

Notice of Meeting

Extraordinary Floodplain Management Advisory Committee Meeting

An Extraordinary Floodplain Management Advisory Committee Meeting of Byron Shire Council will be held as follows:

Venue	Conference Room, Station Street, Mullumbimby
Date	Friday, 12 July 2024
Time	10:00 AM

Phil Holloway
Director Infrastructure Services

*I2024/1016
Distributed 05/07/24*



**BYRON
SHIRE
COUNCIL**

CONFLICT OF INTERESTS

What is a “Conflict of Interests” - A conflict of interests can be of two types:

Pecuniary - an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person or another person with whom the person is associated.

Non-pecuniary – a private or personal interest that a Council official has that does not amount to a pecuniary interest as defined in the Code of Conduct for Councillors (eg. A friendship, membership of an association, society or trade union or involvement or interest in an activity and may include an interest of a financial nature).

Remoteness – a person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to a matter or if the interest is of a kind specified in the Code of Conduct for Councillors.

Who has a Pecuniary Interest? - a person has a pecuniary interest in a matter if the pecuniary interest is the interest of the person, or another person with whom the person is associated (see below).

Relatives, Partners - a person is taken to have a pecuniary interest in a matter if:

- The person’s spouse or de facto partner or a relative of the person has a pecuniary interest in the matter, or
- The person, or a nominee, partners or employer of the person, is a member of a company or other body that has a pecuniary interest in the matter.

N.B. “Relative”, in relation to a person means any of the following:

- (a) the parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descends or adopted child of the person or of the person’s spouse;
- (b) the spouse or de facto partners of the person or of a person referred to in paragraph (a)

No Interest in the Matter - however, a person is not taken to have a pecuniary interest in a matter:

- If the person is unaware of the relevant pecuniary interest of the spouse, de facto partner, relative or company or other body, or
- Just because the person is a member of, or is employed by, the Council.
- Just because the person is a member of, or a delegate of the Council to, a company or other body that has a pecuniary interest in the matter provided that the person has no beneficial interest in any shares of the company or body.

Disclosure and participation in meetings

- A Councillor or a member of a Council Committee who has a pecuniary interest in any matter with which the Council is concerned and who is present at a meeting of the Council or Committee at which the matter is being considered must disclose the nature of the interest to the meeting as soon as practicable.
- The Councillor or member must not be present at, or in sight of, the meeting of the Council or Committee:
 - (a) at any time during which the matter is being considered or discussed by the Council or Committee, or

- (b) at any time during which the Council or Committee is voting on any question in relation to the matter.

No Knowledge - a person does not breach this Clause if the person did not know and could not reasonably be expected to have known that the matter under consideration at the meeting was a matter in which he or she had a pecuniary interest.

Non-pecuniary Interests - Must be disclosed in meetings.

There are a broad range of options available for managing conflicts & the option chosen will depend on an assessment of the circumstances of the matter, the nature of the interest and the significance of the issue being dealt with. Non-pecuniary conflicts of interests must be dealt with in at least one of the following ways:

- It may be appropriate that no action be taken where the potential for conflict is minimal. However, Councillors should consider providing an explanation of why they consider a conflict does not exist.
- Limit involvement if practical (eg. Participate in discussion but not in decision making or vice-versa). Care needs to be taken when exercising this option.
- Remove the source of the conflict (eg. Relinquishing or divesting the personal interest that creates the conflict)
- Have no involvement by absenting yourself from and not taking part in any debate or voting on the issue as of the provisions in the Code of Conduct (particularly if you have a significant non-pecuniary interest)

Committee members are reminded that they should declare and manage all conflicts of interest in respect of any matter on this Agenda, in accordance with the [Code of Conduct](#).

RECORDING OF VOTING ON PLANNING MATTERS

Clause 375A of the Local Government Act 1993 – Recording of voting on planning matters

- (1) In this section, **planning decision** means a decision made in the exercise of a function of a council under the Environmental Planning and Assessment Act 1979:
 - (a) including a decision relating to a development application, an environmental planning instrument, a development control plan or a development contribution plan under that Act, but
 - (b) not including the making of an order under that Act.
- (2) The general manager is required to keep a register containing, for each planning decision made at a meeting of the council or a council committee, the names of the councillors who supported the decision and the names of any councillors who opposed (or are taken to have opposed) the decision.
- (3) For the purpose of maintaining the register, a division is required to be called whenever a motion for a planning decision is put at a meeting of the council or a council committee.
- (4) Each decision recorded in the register is to be described in the register or identified in a manner that enables the description to be obtained from another publicly available document and is to include the information required by the regulations.
- (5) This section extends to a meeting that is closed to the public.

OATH AND AFFIRMATION FOR COUNCILLORS

Councillors are reminded of the oath of office or affirmation of office made at or before their first meeting of the council in accordance with Clause 233A of the Local Government Act 1993. This includes undertaking the duties of the office of councillor in the best interests of the people of Byron Shire and the Byron Shire Council and faithfully and impartially carrying out the functions, powers, authorities and discretions vested under the Act or any other Act to the best of one's ability and judgment.

