

Wyong River Catchment Floodplain Risk Management Study & Draft Plan

Summary Report



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Catchment Simulation Solutions



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1 INTRODUCTION

The Wyong River catchment is located on the Central Coast of New South Wales and occupies a total area of 440 km². The catchment is drained by a network of rivers and creeks including the Wyong River, Cedar Brush Creek, Jilliby Jilliby Creek, Porters Creek, Mardi Creek and Deep Creek that ultimately drain into Tuggerah Lake. Tuggerah Lake, in turn, discharges to the Pacific Ocean via a single outlet at The Entrance.

During periods of heavy rainfall within the catchment, there is potential for water to overtop the banks of the various watercourses and inundate the adjoining floodplain. The catchment has a long history of flooding including significant events in 1949, 1964 and 1977 as well as more recently in 2007.

In recognition of the flooding problems confronting the Wyong River catchment, Central Coast Council commisioned Catchment Simulation Solutions to prepare a Floodplain Risk Management Study and Plan for the catchment. The primary goal of the project was to quantify the nature and extent of the existing flooding problem and evaluate options that could be potentially implemented to manage the existing, future and continuing flood risk.

The Floodplain Risk Management Study & Plan comprises two primary documents:

- Volume 1: contains the report text and appendices;
- Volume 2: contains all figures and maps.

The intent of this Summary Report is to provide a concise summary of the key findings of the study and plan in a single document.

1.1 Report Structure

The following summary report has been divided into the following sections:

- <u>Section 2 The Existing Flood Risk</u>: describes the current impact of flooding on the community for a range of different floods.
- Sections 3 Flood Risk Management Options: discusses the merits of a range of flood, property and response modification measures that could be potentially implemented to manage the flood risk across the catchment
- Section 4 Draft Floodplain Risk Management Plan: provides a preferred list of options that are considered appropriate for adoption by Council to manage the flood risk.
- <u>Section 5 Glossary</u>: provides an alphabetical list of technical terms used in the report and definitions of each term.

2 THE EXISTING FLOODING PROBLEM

2.1 Overview

The nature and extent of the existing flood risk was quantified using a computer flood models of the Wyong River catchment. The flood models were used to simulate range of "design" floods (hypothetical floods that are defined based upon their probability of occurrence). This included the 20% Annual Exceedance Probability (AEP) flood as well as the 5% AEP, 1% AEP and Probable Maximum Floods (PMF). The PMF is the largest flood that could possibly occur.

The results of each design flood were extracted and used to prepare a range of flood maps. The flood maps show peak floodwater levels, depths and velocities. The full list of figures is provided in Volume 2 of the Floodplain Risk Management Study.

The results of the flood modelling were also used to prepare flood hazard mapping. The flood hazard mapping shows the potential impact that floodwaters would likely have on people, buildings and vehicles. Flood emergency response classifications where also prepared to identify the types of emergency response that may be required across different sections of the catchment and to identify locations where roadways would be cut by floodwaters.

The following sections summarise the outcomes of the existing flood assessment across different sections of the Wyong River catchment. The discussion is broken down into different catchment "sectors".

2.2 Summary of Flooding Impacts

2.2.1 Yarramalong Valley

The Yarramalong Valley is a large sector extending from the upper reaches of the floodplain in Cedar Brush Creek and Ravensdale, past Yarramalong village to the eastern limit of Wyong Creek where it meets Wyong and Mardi. **Figure A3.8** on the following page shows peak 1% AEP floodwater depths, levels and velocities in the vicinity of Yarramalong village.

An estimated 49 dwellings in this sector are predicted to be flooded above floor in the 1% AEP event, although most of these have a second storey that could provide a means of reducing damages to contents. While roads are flooded very early cutting access within the valley and to Wyong, most housing is located beyond the floodplain or towards the edge of the floodplain with access to higher ground by foot if not by road or track. But there are some exceptions where access is lost prior to inundation of the house footprint. Plus, for people who do evacuate to higher ground, the duration of isolation is considerable.

2.2.2 Dooralong Valley

The Dooralong Valley sector extends from the upper reaches of Jilliby Jilliby Creek's floodplain in Lemon Tree, through Dooralong and Jilliby to the Wyong River. Peak 1% AEP floodwater depths, levels and velocities in the vicinity of Dooralong village are provided in **Figure A3.17**.







Compared to the Yarramalong Valley, significantly fewer existing houses are estimated to be flooded above floor level for both the 1% AEP and PMF events. But the same problems of very limited warning and lengthy disruption to access prevail.

2.2.3 Mardi Rural Residential

The 'Mardi rural' sector includes rural residential properties along Old Maitland Road, Collies Lane, McPherson Road (including the Wyong Aged Care Facility) and Mardi Road. Peak 1% AEP floodwater depths, levels and velocities for this area are provided in **Figure A3.24**.

Even in the 1% AEP event, this area has a significant flood risk, with 27 dwellings flooded above floor and with evacuation routes likely to be flooded even before a formal flood warning is issued. This means that evacuation would need to commence based on another trigger such as issuance of a Flood Watch or Severe Weather Warning.

Of particular concern for these properties is the high flood hazard experienced at most dwellings in this area in the PMF, which could threaten building integrity as well as make it unsafe to seek on-site refuge. And this event provides even more of a warning time deficit because the floodwater would rise very rapidly.

The Wyong Aged Care Facility is particularly susceptible to inundation. More specifically, access would be cut, and inundation of the property is predicted during each of the design flood events (however, above floor inundation is not anticipated until the 1% AEP event). Access to the aged care facility would be cut before inundation of the property occurs.

2.2.4 Mardi Urban

The 'Mardi urban' sector includes land in Mardi zoned for residential use. Peak 1% AEP floodwater depths, levels and velocities for this area are shown in **Figure A3.26**.

Its flood exposure is relatively modest, with no dwellings anticipated to flood over floor in the 1% AEP event. Access via Woodbury Park Drive to Wyong Road during the 1% AEP flood is subject to negligible disruption by floodwaters from Mardi Creek.

In the PMF, a large number of houses on the eastern side of the suburb would be flooded over floor, though not to depths and velocities expected to threaten dwelling integrity. Access to the suburb would be lost very early in such a flood and would continue for 21 hours at Woodbury Park Drive near Wyong Road.

2.2.5 Tuggerah Straight Industrial

The Tuggerah Straight industrial area contains about 238 industrial buildings, 64 of which are flooded above floor in the 1% AEP event and 210 in the PMF. Peak 1% AEP floodwater depths, levels and velocities for this area are shown in **Figure A3.26**.

In the PMF, 68 buildings are subject to H5 hazard conditions and seven to H6 hazard conditions, which could threaten buildings' structural integrity. Some warning time (up to 6.5





hours) could be available for the evacuation of assets and personnel towards the Pacific Highway in the 1% AEP event, but not in the PMF.

2.2.6 Wyong West of Pacific Highway

The 'Wyong west' sector extends between the Pacific Motorway and the Pacific Highway. It includes houses in the main urban area of Wyong fronting the Wyong River, as well as houses along Alison Road west of Porters Creek bridge. Peak 1% AEP floodwater depths, levels and velocities for this area are provided in **Figure A3.27**.

Relatively few dwellings are flooded over floor in the 1% AEP event. All buildings that are inundated above floor level are located along Alison Road, which can be cut at Porters Creek before a formal flood warning is issued. Provided evacuation commences before flooding, these houses generally have rising road access towards the Pacific Motorway.

The flood height range between the 1% AEP flood level and the PMF level is at a maximum between the Pacific Motorway and Pacific Highway, reaching about 3.75m at some houses along Alison Road west of Porters Creek. As a consequence, the hydraulic hazard in the PMF is high, reaching H5 at 25 dwellings and H6 at 8 dwellings. This degree of hazard could threaten building integrity, making it unsafe for on-site refuge, even if floor space above the PMF were available.

2.2.7 Wyong East of Pacific Highway

The 'Wyong east' sector extends from the Pacific Highway to the eastern end of McDonagh Road. Peak 1% AEP floodwater depths, levels and velocities for this area are provided in **Figure A3.27**.

A large number of dwellings are predicted to be flooded above floor level in the 1% AEP event, but not to depths/velocities expected to threaten the structural integrity of standard buildings, and a short window should be available for people's evacuation.

