	F2 F4	F2	F2	F2 F3	F2 F3 F4	F1 F3		F4			F2 F3	F2 F3 F4					
Stormwater						G2				G1	G1	G1	G2		G1	G1	G1	G1	G1	G2		G1	G1					
Parking and Driveway Access						H2 H4 H6 H7	H6 H7 H8			H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8			H1 H3 H5 H6	H1 H3 H5 H6	H1 H3 H5 H6	H2 H4 H6	H6 H8	H3	H3					

	Not Relevant		Unsuitable Land Use

Prescriptive controls for associated planning considerations under each FPCC

Minimum Habitable Floor Level

A1 Habitable floor levels to be set no lower than the 5% AEP flood level plus freeboard(1) unless justified by site specific assessment.

A2 Habitable floor levels to be set no lower than the 1% AEP flood level plus freeboard(1).

A3 Habitable floor levels to be set no lower than the PMF flood level.

A4 Habitable floor levels to be as close to the Minimum Habitable Floor Level as practical and no lower than the existing floor level when undertaking concessional development.

A5 Habitable floor levels to be as close to the 1% AEP flood level plus freeboard(1) as practical, but no lower than the 5% AEP flood level plus freeboard(1). In situations where the habitable floor level is set below the 1% AEP flood level plus freeboard(1), a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard(1).

Building Components & Method

B1 All structures to have flood compatible building components below the 1% AEP flood level plus freeboard(1) (refer **Schedules 3A** and **3B**).

B2 All structures to have flood compatible building components below the 1% AEP flood level plus freeboard(1) or the 0.2% AEP flood level, whichever is the highest (refer **Schedules 3A** and **3B**).

B3 All structures to have flood compatible building components below the 1% AEP flood plus freeboard(1) or the PMF level, whichever is the highest (refer **Schedules 3A** and **3B**).

Structural Soundness

C1 Engineers report to certify that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus freeboard(1).

C2 Engineers report to certify that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus freeboard(1) or a 0.2% AEP flood, whichever is the greatest.

C3 Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus freeboard(1) or a 0.2% AEP flood, whichever is the greatest, alternatively PMF if required to satisfy emergency response criteria (see below).

C4 Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus freeboard(1) or a PMF, whichever is the greatest.

Flood Affectation

D1 Engineers report required to certify that the development will not increase flood affectation elsewhere.

D2 The impact of the development on flooding elsewhere to be considered.

Note: When assessing flood affectation the following must be considered:

1. Loss of storage in the floodplain (Only for development being assessed under Schedule 2A).

2. Changes in flood levels and flow velocities caused by alteration of conveyance of flood waters.

3. Impacts of urbanisation on peak flood flows and volumes.

Emergency Response

E1 Reliable egress for pedestrians and vehicles required during a 1% AEP flood.

E2 Reliable egress for pedestrians and vehicles required during a PMF.

E3 Reliable egress for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF level, or a minimum of 20 m^2 of the dwelling to be above the PMF level.

E4 The development is to be consistent with any relevant flood evacuation strategy or similar plan.

E5 Applicant to demonstrate that there is rising road egress/access from all allotments internal to the subdivision to land which lies above the PMF.

Management and Design

F1 Applicant to demonstrate that potential development as a consequence of a subdivision or development proposal can be undertaken in accordance with the controls set out in this Development Control Plan.

F2 Flood Safe Plan (home or business or farm houses) to address safety and property damage issues (including goods storage and stock management) considering the full range of flood risk.

F3 Site Emergency Response Flood Plan required considering the full range of flood risk

F4 No external storage of materials below the Minimum Habitable Floor Level which may cause pollution or be potentially hazardous during any flood.

Stormwater

G1 Engineers report required to certify that the development will not affect stormwater drainage.

G2 The impact of the development on local overland flooding to be considered.

Parking and Driveway Access

H1 The minimum surface level of open car parking spaces or carports shall be as high as practical, but no lower than the 5% AEP flood or the level of the crest of the road at the location where the site has access. In the case of garages, minimum surface level shall be as high as practical but no lower than the 5% AEP flood.