In the PMF about 400 dwellings are estimated to be flooded above floor level, and H5 hazard conditions would be experienced at about half of these, indicative of the likelihood of structural damage or even failure. In such a fast-rising flood, roads could be cut before a formal flood warning is issued.

2.2.8 Tacoma

Peak 1% AEP floodwater depths, levels and velocities for Tacoma are provided in **Figure A3.28**. Tacoma includes an estimated 78 dwellings subject to above floor flooding in the 1% AEP event. Fortunately, some warning time may be available for evacuation prior to the loss of evacuation routes in this design event.

In the PMF, almost all dwellings on the floodplain would be flooded above floor level, about 18 would be subject to H5 hazard conditions (these are mainly located along Wolseley Avenue west of Hillcrest Avenue) and roads could be cut before a formal flood warning is issued. Once roads are cut, a significant period of isolation is anticipated (1–1½ days from Wyong River



flooding, but potentially longer if affected by flooding from Tuggerah Lake, and with a loss of sewerage service).

2.2.9 South Tacoma

The South Tacoma sector includes 97 dwellings, 53 of which are subject to above floor flooding in the 1% AEP event. Peak 1% AEP floodwater depths, levels and velocities for South Tacoma are provided in **Figure A3.28**.

Evacuation in advance of flooding is difficult because South Tacoma Road is flooded at ~1.2m AHD as it passes under the Pacific Highway and railway bridges. Even though the Bureau provides six hours' warning of minor floods, egress could still be lost 3½ hours before the warning is issued, making early evacuation difficult.

2.2.10 Tuggerah Residential

Peak 1% AEP floodwater depths, levels and velocities for the Tuggerah residential area are shown in **Figure A3.29**.

Relatively few houses are located in Tuggerah, mostly in Lake Road. Only two of these buildings, located at the eastern end of Lake Road, are estimated to be flooded over floor in the 1% AEP event, and in this event, these have a relatively long time before access is cut, which should allow time for evacuation.

In the PMF, 12 houses would be flooded over floor, including four single-storey houses to depths >1.2m that would oblige the residents to evacuate.

2.3 The Cost of Flooding

To assist in quantifying the financial impacts of flooding on the community, a flood damage assessment was completed. The flood damage assessment aimed to quantify the potential flood damage costs incurred to private and public property during a range of design floods across the Wyong River catchment.

The final flood damage estimates for each design flood are summarised in **Table 1** for existing topographic and development conditions. It indicates that if a 1% AEP flood was to occur, over \$80 million worth of damage could be expected. Approximately half of that damage cost would be incurred across residential property.

The damage estimates were also used to prepare an Average Annual Damage (AAD) estimate for each property. The AAD takes into consideration the frequency of a particular event occurring and the damage incurred during that event to estimate the average damage that is likely to occur each year, on average. The AAD for the Wyong River catchment was determined to be **\$4.3 million**. Accordingly, if the "status quo" was maintained, residents and business owners within the catchment as well as infrastructure providers, such as Council, would likely be subject to cumulative flood damage costs of approximately \$4.3 million per annum (on average).

	Flood Damages (\$ millions)							
Flood Event	Residential	Commercial/ Industrial	Infrastructure	Total Damages				
20% AEP	0.62	0.00	0.09	0.71				
10% AEP	2.82	0.44	0.49	3.75				
5% AEP	14.28	5.91	3.03	23.2				
2% AEP	31.8	14.3	6.91	53.0				
1% AEP	48.7	28.6	11.6	88.9				
0.5% AEP	60.5	52.4	16.9	130				
PMF	213	239	67.8	520				

Table 1 Summary of Flood Damage Costs for Existing Conditions

2.4 Summary of Flooding "Trouble Spots"

The information generated as part of the computer flood modelling indicates that the following areas are likely to experience significant property damage, risk to life and/or evacuation difficulties during floods within the Wyong River catchment:

- Yarramalong valley
- Rural residential properties located in the vicinity of Deep Creek including Yarramalong Road, Old Maitland Road, Collies Lane, McPherson Road and Mardi Road.
- The Tuggerah straight industrial area
- Properties in the vicinity of South Tacoma and Tacoma.
- Properties in Wyong adjoining Panonia Road and Boyce Avenue
- The Wyong Aged Care facility

3 OPTIONS FOR MANAGING THE FLOOD RISK

3.1 General

As outlined in Section 2, a number of properties within the Wyong River catchment are predicted to be exposed to a significant flood risk and/or significant financial impacts during floods within the catchment. Accordingly, the following chapter outlines options that were investigated to better manage the existing flood risk across the catchment.

3.2 Potential Options for Managing the Flooding Risk

Options for managing the flood risk can be broadly grouped into one of the following categories:

- Flood Modification Options: are measures that aim to modify existing flood behaviour, thereby, reducing the extent, depth and velocity of floodwater across flood liable areas. Flood modification measures will generally benefit a number of properties and are primarily aimed at reducing the <u>existing</u> flood risk.
- Property Modification Options: refers to modifications to planning controls and/or modifications to individual properties to reduce the potential for inundation in the first instance or improve the resilience of properties should inundation occur. Modifications to individual properties is typically used to manage existing flood risk while planning measures (e.g., land use/development controls) are employed to manage future flood risk.
- Response Modification Options: are measures that can be implemented to change the way in which emergency services as well as the public responds before, during and after a flood. Response modification measures are the key measures employed to manage the continuing flood risk.

The options listed in **Table 2** were ultimately selected for detailed assessment as part of the study.

A summary of the outcomes of the options evaluation are provide in Section 3.3 (flood modification options), Section 3.4 (property modification options) and Section 3.5 (response modification options).

Flood Modification Options	Property Modification Options	Response Modification Options
Mardi Creek Detention Basin	Updates to DCP	Flood Education
Anzac Road Flood Gates	Voluntary flood proofing	Upgrade flood warning system
Mardi Creek floodway	Voluntary house raising	Install flood gates at road overtopping points
South Tacoma relief floodway	Voluntary house purchase of select properties	Local flood plan updates
Lower floodplain maintenance / clearing		Private flood plans for Tuggerah industrial area
Mardi Creek debris control structures		Improve flood access for South Tacoma
Pacific Highway / Pacific Motorway debris control structures		Improve flood access along Yarramalong Road
Tuggerah Lake Entrance dredging		Improve flood access along McPherson Road
Wyong River dredging		
Main northern railway culvert upgrades		
Floodgates on drainage pipes to Wyong River		

Table 2 Flood Risk Management Options Adopted for Detailed Investigation

3.3 Flood Modification Options

3.3.1 Detention Basins

Mardi Creek Detention Basin

Recommendation: Further detailed feasibility assessment recommended.

This option would involve construction of a flood detention basin on Mardi Creek upstream of the Pacific Motorway. A concept design for the basin is shown in **Figure B1**.

It is expected the basin would cost approximately \$440,000 to implement and maintain.

The results of revised flood modelling showed that the detention basin is predicted to reduce existing flood levels and extents along Mardi Creek as well as adjoining floodplain areas during both the 20% AEP and 1% AEP floods. In general, flood level reductions are typically around 0.1 metres in the vicinity of Anzac Road and Ace Crescent.

The outcomes of a revised flood damages assessment estimates that the detention basin would reduce flood damage costs by \$770,000 over the 50-year design life of the basin. This yielded a preliminary benefit-cost ratio of 1.75. Accordingly, the financial benefits of implementing the basin outweigh the costs.

LEGEND

\bigcirc	Gross Pollutant Trap
	Culvert
	Basin Wall
	Spillway
	Detention Basin

Access Roadway

Notes:

Scale 1:8,000 (at A3) 0.25 0.5

Ω

Figure B1: Conceptual Layout for Mardi Creek Detention Basin

diameter from basin Overall, the Mardi Creek detention basin appears to afford some significant benefits. However, further investigations are recommended to confirm the feasibility of this option. This should include a flora/fauna impact assessment and Aboriginal Heritage Assessment.

3.3.2 Levees

Anzac Road Levee and Flood Gates

<u>Recommendation</u>: Recommended for implementation.

The Tuggerah industrial area is predicted to be subject to frequent inundation from Mardi Creek as well as the Wyong River. In particular, Anzac Road is low lying and susceptible to flooding from "backwater" inundation from Mardi Creek. Therefore, Council requested that a levee embankment across a "feeder" channel adjoining Anzac Road be investigated to reduce the potential for floodwaters "backing up" from the Mardi Creek channel and inundating properties located near the McDonalds and Hungry Jack's restaurants. A concept design for the levee is provided in **Figure C1**.

It is expected that the levee and gated culvert would have a total implementation cost about \$150,000.

The results of revised hydraulic modelling with the levee in place showed that inundation would be prevented during the 20% AEP flood. Accordingly, significant benefits are predicted during frequent floods. Flood level reductions of around 0.1 metres are also predicted during the 1% AEP flood

A revised damages assessment was also completed based on the results of the revised flood simulations. This determined that implementation of the levee would reduce flood damage costs by approximately \$60,000 over the projected life of the levee system (i.e., 50 years). This yields a preliminary BCR of 0.37. Therefore, the costs of implementing the option are predicted to outweigh the reductions in flood damage costs. Nevertheless, the relatively low capital and ongoing costs and the financial benefits of businesses being exposed to less frequent inundation may be sufficient financial evidence to support the option.

It is recommended that construction of the levee is pursued.

3.3.3 Channel Modifications

Mardi Creek Relief Floodway

Recommendation: Not recommended for implementation

The Mardi Creek relief floodway would aim to provide an additional flow path starting near the Mardi Creek channel east of the Pacific Highway, through the existing railway embankment and re-joining Mardi Creek east of the railway line. Key features of the floodway are shown in **Figure D1**.

It is expected that the floodway would cost approximately \$560,000 to implement.

Revised hydraulic modelling results show minimal changes in existing flood levels and extents are predicted during the 20% AEP event. Flood level reductions of around are predicted along the western side of the railway line in the 1% AEP flood.

A revised damages assessment was also completed based on the results of the revised simulations. This determined that flood damages could be expected to reduce by \$160,000 over the 50-year design life of the floodway. This provides a preliminary BCR of 0.28, which indicates that the financial gains associated with implementation of the floodway do not outweigh the costs.

Overall, the low financial and hydraulic benefits of the floodway indicate that this option is unlikely to be feasible.

South Tacoma Relief Floodway

<u>Recommendation</u>: Not recommended for implementation.

The South Tacoma floodway would involve regrading of the floodplain to allow a more streamlined transfer of water between the river and Tuggerah via a secondary flow path. The main river would continue to be the primary conveyance area with the floodway only becoming active once the water levels within the river are sufficiently high to overtop South Tacoma Road. Key features of the floodway are shown in **Figure E1**.

It is expected that the floodway would cost about \$2.54 million to implement.

A geotechnical assessment confirmed that acid sulphate soils are located within the proposed floodway footprint at a depth of 0.8 metres. As construction of the floodway will involve excavating up to a 1 metre of soil from the floodplain, the acid sulphate soils will likely be exposed. The potential environmental impacts of the acid sulphate soils are significant, and the costs associated with management of this spoil would be large.

The hydraulic impacts associated with the floodway were quantified by including the floodway channel within the TUFLOW model. This shows that the effectiveness of the floodway is limited during smaller Wyong River floods. This is associated with South Tacoma Road which controls the elevation at which water can "spill" from the river and into the floodway.

However, some significant reductions in flood levels are predicted during the 1% AEP event. This includes reductions in flood levels of around 0.05 metres across large sections of the Wyong River floodplain located east of the Pacific Highway.

Revised flood damage calculations were prepared based on the results of the revised simulations. The damage calculations determined that flood damage costs would be reduced by approximately \$2.49 million over the 50-year design life of the floodway. This provides a

BCR of 0.98 indicating the reductions in flood damage costs are roughly equal to the costs to implement the option. The major financial limitation associated with this option is the relatively high capital cost which may be difficult to fund.

Although the hydraulic and financial benefits of this option are significant, the presence of acid sulphate soils and the associated environmental impacts and cost implications are considered to be prohibitive. Therefore, this option is not considered feasible.

Vegetation Removal across Lower Floodplain

Recommendation: Not recommended for implementation

Several residents noted that many waterways and drainage gullies within the catchment had become significantly overgrown with vegetation. The vegetation can serve to restrict the flow of water, thereby elevating upstream water levels. Parts of the vegetation (e.g., branches) may also be mobilised during floods leading to blockage of downstream culverts/bridges, further inhibiting the drainage of the area. Therefore, the potential benefits associated with removing vegetation/debris from major waterways across the lower Wyong River floodplain were investigated. The extent of the area where vegetation removal was investigated as part of the study is shown in **Figure F1**.

A preliminary cost estimate and this determined that vegetation removal would cost approximately \$1.68 million to implement over 50 years.

Revised hydraulic modelling showed that the vegetation removal will have negligible impact on flood levels across the northern floodplain during major Wyong River floods. Reductions of up to 0.1 metres are predicted along Tuggerah and Mardi Creeks.

Revised flood damage calculations were also prepared to quantify the financial impacts associated with the vegetation clearing. This determined that vegetation clearing would reduce flood damage costs by about \$0.8 million over 50 years. This provides a BCR of 0.47. Therefore, the financial benefits associated with vegetation clearing are lower than the costs to implement and maintain this option.

The primary disadvantage associated with this option is the potential for adverse environmental impacts. Experts would be required to identify and remove only select species which will add to the cost of implementing this option. There may also be adverse water quality impacts (i.e., less vegetation to "filter" nutrients and sediments from runoff) as well as increased potential for erosion. The need to remove and maintain only select species will also add to ongoing maintenance costs once the initial vegetation removal is complete.

Overall, the high capital and ongoing costs and comparatively lower financial benefits mean that vegetation clearing is not supported for implementation.

Mardi Creek Debris Control Structures

Recommendation: Not recommended for implementation.

Several community questionnaire responses noted that flooding across the Tuggerah industrial area is exacerbated when the channels, bridges and culverts become blocked by debris. The installation of debris control structures (e.g., GPTs, trash racks) would aim to collect such debris in less populated areas to ensure the efficiency of the existing drainage infrastructure is maximised and the existing flooding problem is not increased.

Ultimately the location shown in **Figure G1** was selected as the preferred location of the debris control structure. This location is situated downstream of the confluence of Mardi Creek and the culvert from the Westfield Tuggerah site. Therefore, it should be capable of capturing debris from both the upper Mardi Creek catchment and Westfield sites before it reaches Gavenlock Road, the Pacific Highway and the railway line.

The debris control structure is predicted to cost \$60,000 to implement and maintain.

The outcomes of revised flood modelling showed that water levels along Mardi Creek upstream of the structure are predicted to increase by up to 0.5 metres as far upstream as Woodbury Park Road. The structure is also predicted to divert floodwaters into some adjoining properties fronting Green Cl. Accordingly, the hydraulic benefits associated with implementing this option are minimal.

The revised modelling results were used as a basis for undertaking a revised flood damage assessment. This determined that implementation of the debris control structures is predicted to generate negligible changes to existing flood damages. Therefore, the BCR for the debris control structures was determined to be zero. This indicates that there is no obvious financial benefit associated with implementing this option.

Overall, the low BCR, minimal hydraulic benefits and negative emergency response impacts indicate that installation of debris controls structures is not a preferred mitigation option.

Pacific Highway / Pacific Motorway Debris Control Structures

Recommendation: Not recommended for implementation.

Debris controls structures were also investigated at other locations where blockage of bridges/culverts have the potential to significantly impact on upstream properties. In this regard, debris controls structures were investigated upstream of the Wyong River crossings of:

- Pacific Motorway;
- Pacific Highway.

However, implementation of debris control structures at these locations is not recommended for implementation for the following reasons:

- There are a number of flood liable properties and/or vulnerable facilities located upstream of the Pacific Highway (e.g., Wyong Aged Care Facility, Wyong Christian Community School, properties adjoining Collies Lane). In addition, there is a significant natural narrowing of the floodplain in this area which exacerbates the impact of partial blockage of the river. Therefore, the partial obstruction to flow afforded by debris control structures has the potential to adversely impact on existing flood levels across these properties
- Debris control structures would likely obstruct recreation vehicles such as boats reducing the recreational amenity provided by the river
- A review of 'Blockage of Hydraulic Structures (Engineers Australia, 2015)' indicates that there is only a relatively small potential for blockage of the Pacific Highway and Pacific Motorway structures. Therefore, implementation of debris control structures is not likely to provide a significant reduction in existing flood damages leading to low BCR

Tuggerah Lake Entrance Dredging

Recommendation: Not recommended for implementation.