H2 The minimum surface level of open car parking spaces, carports or garages shall be as high as practical

H3 Garages capable of accommodating more than three motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods up to the 1% AEP flood plus freeboard(1).

H4 The driveway providing access between the road and parking space shall be as high as practical and generally rising in the egress direction.

H5 The level of the driveway providing access between the road and parking space shall be no lower than 0.3 m below the 1% AEP flood or such that the depth of inundation during a 1% AEP flood is not greater than either the depth at the road or the depth at the car parking space. A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.

H6 Enclosed car parking and car parking areas accommodating more than three vehicles (other than on Rural zoned land), with a floor level below the 5% AEP flood or more than 0.8 m below the 1% AEP flood level, shall have adequate warning systems, signage and exits.

H7 Restraints or vehicle barriers to be provided to prevent floating vehicles leaving the site during a 1% AEP flood.

H8 Driveway and parking space levels to be no lower than the design ground/floor levels. Where this is not practical, a lower level may be considered. In these circumstances, the level is to be as high as practical, and, when undertaking concessional development, no lower than existing levels.

H9 Flood related parking and access requirements to be advised by Council if necessary. Contact Council for advice as early as possible.

1. Unless stated otherwise in an adopted location specific Floodplain Risk Management Study and Plan, freeboard is equal to 0.5 m for development being assessed under Schedule 2A and 0.3 m for development being assessed under Schedule 2B.

SCHEDULE 3A
GENERAL BUILDING MATTERS

Electrical and Mechanical Equipment

For dwellings constructed on land to which this policy applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.

Main Power Supply

Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. Means shall be available to easily isolate the dwelling from the main power supply.

Wiring

All wiring, power outlets, switches, etc, should be, to the maximum extent possible, located above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. All electrical wiring installed below this level should be suitable for continuous underwater immersion and should contain no fibrous components. Earth leakage circuit breakers (core balance relays) must be installed. Only submersible type splices should be used below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.

Equipment

All equipment installed below or partially below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B** should be capable of disconnection by a single plug and socket assembly.

Reconnection

Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.

Heating and Air Conditioning Systems

Where viable, heating and air conditioning systems should be installed in areas and spaces of the house above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. When this is not feasible, every precaution should be taken to minimise the damage caused by submersion according to the following guidelines:

i) Fuel

Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off.

ii) Installation

The heating equipment and fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks should be vented to the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**.

iii) Ducting

All ductwork located below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B** should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a watertight wall or floor below the relevant flood level, a closure assembly operated from above the relevant elevation set out under B1 or B2 of **Schedules 2A** and **2B** should protect the ductwork.

Sewer

All sewer connections to properties in flood prone areas are to be fitted with reflux valves.

SCHEDULE 3B
FLOOD COMPATIBLE MATERIALS

Building Component	Flood Compatible Material	Building Component	Flood Compatible Material
Flooring and Sub Floor Structure	• Concrete slab-on-ground monolith construction. Note: clay filling is not permitted beneath slab-on-ground construction which could be inundated. • Pier and beam construction or • Suspended reinforced concrete slab	**Doors**	• Solid panel with waterproof adhesives • Flush door with marine ply filled with closed cell foam • Painted material construction • Aluminium or galvanised steel frame
Floor Covering	• Clay tiles • Concrete, precast or in situ • Concrete tiles • Epoxy formed-in-place • Mastic flooring, formed-in-place • Rubber sheets or tiles with chemical set adhesive • Silicone floors formed-in-place • Vinyl sheets or tiles with chemical-set adhesive • Ceramic tiles, fixed with mortar or chemical set adhesive • Asphalt tiles, fixed with water resistant adhesive • Removable rubber-backed carpet	**Wall and Ceiling Linings**	• Brick, face or glazed • Clay tile glazed in waterproof mortar • Concrete • Concrete block • Steel with waterproof applications • Stone natural solid or veneer, waterproof grout • Glass blocks • Glass • Plastic sheeting or wall with waterproof adhesive
Wall Structure	Solid brickwork, blockwork, reinforced, concrete or mass concrete	**Insulation**	• Foam or closed cell types
Windows	Aluminium frame with stainless steel or brass rollers	**Nails, Bolts, Hinges and Fittings**	• Galvanised • Removable pin hinges