A number of residents and business owners within the catchment suggested that the Tuggerah Lake entrance at The Entrance could be enlarged which would assist in reducing flood levels across the Tuggerah Lake system as well as the lower Wyong River.

A study was commissioned by the NSW State Government in 2015 to quantify the potential impacts of deepening the entrance channel (through dredging and removal of a part section of the underlying rock shelf) (Cardno, 2015). Entrance training walls and four alternate dredging depths were considered as part of the assessment. The assessment determined that:

- The dredged channel would begin to infill with sand almost immediately resulting in costly ongoing works to maintain.
- There would be minimal reductions in lake levels during most runoff events (typically less than 0.1 metre during events less than the 5% AEP flood). These flood level benefits are only likely to benefit those sections of the Wyong River located downstream of Tacoma.

Overall, the study determined that the potential costs associated with dredging and maintaining the Tuggerah Lake entrance would outweigh the benefits. The potential environmental costs associated with dredging are also significant (refer to discussion in the following section of this report). Accordingly, this option was not considered further as part of the current study.

Wyong River Dredging

<u>Recommendation</u>: High costs and adverse environmental impacts will limit the potential for implementation. Not recommended.

Several community members also noted that the Wyong River shallows significantly as it approaches Tuggerah Lake. This shallowing is likely associated with the reduction in flow

velocities along the river as it approaches the lake. Therefore, dredging of the downstream section of the river was investigated as a potential option for improving the flow carrying capacity of the river. The extent of the dredging considered as part of the current study is shown in **Figure H1**.

The potential environmental impacts associated with dredging are significant. The environmental impacts are primarily associated with dredging mobilising sediment (and associated contaminant) which causes turbidity of the water (i.e., reduced water quality) and potentially covers sea-grass (i.e., loss of vegetation and habitat for aquatic life). Any nutrients released during dredging, particularly nitrogen and phosphorus, risk triggering algal blooms which can have adverse impacts on human health.

The up front and ongoing costs of dredging are also likely to be significant. It is expected that dredging would comprise a total implementation cost over 50 years of over \$11 million.

During the 20% AEP flood, the dredging is predicted to generate small reductions in flood levels that are typically contained in close proximity to the river. More extensive water level reductions are predicted during the 1% AEP flood (reductions of between 0.05 and 0.20 metres are predicted across the northern and southern floodplains of the Wyong River downstream of the Pacific Highway).

Revised damage estimates were also prepared based on the revised simulation results and determined that the dredging would potentially reduce flood damage costs by \$5.5 million. This yields a BCR of 0.47. Therefore, although the anticipated damage reductions are significant, the high capital and ongoing costs are likely to outweigh the financial benefits.

The significant capital and ongoing costs coupled with the potential for significant environmental impacts make this option difficult to support.

3.3.4 Drainage Upgrades

Railway Drainage Upgrades

Recommendation: Not recommended for implementation

The main northern railway line serves as a significant impediment to flow from the Mardi Creek and Wyong River catchments. Therefore, opportunities to increase the drainage capacity through the railway line have been investigated on several occasions. The options previously investigated include the installation of additional culverts at selected locations along the railway alignment right through to replacing the railway line with an elevated viaduct across the full width of the floodplain.

In general, the railway culvert upgrades were found not to provide a significant hydraulic benefit, particularly during larger events. The replacement of the railway embankment with a viaduct was also determined to be prohibitively expensive. Therefore, the previous investigations did not consider the railway drainage upgrades to be feasible options.

The provision of railway drainage upgrades was not explicitly considered as part of the current study with the exception of the additional culvert included as part of the Mardi Creek floodway. The Mardi Creek floodway results tend to confirm the outcomes of the previous assessments (i.e., minor hydraulic benefits for comparatively high capital costs).

Local Drainage Studies

<u>Recommendation</u>: Undertake a local drainage study for the northern floodplain of the Wyong River between Wyong and Tacoma.

It was noted that during consultation with the community that a number of residents advised of poor drainage across some floodplain areas. The most prevalent drainage "problem area" reported by the community was the northern floodplain of the Wyong River around McDonagh Road and Kooindah Waters. In general, the residents stated that the poor drainage was mainly associated with a lack of maintenance of the various drainage channels and culverts.

The focus of the current study is assessing mainstream flooding from major rivers and creeks within the Wyong River catchment. Therefore, the modelling tools developed and used as part of the current study are not sufficiently detailed to provide a detailed assessment of local drainage.

Therefore, it is recommended that a separate, detailed drainage study be completed for these local catchments. The drainage study should include the development of a more detailed hydraulic model of the local catchment, including all major drainage infrastructure (e.g., culverts). The model should be capable of quantifying the extent of the existing drainage problem and assessing potential drainage improvement options.

Installation of Flood Gates on Pipes Draining to Wyong River

<u>Recommendation</u>: To be investigated as part of the local drainage study

Council identified the potential to install flood gates on existing pipes that discharge to the Wyong River to prevent "backwater" inundation of low-lying areas during Wyong River floods. Most notably, the area around Marathon Street and Rockleigh Street, Wyong is typically located around 1 mAHD. However, the area is largely protected from inundation from Wyong River floodwaters by a natural levee that is typically located above 2 mAHD. Nevertheless, there is potential for water to "back up" the pipe system and inundate the area behind the natural levee. Accordingly, the installation of floodgates at the downstream end of these pipes should prevent backwater inundation of the area and afford a higher level of flood immunity.

Unfortunately, the broad-scale nature of the flood model that was developed for this study meant that local drainage infrastructure, such as stormwater pipes, was not included. Therefore, the hydraulic benefits afforded by the installation of flood gates cannot be represented in the model. Therefore, it is recommended that analysis of this local drainage

system and the benefits afforded by the installation of flood gates be completed as part of the local drainage study.

3.4 Property Modification Options

3.4.1 Voluntary House Purchase

<u>Recommendation</u>: Voluntary house purchase not considered feasible

Voluntary house purchase (VHP) refers to the voluntary purchase of an existing property on a high-risk area of the floodplain. The purchased property is typically demolished, and the land is retained as open space or an equivalent land use that is more compatible with the flood risk.

A total of eight houses were identified as being potentially eligible for voluntary purchase. The location of each house is shown in **Figure I1**. As shown in **Figure I1**, most of the identified properties are rural residential dwellings located within the Yarramalong Valley.

The total purchase price for the 8 properties is predicted to be about \$6.4 million.

Revised flood damage estimates were also prepared by removing the damage contribution provided by these houses. The revised damage calculations yielded a reduction in flood damages of \$1.8 million, providing a preliminary BCR of 0.28.

The high capital cost and low BCR associated with voluntary purchase indicates that this measure is unlikely to be financially viable.

3.4.2 Voluntary House Raising

<u>Recommendation</u>: voluntary house raising not considered viable. However, discussions could be held with property owner to encourage flood-compatible redevelopment.

Voluntary house raising (VHR) is a well-established method of reducing the frequency, depth and duration of above floor inundation.

One house in South Tacoma was identified as being potentially eligible for raising. The location of this house is shown in **Figure 12**.

It is expected that raising the house would cost in the order \$82,000. However, a review of the identified house indicates that the value of the house itself is likely to be significantly less than the cost to raise the property. Therefore, allocating funds for house raising would likely be overcapitalising. That is, the financial viability of this option is considered to be low.

Nevertheless, the identified property is predicted to be subject to relatively frequent inundation. Therefore, other opportunities to reduce the potential for frequent inundation of

this property are worth pursuing. More specifically, discussions could be held with the property owner to outline the potential high cost of ongoing ownership of the existing property due to flood damages and encourage flood-compatible redevelopment of the existing site.

3.4.3 Voluntary Flood Proofing

Recommendation: Not recommended

For houses within low hazard areas that are subject to regular inundation but are otherwise unsuitable for house raising (e.g., brick, slab-on-ground houses), voluntary flood proofing techniques may be employed to reduce the cost of flooding.

A total of 7 properties were identified as potentially benefiting voluntary flood proofing. The location of the houses is shown in **Figure 13** and includes houses in Tacoma, South Tacoma, Wyong and Alison.

Flood proofing is expected to cost \$58,000 per building. Accordingly, the total cost to flood proof 7 properties is estimated to be \$406,000.

Revised flood damage calculations were prepared to determine the reduction in flood damages costs likely to be afforded by the flood proofing. The revised damage calculations determined that the flood damage costs would be reduced by \$228,000 over 50 years. This provides a BCR of 0.49 indicating the financial costs of implementing this option are greater than the reduction in flood damages.

Overall, there appears to be limited value in flood proofing the identified buildings. Therefore, this option is not recommended for implementation.

3.4.4 Wyong Aged Care Facility Modifications

<u>Recommendation</u>: Council to undertake discussions with Riviera Health to determine the potential for including an elevated flood refuge as part of any future development of the aged care facility

The Wyong Aged Care Facility requires special consideration as part of this study as it can be isolated during relatively frequent floods and is home to vulnerable residents.

It is understood that Riviera Health do have plans to expand the facility. Although intensification of development across this facility is not considered desirable, it may present an opportunity to incorporate an elevated on-site flood refuge. This will ideally provide a structurally sound on-site refuge for residents above the peak level of the PMF that could be utilised if early evacuation is not achievable/viable.

It is recommended that Council undertake discussions with Riviera Health if/when expansion of the facility is proposed to determine the feasibility of including an elevated flood refuge. However, evacuation is the preferred mitigation measure to employ for any property. The

provision of a refuge would only serve as a backup plan in the event that evacuation cannot be completed.

3.4.5 Planning Revisions

Recommendations:

- 1) Consider amending Wyong DCP taking into account the detailed review presented in Section 4.2.2 of the floodplain risk management study report.
- 2) Council to seek clarification from Department of Planning and Environment as to whether 'exceptional circumstances' are required to promote safer onsite refuge above the level of the PMF in dwellings located on land within the Flood Planning Area
- 3) Council to consider applying for exceptional circumstances to better ensure risk to life is managed satisfactorily in those parts of the floodplain located between the Flood Planning Area and the PMF extent

A detailed review of the floodplain management chapter of Wyong DCP 2013 was completed as part of the study. It is recommended that Council consider the review when next amending the DCP. Among the suggested changes are:

- Consider emerging best practice for mapping Flood Planning Constraint Categories;
- Indicate in the prescriptive criteria matrix where development is *unsuitable*;
- Review and update the climate-change related provisions;
- Require houses in Precinct 2 to provide safe access/egress (or an on-site refuge above the PMF, where appropriate); and,
- Prepare different flood risk matrices for different styles of flooding within the LGA (e.g., flash flooding versus riverine versus coastal inundation).

It is also recommended that Council consider strengthening its planning and development controls to proscribe residential development in Flood Risk Precinct 4, and to ensure that any future houses in the floodplain provide for safe evacuation to higher ground or on-site refuge above the PMF (this may require an application for the granting of 'exceptional circumstances' from the Department of Planning and Environment).

3.5 **Response Modification Options**

3.5.1 Local Flood Plan Updates

<u>Recommendations</u>: Update Wyong Local Flood Plan to align with new SES LFP template and to incorporate new flood intelligence (NSW SES)

Wyong Shire Local Flood Plan was reviewed in Section 5.1 of the Floodplain Risk Management Study. The review determined that the Plan needs to be updated to align the structure and contents with the new NSW SES Local Flood Plan template, and to incorporate flood intelligence from recent flood studies, floodplain risk management studies, and actual floods. Among the flood intelligence available from the current study is:

- Design flood extents, depths, velocities, hazard and warning times;
- Predicted building inundation in design floods up to PMF;
- Predicted road inundation in design floods up to PMF; and
- Evacuation constraints in design floods up to PMF.

3.5.2 Flood Intelligence Card Updates

Recommendations:

1) Update Wyong Bridge Flood Intelligence Card to align with new flood modelling and Pacific Highway Bridge upgrade (NSW SES)

2) Prepare new flood intelligence cards for any river level gauges proposed to be used

as triggers for communities/users (e.g. Yarramalong gauge) (NSW SES)

The Wyong Bridge Flood Intelligence Card needs to be updated to incorporate outputs from the latest design flood modelling.

If other river level recorders will be used as triggers for various communities such as Yarramalong village, it is also recommended that simple flood intelligence cards be prepared for these using historical and design flood information.

3.5.3 Community Education

SES Community Education Strategy

<u>Recommendations</u>: Audit the degree to which the *Flood & Coastal Storms Education Strategy* (2011) has been implemented and the relative success of these strategies (NSW SES)

The SES developed a *Flood & Coastal Storms Education Strategy* (2011) that aims to build community resilience by improving the capacity of the Central Coast community to better prepare, respond and recover from major floods. The document aims to achieve this by developing an effective community education strategy.

A review of the *Flood & Coastal Storms Education Strategy* was completed as part of the current study. It describes different styles of flooding on the Central Coast, eight objectives, three target groups and stakeholders. Key messages are described to achieve each objective. These include, 'Never enter floodwaters', 'Have a home or business FloodSafe plan', 'Know your evacuation route' and 'Do not rely on being rescued'. Various activities are listed and prioritised to convey the messages, including signage, a Business Breakfast, website, newspaper features, radio spots, a FloodSafe brochure, school newsletters, displays, SES days and street barbeques. How many of these activities have been conducted, and the degree to which they have succeeded in changing attitudes and behaviours such that people are more resilient, is not known, suggesting the need for an audit.

Education Messages

<u>Recommendations</u>: Develop educational messages targeting dangerous behaviours (NSW SES)

From the flood risk assessments, community consultation and discussions with stakeholders, a number of key messages emerge for people in the study area:

- 'Never drive, ride, walk or play in floodwaters'. The need to continue broadcasting this message is suggested by the knowledge that motorists in NSW continue to lose their lives when attempting to cross floodwaters, and by the number of roads in the study area that are frequently flooded, especially between Wyong and Yarramalong. Messages could also provide technical information to dissuade drivers from crossing flooded roads, such as the depths at which cars float. Messages could also target the motivations for crossing floodwater, pointing out that it's better to arrive home late than not at all.
- One day a bigger, faster flood will happen than what anyone has ever seen. Council has modelled what these floods might be like. Learn whether your house/business could be flooded in an extreme flood. Identify whether it's safe for you to stay or whether you need to evacuate before flooding. Plan ahead to keep your family/staff safe'. A message such as this is important because of the high proportion of respondents to the community questionnaire who indicated they would remain at home rather than evacuate. While such a response might have worked for the relatively small historical floods people have observed, it could lead to disaster in an extreme flood.

Property Level Flood Information

Recommendations:

1) Make available additional flood hazard information at a property scale, including flood depths, hazards and emergency response classifications, with suitable explanations and guidance as to how this information can be used to inform flood emergency plans (Council; NSW SES)

2) Consider undertaking a pilot project involving the distribution of property level flood information to a small section of the catchment (Council)

A starting point for improving people's readiness for floods is to help them better understand how they could be directly affected by floods. Knowing how their house or business could be directly affected by floods is more likely to cut through the scepticism that can grow when communities are not flooded for some years, than more generic advice.

Council already makes Flood Precinct mapping extents available via the Wyong Council Online Mapping System. Therefore, the existing information provided on Council's online mapping page could be expanded to convey additional flood hazard information including design flood depths, hydraulic hazard, information describing when and where access to individual properties will be cut as well as special risk factors such as the location of "low flood islands". But additional resources would be required to explain what this information means and how it could be used to assist in the preparation of property level flood response plans.

If Council's existing mapping website cannot accommodate this information, it could be included in a separate flood information portal website. However, as reported by one community member, there is some uncertainty within the community about where to source flood information (including flood warnings). Therefore, it is considered desirable to avoid distributing flood information across multiple sites to help ensure this uncertainty is avoided (i.e., hold all flood information on a single website).

The high level of detail available from the Emergency Response Planning Classification tool also makes it possible to prepare customised flood information flyers, fridge magnets etc for individual properties. These flyers/magnets can be printed by specialist printers using mail merge techniques to provide property level information for all potentially flood liable properties. Alternatively, the flyers/magnets can be generated via a website and individual property owners can print their own. Information that could be potentially included on a customised flyer/magnet may include:

- A river gauge diagram (for the closest river gauge) showing the peaks of past floods and information on the gauge level typically coinciding with any cut of the evacuation route for the property.
- The closest evacuation centre, approximate driving distance and even the best route. This could even be presented as a map.
- Identification of any special risk factors such as being in an area that may get surrounded by floodwaters or an area at risk of flash flooding.

Council may be interested in undertaking a pilot project across a small section of the catchment (e.g., Yarramalong village) to determine the effectiveness of providing this type of property level flood information. It is suggested that the pilot project employ multiple communication techniques (e.g., letters, fridge magnets, online portal) and include a brief survey to seek feedback on which option(s) the community sees as being most beneficial. If feedback from this pilot project is positive, opportunities to extend the project to include all potentially flood liable properties or, as a minimum, high risk properties, could be explored.

Flood Information Portal

<u>Recommendations</u>: Undertake a flood information portal pilot study to develop basic web site. Functionality could be expanded as funding becomes available (Council)

As discussed, the development of a flood information portal is likely to be an effective means of emergency response planning by facilitating the wide spread distribution of flooding information to emergency services as well as the public. This could be facilitated by expanding Council's existing online mapping site or through the development of a separate website dedicated specifically to flooding across the Wyong River catchment or, alternatively, the Central Coast LGA.

A flood information portal would aim to provide the following:

- Information that will allow property owners to understand their existing flood risk which can "feed" into the preparation of a flood plan.
- Real time flood information that can be accessed during floods (e.g., flood warnings, current & projected water levels at gauges).

It is recommended that Council undertake a flood information portal pilot study to develop basic web site. Functionality could be expanded as funding becomes available.

3.5.4 Emergency Response Plans

Flood Plans for Major Facilities

<u>Recommendations</u>: Assist the following facilities to prepare or update their own flood emergency response plans incorporating new flood intelligence (NSW SES, Council):

- 1) Wyong Aged Care Facility, McPherson Road, Mardi;
- 2) Wyong Christian Community School, Alison Road, Wyong;
- 3) C3 Church, Gavenlock Road, Tuggerah;
- 4) Meander Village, Boyce Avenue, Wyong.

There would be benefit in NSW SES and Council encouraging and helping key floodplain exposures to prepare or update their own flood emergency response plans, taking advantage of the superior flood behaviour information generated from the current study. Among the higher priorities for flood plans are:

- Wyong Aged Care Facility, McPherson Road, Mardi;
- Wyong Christian Community School, Alison Road, Wyong;
- C3 Church, Gavenlock Road, Tuggerah;
- Meander Village, Boyce Avenue, Wyong.

Home Flood Plan Preparation / Updates

<u>Recommendations</u>: Host meetings in various communities to promote the preparation of Home Emergency Plans (NSW SES; Council)

It is unlikely that many private dwellings within the floodplain have formal flood emergency response plans. This requires innovative approaches to persuade residents to plan ahead for floods. It is considered that the most effective method, albeit a labour-intensive method, will be via direct outreach from the NSW SES to particular communities and residents. The SES could, with Council's assistance, host flood planning mornings or evenings in various communities, including in Yarramalong village, Wyong Creek, Wyong (western side), Wyong (eastern side), Tacoma, Mardi (rural), Mardi (urban) and South Tacoma. Council could staff the meetings with laptops enabling the inspection of flood risks at property scales (booking times might be required to ensure adequate resources are made available), and SES personnel could then help homeowners translate that information into effective home emergency plans.

Prior to these public information sessions, there would need to be an acceptance from official stakeholders that on-site refuge may be acceptable and even preferred at some sites (and is generally preferred by residents, especially those caring for animals), rather than a general insistence upon evacuation.

Business Flood Plan Preparation / Updates

<u>Recommendations</u>: Conduct an audit and host a Business FloodSafe Breakfast to promote the preparation of Business FloodSafe Plans (NSW SES; Council)

Businesses across flood liable sections of the catchment would also benefit from flood plans. The plans set out protocols to follow by the business before, during and after a flood to help mitigate damages and the potential for risk to life at the property level. The preparation and implementation of such plans is an important risk management option across particularly flood liable sections of the catchment (e.g., Tuggerah industrial area).

Although flood plans may have already been prepared for some businesses, they need to be reviewed and updated regularly to ensure all staff remain fully aware of the requirements of the plan and to ensure the plan takes advantage of the latest available information. As for private flood plans, Council should be able to provide significant information describing the flood risk at the property scale based on the outputs from this study including the potential frequency and depth of inundation as well which roadways will be cut and the likely duration of any isolation.

In the first instance, an audit could be conducted to confirm if each business across the Tuggerah industrial area has developed a business flood plan. There may be opportunities for the Wyong Regional Chamber of Commerce to assist in this regard. The SES has developed a Business FloodSafe Toolkit to assist with the preparation of Business FloodSafe plans. These can be completed either online or as a hardcopy (see http://www.floodsafe.com.au/what-floodsafe.com.au/what-floodsafe-means-for-you/business).

Following the audit, an SES Business Breakfast could be hosted to promote the development or updating of Business FloodSafe Plans, with sufficient Council and SES staff present to help guide business owners through the process. A follow up audit/breakfast could then be completed at a later date (say, 6 months later) to ensure that the FloodSafe plans have been developed/updated.

Council could also consider regulation to promote the development of a business flood plans when businesses change ownership / use.

3.5.5 Options to Improve Emergency Response During a Flood

Flood Warning System

Recommendations:

1) Make real-time information more readily accessible (e.g. through a flood portal) (Council)

2) Help floodplain residents interpret real-time information by providing design flood heights for gauges as well as design flood depths at their properties (Council & SES)

3) Pre-prepare flood bulletin messages for distinct communities (SES)

4) Establish river level triggers for various gauges that issue phone messages or SMS directly to subscribers (SES)

5) Improve mobile phone coverage in Yarramalong and Dooralong Valleys (Telstra)

6) Confirm reviews of the system are completed following each flood (BoM)

The purpose of a flood warning is to provide advice on impending flooding so people can take action to minimise its negative impacts. The Wyong River is serviced by a flood warning system. As indicated in the NSW State Flood Sub Plan, the Bureau of Meteorology issues height-time predictions for the Wyong River at Wyong Bridge as well as for Tuggerah Lake.

The opportunity to enhance the flood warning system was considered based upon the Bureau of Meteorology's Flash Flood Advisory Resource (FLARE). This review determined several opportunities for improving the existing flood warning system. This included:

- Make real-time information more readily accessible (e.g. through a flood portal).
- Help floodplain residents interpret real-time information by providing design flood heights for gauges as well as design flood depths at their properties.
- Pre-prepare flood bulletin messages for distinct communities.
- Establish river level triggers for various gauges that issue phone messages or SMS directly to subscribers
- Improve mobile phone coverage in Yarramalong and Dooralong Valleys
- Confirm reviews of the system are completed following each flood

Upgrade of Existing Evacuation Routes

General Recommendations:

1) Install flood gates at a selection of critical location on a trial basis. If trial is deemed successful, look to install flood gates across remaining critical locations (Council)

2) Council to discuss opportunities to open fire trails with the Forestry Corporation of NSW to provide access to upper catchment areas during times of flood. Assuming discussions are fruitful, undertake an audit of fire trails and develop a plan to remediate and maintain trails for future use

Several options were investigated for upgrading existing evacuation routes across the catchment. The improvements would aim to provide less frequent inundation, lower inundation depths and additional time for evacuation. Options considered as part of the study included:

- Installation of Gates on Flood Liable Roadways;
- Installation of Flood Depth Indicators;
- Road Raising in Yarramalong and Dooralong Valleys;
- Open and Maintain Rural Fire Trails.

The following options were considered to afford evacuation benefits and are recommended for implementation:

- Installation of Gates on Flood Liable Roadways;
- Open and Maintain Rural Fire Trails.

In addition, a detailed assessment of potential evacuation route options was completed for South Tacoma. This review identified the potential to provide an alternate evacuation route through the Pioneer Dairy site. However, at the current time it is not suitable for use as a flood evacuation route because it is unsealed and the load capacity of bridges along the route is not known. In additional, the sensitive environment in the area could also restrict the extent of any evacuation upgrade works. Therefore, the following recommendations are made regarding the alternate evacuation route to confirm its feasibility:

Recommendations:

1) Investigate the feasibility of upgrading the flood evacuation route track between South Tacoma and Lake Road through Pioneer Dairy to provide wetweather access with due regard given to environmental conservation of the area

2) Assess relative level, utility, safety and load capacity of existing bridge crossing over Tuggerah Creek near Pioneer Dairy

3) Formalise permissions for evacuation traffic and emergency services' vehicles to use the route during flood emergencies

4) Ensure that the proposed development of the Tuggerah Regional Sporting and Recreation Complex preserves a capacity for evacuation traffic from South Tacoma to pass through the site from its northern boundary (aligned with the existing track) to Lake Road

5) Ensure that any future development of the Pioneer Dairy property preserves a capacity for evacuation traffic from South Tacoma to pass through the site from South Tacoma Road to the proposed Tuggerah Regional Sporting and Recreation Complex. This may take the form of an easement or restriction on use over the land.

3.6 Options to Aid in Post-Flood Recovery

3.6.1 Recovery Planning

<u>Recommendation</u>: SES look to update Local Flood Plan to reflect additional flood recovery responsibilities for various agencies

The Wyong Shire Local Flood Plan (LFP) sets out the responsibilities of various agencies in post-flood recovery.

It is suggested that additional, specific items could be included in the LFP to further assist emergency services and the community to expedite post-flood recovery, including:

- Council to ensure vital facilities such as water and sewer are restored/operational
- Council to aid in removing waste and debris as part of clean-up activities
- Appropriate agencies to ensure vital utilities such as power and gas are restored/operational
- Appropriate agencies to offer welfare assistance and counselling services
- Various agencies to record post-flood information to assist in future updates/calibration of flood models and flood studies.

3.6.2 Flood Insurance

Recommendations:

- 1) Individual property owners should consider flood insurance.
- 2) Council to assist property owners by providing property specific flood information.

Flood insurance is now available for residential, commercial and industrial buildings as part of most home and contents insurance policies. Flood insurance can also be taken out on public infrastructure and buildings.

Although flood insurance does not reduce the potential for flood damage nor reduce the residual flood risk, it can help in post-flood recovery by providing financial assistance to offset flood damage costs.

Therefore, buildings with a high likelihood of flooding and/or high flood damage potential will face higher insurance premiums. The cost of insurance must be borne by the building owners. Therefore, those properties that are at higher risk of flooding and would arguably benefit the most from flood insurance will face the highest premiums. In such instances, property owners may not be able to afford such premiums.

Nevertheless, flood insurance should be considered by property owners in high risk areas, where a single large flood may result in an unaffordable loss. Council could assist property owners as part of this process by providing property level flood information, so property owners can understand their flood risk and the potential financial implications of a significant flood. Based on this, the property owners can make an informed decision on the need to

acquire flood insurance. Assuming flood insurance is desired by the property owners, the property level flood information can also be used to assist in negotiating premiums with insurance companies.

3.6.3 Disaster Relief

Recommendation: No actions necessary

Disaster relief provides financial assistance following the declaration of a natural disaster. A disaster declaration is initiated by the State Government and, depending on the nature and extent of the disaster, may be supplemented by the Federal Government (subject to a natural disaster declaration by the attorney-General's Department).

Local government areas that are declared natural disaster zones are eligible for the Natural Disaster Assistance Scheme, including:

- Disaster assistance for Individuals
- Primary producers (loans & transport subsidies)
- Small businesses
- Assistance for Councils
- Trustees of parks and reserves
- Sporting clubs
- Churches and voluntary non-profit organisations

However, such disaster assistance may not be available to all individuals or organisations. For example, relief grants for individuals will typically only be available for those with limited financial resources and no insurance. Furthermore, funding may only partly offset the total damage costs.

Therefore, disaster relief may only provide financial support for some individuals and groups during large floods that are declared a natural disaster. Like flood insurance, disaster relief funding does not reduce the potential for flood damage or the residual flood risk.

4 DRAFT FLOODPLAIN RISK MANAGEMENT PLAN

4.1 Introduction

The draft Floodplain Risk Management Plan sets out a preferred set of options that can be implemented in the short, medium and long term to manage the flood risk across the Wyong River catchment. It also outlines responsibilities for the implementation of each option along with cost estimates and funding opportunities.

4.2 Recommended Options

The options that are recommended for implementation as part of the draft Wyong River Catchment Floodplain Risk Management Plan are summarised in **Table 3** and are also shown in **Figure K1**. The options have been selected from a range of potential flood modification, property modification and response modifications measures based upon their impact on flood hydraulics and existing properties, capital and ongoing costs as well as any potential social and environmental impacts.

4.3 Plan Implementation

4.3.1 Costs and Funding

The total capital cost to implement the Plan is expected to be about \$1.2 million. The most significant costs are associated with implementation of automatic flood gates (~\$800,000 capital cost plus ongoing maintenance costs) and the Mardi Creek detention basin (~\$290,000 capital cost plus ongoing maintenance costs).

In addition to the capital costs, some options will incur ongoing maintenance costs. As noted in **Table 3**, many of the options will require an investment in time from various agencies including Central Coast Council, the State Emergency Service and the Bureau of Meteorology in addition to monetary contributions.

Funding for implementation of the plan could be obtained from the following sources:

- Central Coast Council's capital and operating budgets
- NSW State Government's Floodplain Management Grants (through OEH)
- Section 94 contributions
- Commonwealth Government's Natural Disaster Resilience Program
- Volunteer labour from community groups

It is expected that most options will be eligible for funding through the NSW State Government's Floodplain Management Grants on a 2:1 basis (State Government : Council). This can include additional investigations, design activities as well as construction. However, funding under this program cannot be guaranteed as funding must be distributed to competing projects across the state. Furthermore, the NSW Government's Floodplain Management Grants are primarily available to manage risk to residential properties and are generally not awarded to manage the flood risk to commercial and industrial properties. It should also be noted that ongoing costs will generally be the responsibility of Council.

4.3.2 Review of Plan

It is important that the Floodplain Risk Management Plan is continually reviewed and updated over time to ensure that it evolves with the catchment and takes advantage of any improvements in flood knowledge, such as new flood studies, historic floods or information on climate change.

As noted in **Table 3**, most options are scheduled for implementation within a 5-year time frame. Therefore, as a minimum, it is recommended that the Plan be revisited after 5 years.

Draft Wyong River Catchment Floodplain Risk Management Plan Table 3

 FM
 Flood modification option
 PM
 Property modification option

RM Response modification option

Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
Mardi Creek Detention Basin	FM1	Council	\$380k	\$60k	Medium	4 years	
Anzac Road Levee	FM2	Council	\$120k	\$30k	Medium	2 years	
Local Drainage Study for northern floodplain of the lower Wyong River	FM3	Council	\$50k	\$0k	High	2 years	Wyong River flood gate investigation could be included as part of this study
Look at opportunities for incorporating PMF refuge at Wyong Aged Care Facility	PM1	Riviera Health & Council	Not determined as part of study		Medium	<5 years	Dependent on Riviera Health's development plans
Clarify the need for Exceptional Circumstances to promote safer on-site refuge for dwellings located on land below the FPL	PM2	Council	Council time	\$0k	High	1 year	
Consider applying for Exceptional Circumstances	PM3	Council	Council time	\$0k	High	1 year	
DCP Amendments	PM4	Council	Council time	\$0k	High	1 year	
Wyong Local Flood Plan Updates	RM1	SES	SES time	\$0k	High	1 year	

		Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
Floo	d Intellig	ence Card Updates	RM2	SES	SES time	\$0k	High	1 year	
pdates		Wyong Aged Care Facility	RM3	Riviera Health & Council	Council & Riviera Health time	Minimal			
	ain exposures	Wyong Christian Community School	RM4	Wyong Christian Community School & Council	Council & Wyong Christian Community School time	Minimal	High	High	<2 vears
paration / L	Key floodpl	C3 Church	RM5	C3 Church & Council	Council & C3 Church time	Minimal	Ŭ	,	
-lood Plan Prep		Meander Village	RM6	Meander Village & Council	Council & Meander Village time	Minimal			
	Host m promo Emerge	eetings in various communities to te the preparation of Home ency Plans	RM7	Council	Council time + venue hire (\$3k assuming 3 meetings completed)	~\$3k every 5 years	Medium	<2 years	Should be repeated periodically (e.g., every 5 years) to cater

	Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
	Conduct an audit and host a Business FloodSafe Breakfast	RM8	Council, SES & Chamber of Commerce	Council, SES and Chamber of Commerce time + venue hire (\$1k)	~\$1k every 5 years	High	1 year	for potential turnovers.
Flood warning system upgrades	Make real-time information more readily accessible	RM9	Council & BoM	Council & BoM time	Minimal	Medium	3 years	Could be augmented as part of flood portal project
	Help floodplain residents interpret real-time information	RM10	Council	Council time	Minimal	Medium	2 years	Can be incorporated into other community education components
	Pre-prepare flood bulletin messages for distinct communities	RM11	SES	SES time	Minimal	Medium	2 years	
	Establish river level triggers for various gauges that issue phone messages or SMS directly to subscribers	RM12	SES	SES time	\$0	High	3 year	

	Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
	RM1 Improve mobile phone coverage in Yarramalong and Dooralong Valleys		Telstra	Not determined a	s part of study.	High	2 years	Currently on Telstra's work plan for implementation by 2018
	Confirm reviews of the system are completed following each flood	RM14	BoM & SES	Variable	Variable	Medium	Ongoing	Costs will vary depending on the frequency of floods
nmunity Education	Audit Flood & Coastal Storms Education Strategy	RM15	SES	SES time	Minimal	Medium	1 year	Costs are dependent on the outcomes of the audit
	Develop educational messages targeting dangerous behaviours	RM16	SES	SES time	Minimal	Medium	1 year	
Cor	Undertake a flood information portal website pilot study	RM17	Council	\$30k	\$2k pa for hosting, maintenance	Medium	1 year + ongoing updates	Property level flood information and flood

	Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
					and ongoing upgrades			portal pilot study could be completed
	Make property level flood information available	RM18	Council	\$10k for pilot project. \$15k for balance of catchment	\$5k every 5 years for mail outs	Medium	1 year + ongoing updates	together
	Continue to develop social media platforms for flood safe messaging	RM19	SES	SES time	Minimal	High	2 years	
valuation	Upgrade the flood evacuation route track between South Tacoma and Lake Road through Pioneer Dairy to provide wet- weather access	RM20	Council	~\$150k	Minimal	Medium	5 years	Total cost of the Pioneer dairy flood
acuation e	Assess relative level, safety and load capacity of existing bridge crossing over Tuggerah Creek near Pioneer Dairy	RM21	Council	\$20k	\$0K	Medium	2 years	evacuation evaluation and upgrade will be dependent on the outcomes of the review of the existing bridge capacity. Any bridge upgrades may increase the
Pioneer dairy flood eva	Formalise permissions for evacuation traffic and emergency services' vehicles to use the route during flood emergencies	RM22	Council	Minimal	\$0К	High	2 years	
	Ensure that the proposed Tuggerah Regional Sporting and Recreation Complex preserves a capacity for evacuation traffic from South Tacoma to pass through the site from its northern boundary to Lake Road	RM23	Council	Minimal	\$0K	High	<1 year	

	Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments
	Ensure that any future development of the Pioneer Dairy property preserves a capacity for evacuation traffic from South Tacoma to pass through the site from South Tacoma Road to Lake Road.	RM24	Council & Developers	Minimal	Minimal	Medium	unknown	cost considerably. This option is also highly dependent on discussions with land owners for access.
Install flood gates RM25		RM25	Council	\$100k for pilot project. \$700k for balance of catchment	Variable maintenance costs depending on number of gates installed	Low	2 years for pilot project 10 years for full catchment	
Open fire trails for access to upper catchment during times of flood		RM26	Council & Forestry Corporation of NSW	Not determined a	s part of study.	Low	5 years	Total cost to upgrade and maintain fire trials is dependent on the current state of the trails. Therefore, an audit of the trials should be

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Option		Implementation Responsibility	Capital Cost	Ongoing Cost	Priority	Timing	Comments	
								completed and will confirm the implementation cost of this option
Flood Insurance	Individual property owners should consider flood insurance	RM27	Property owners	Varies depending questi	on property in ion	Low	< 2 years	Individual property owners should consider flood insurance
	Council to assist property owners by providing property specific flood information	RM28	Council	Council time	Council time	Low	As required	

5 GLOSSARY

acid sulphate soils	are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
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. Eg, if a peak flood discharge of 500 m ³ /s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m ³ /s or larger event occurring in any one year (see ARI).
Australian Height Datum (AHD)	a common national surface level datum approximately corresponding to mean sea level.
average annual damage (AAD)	depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
average recurrence interval (ARI)	the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
caravan and moveable home parks	caravans and moveable dwellings are being increasingly used for long- term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the Local Governments Act.
catchment	the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	the council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the council, however legislation or an EPI may specify
	a Minister or public authority (other than a council), or the Director General of OEH, as having the function to determine an application.

development	is defined in Part 4 of the Environmental Planning and Assessment Act (<i>EP&A Act</i>).
	infill development: refers to development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development.
	<u>new development</u> : refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.
	<u>redevelopment:</u> refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	a step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s) . Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s) .
ESD	Ecologically Sustainable Development (ESD) using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act, 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.

flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	the remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	is synonymous with flood prone land, i.e., land susceptible to flooding by the PMF event. Note that the term flood liable land covers the whole floodplain, not just that part below the FPL (see flood planning area).
flood mitigation standard	the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	a management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, division and local levels. Local flood plans are prepared under the leadership of the SES.
flood planning area	the area of land below the FPL and thus subject to flood related development controls.
flood planning levels (FPLs)	are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for

	floodplain risk management purposes, as determined in management studies and incorporated in management plans.
flood proofing	a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
flood readiness	Readiness is an ability to react within the effective warning time.
flood risk	potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below.
	existing flood risk: the risk a community is exposed to as a result of its location on the floodplain.
	<u>future flood risk</u> : the risk a community may be exposed to as a result of new development on the floodplain.
	<u>continuing flood risk</u> : the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	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.
freeboard	provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL 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.

hazard	a source of potential harm or a situation with a potential to cause loss. In relation to this study the hazard is flooding which has the potential to cause damage to the community.	
	Definitions of high and low hazard categories are provided in Appendix L of the <i>Floodplain Development Manual</i> (2005).	
historical flood	a flood which has actually occurred.	
hydraulics	term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.	
hydrograph	a graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.	
hydrology	term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.	
local overland flooding	inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.	
local drainage	smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.	
mainstream flooding	inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.	
major drainage	councils have discretion in determining whether urban drainage problems are associated with major or local drainage. Major drainage involves:	
	 the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or 	
	 water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or 	
	 major overland flowpaths through developed areas outside of defined drainage reserves; and/or 	
	 the potential to affect a number of buildings along the major flow path. 	
mathematical / computer models	the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.	

merit approach	the merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
	The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local flood risk management policy and EPIs.
minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood.
	minor flooding: Causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.
	<u>moderate flooding</u> : Low lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.
	major flooding: Appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	measures that modify either the flood, the property or the response to flooding.
peak discharge	the maximum discharge occurring during a flood event.
probable maximum flood (PMF)	the PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. 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. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
probable maximum precipitation (PMP)	the PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.

probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).
risk	chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	the amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to water level (both measured with reference to a specified datum).
stage hydrograph	a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	a plan prepared by a registered surveyor.
TUFLOW	is a 1-dimensional and 2-dimensional flood simulation software. It simulates the complex movement of floodwaters across a particular area of interest using mathematical approximations to derive information on floodwater depths, velocities and levels.
velocity	the speed or rate of motion (<i>distance per unit of time, e.g., metres per second</i>) in a specific direction at which the flood waters are moving.
water surface profile	a graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	the horizontal distance in the direction of wind over which wind waves are generated.
XP-RAFTS	is a non-linear runoff routing software. It incorporates subcatchment information such as area, slope, roughness and percentage impervious and is used to simulate the transformation of historic or design rainfall into runoff (i.e., discharge hydrographs).

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