BYRON SHIRE COUNCIL

BUSINESS OF MEETING

1. APOLOGIES

2. DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

3. ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

- 3.1 Adoption of Minutes from Previous Meetings 6

4. STAFF REPORTS

Infrastructure Services

- 4.1 Community Education Strategy and Review of Flood Options / North Byron
Flood Investigations - Projects Update 17

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

Report No. 3.1 Adoption of Minutes from Previous Meetings

5 **Directorate:** Infrastructure Services

File No: I2024/997

10 **RECOMMENDATION:**

That the minutes of the Floodplain Management Advisory Committee Meeting held on 14 May 2024 be confirmed subject to the following amendment:

15 **Removal of the recommendation for Report No. 4.5 ‘Community Education Strategy and Review of Flood Options / North Byron Flood Investigations - Projects Update’ and instead a note added to the minutes to say this item was deferred.**

20 **Attachments:**

1 Minutes 14/05/2024 Floodplain Management Advisory Committee, I2024/734 , page 10  

Report

The attachment to this report provides the minutes of the Floodplain Management Advisory Committee Meeting of 14 May 2024 .

5

Report to Council

The minutes were reported to Council on 27 June 2024.

Comments

10

In accordance with the Committee Recommendations, Council resolved the following:

24-001 Resolved that Council notes the minutes of the Floodplain Management Advisory Committee Meeting held on 14 May 2024. (Lyon/Westheimer)

24-002 Resolved that Council adopts the following Committee Recommendations:

Report No. 4.1 Amendments to Byron Shire DCP 2014 Chapter C2: Areas Affected by Flood - Draft for Exhibition

File No: I2024/661

Committee Recommendation 4.1.1

That Council:

1. Notes the committee received a presentation by BMT and as contained in the report attachments; and
2. Adds within the public exhibition version of the DCP, and note that the committee wishes to add the following sentence in C2.1.8 "Where a significant flood has occurred and studies require updating but that has not yet happened, flood data such as reported Flood Heights (where available) should be taken into account".
3. Notes that committee members are able to make submissions to the proposed amendments to Byron Shire DCP 2014, Chapter 'C2: Areas Affected by Flood', for Council's consideration prior to final adoption. (Lyon/Westheimer)

24-003 Resolved that Council adopts the following Committee Recommendation:

BYRON SHIRE COUNCIL

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1

Report No. 4.2 Flood Levee Raising Investigation - South Golden Beach File No: I2024/161

Committee Recommendation 4.2.1

That Council, based on the reasons discussed in this report, it is recommended that raising the levee by either 300mm or 600mm is not undertaken. (Lyon/Westheimer)

24-004 Resolved that Council adopts the following Committee Recommendations:

Report No. 4.3 Flood Gate Upgrade Options Investigation - South Golden Beach File No: I2024/164

Committee Recommendation 4.3.1

That Council:

1. Notes that the committee was presented with the Floodgate Upgrade Options Investigation prepared by JB Pacific March 2024– Attachment 1 (E2024/47404).
2. Applies to the State for funding to carry out the recommendations contained in Section 4.2 and 5 of the report. (Lyon/Westheimer)

24-005 Resolved that Council adopts the following Committee Recommendation:

Report No. 4.4 Post 2022 Event Flood Behaviour Analysis - Brunswick River , Belongil Creek and Tallow Creek - NSW Department of Planning & Environment

File No: I2024/676

Committee Recommendation 4.4.1

That the Floodplain Management Advisory Committee notes that the Department of Climate Change, Energy, the Environment and Water (DCCEEW) have finalised and published Post 2022 Flood Analysis Assessments for the three (3) main catchments contained within Byron Shire Council. These include the North Byron/Brunswick River, Belongil Creek and Tallow Creek catchments. (Lyon/Westheimer)

24-006 Resolved that Council adopts the following Committee Recommendation:

Report No. 4.5 Community Education Strategy and Review of Flood Options / North Byron Flood Investigations - Projects Update

File No: I2024/677

BYRON SHIRE COUNCIL

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1

Committee Recommendation 4.5.1

That Council requests the NSW Department of Planning & Environment (DPE) to commission animation graphic models of the 2022 flood event and provide to Council to assist in future community engagement, with an extended area to the north.

(Lyon/Westheimer)

*The motions **24-321** to **24-326** were put to the vote and carried unanimously.*

Minutes of Meeting
Floodplain Management Advisory
Committee Meeting

Venue	Conference Room, Station Street, Mullumbimby
Date	Tuesday, 14 May 2024
Time	11.30am



BYRON SHIRE COUNCIL

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 - ATTACHMENT 1

BYRON SHIRE COUNCIL

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 - ATTACHMENT 1

BYRON SHIRE COUNCIL

FLOODPLAIN MANAGEMENT ADVISORY COMMITTEE MEETING MINUTES 14 MAY 2024

Minutes of the Floodplain Management Advisory Committee Meeting held on Tuesday, 14 May 2024

File No: I2024/734

PRESENT:

Councillors:	Cr M Lyon (Mayor)	In person
	Cr D Dey	In person
	Cr Coorey	Absent
Staff:	Phil Holloway	Apologies
	Samuel Frumpui (Manager Works)	In person
	James Flockton (Infrastructure Planning Coordinator)	In person
	Steve Twohill (Flood and Drainage Engineer)	In person
	Dominika Tomanek (Minute Taker)	In person
	Alex Caras	In person
Invited members:	Scott Moffett (Dept of Planning and Environment)	Apologies
	Peter Mair (State Emergency Service) – voting member	In person
	Jeremy Carpenter (SES)	Apologies
Community:	Karl Allen	Apologies
	Matthew Lambourne	In person
	Steven Harris	In person
	Catherine Lane	In person

BYRON SHIRE COUNCIL

BYRON SHIRE COUNCIL

FLOODPLAIN MANAGEMENT ADVISORY COMMITTEE MEETING MINUTES 14 MAY 2024

	Robert Crossley	In person
Visitors:	Damion Cavanagh	In person

Cr Lyon (Chair) opened the meeting at 11:37 am and acknowledged that the meeting was being held on Bundjalung Country.

ATTENDANCE VIA AUDIO-VISUAL LINK:

APOLOGIES:

Scott Moffett

Karl Allen

Jeremy Carpenter (SES)

Phil Holloway

Absent:

Cr Coorey

DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

There were no declarations of interest.

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

Report No. 3.1 Adoption of Minutes from Previous Meeting
File No: I2024/682

Committee Recommendation:

That the minutes of the Floodplain Management Advisory Committee Meeting held on 13 February 2024 be confirmed.

BYRON SHIRE COUNCIL

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 - ATTACHMENT 1

BYRON SHIRE COUNCIL

FLOODPLAIN MANAGEMENT ADVISORY COMMITTEE MEETING MINUTES 14 MAY 2024

(Lyon/Lambourne)

The recommendation was put to the vote and declared carried.

BUSINESS ARISING FROM PREVIOUS MINUTES

Minutes of 13 February 2024 to be reported to Council meeting in May 2024.

PROCEDURAL MOTION

Committee Recommendation:

That Council change the order of business to deal with Reports 4.4 first on the Agenda.

The recommendation was put to the vote and declared carried.

STAFF REPORTS - SUSTAINABLE ENVIRONMENT AND ECONOMY

Report No. 4.1 Amendments to Byron Shire DCP 2014 Chapter C2: Areas Affected by Flood - Draft for Exhibition

File No: I2024/661

Committee Recommendation:

That Council :

1. Notes the committee received a presentation by BMT and as contained in the report attachments; and
2. Adds within the public exhibition version of the DCP, and note that the committee wishes to add the following sentence in C2.1.8 "Where a significant flood has occurred and studies require updating but that has not yet happened, flood data such as reported Flood Heights (where available) should be taken into account".
3. Notes that committee members are able to make submissions to the proposed amendments to Byron Shire DCP 2014, Chapter 'C2: Areas Affected by Flood', for Council's consideration prior to final adoption.

(Dey/Lambourne)

The recommendation was put to the vote and declared carried.

BYRON SHIRE COUNCIL

FLOODPLAIN MANAGEMENT ADVISORY COMMITTEE MEETING MINUTES 14 MAY 2024

STAFF REPORTS - INFRASTRUCTURE SERVICES

Report No. 4.2 Flood Levee Raising Investigation - South Golden Beach
File No: I2024/161

Committee Recommendation:

That Council, based on the reasons discussed in this report, it is recommended that raising the levee by either 300mm or 600mm is not undertaken.

(Lyon/Lane)

*The recommendation was put to the vote and declared carried.
Matthew Lambourne voted against.*

Report No. 4.3 Flood Gate Upgrade Options Investigation - South Golden Beach
File No: I2024/164

Committee Recommendation:

That Council:

- 1. Notes that the committee was presented with the Floodgate Upgrade Options Investigation prepared by JB Pacific March 2024– Attachment 1 (E2024/47404).**
- 2. Applies to the State for funding to carry out the recommendations contained in Section 4.2 and 5 of the report.**

(Dey/Lyon)

The recommendation was put to the vote and declared carried.

BYRON SHIRE COUNCIL

FLOODPLAIN MANAGEMENT ADVISORY COMMITTEE MEETING MINUTES 14 MAY 2024

Report No. 4.4 **Post 2022 Event Flood Behaviour Analysis - Brunswick River ,
Belongil Creek and Tallow Creek - NSW Department of Planning
& Environment**
File No: 12024/676

Committee Recommendation:

That the Floodplain Management Advisory Committee notes that the Department of Climate Change, Energy, the Environment and Water (DCCEEW) have finalised and published Post 2022 Flood Analysis Assessments for the three (3) main catchments contained within Byron Shire Council. These include the North Byron/Brunswick River, Belongil Creek and Tallow Creek catchments.

(Lyon/Dey)

The recommendation was put to the vote and declared carried.

Report No. 4.5 **Community Education Strategy and Review of Flood Options /
North Byron Flood Investigations - Projects Update**
File No: 12024/677

Committee Recommendation:

That Council requests the NSW Department of Planning & Environment (DPE) to commission animation graphic models of the 2022 flood event and provide to Council to assist in future community engagement, with an extended area to the north.

(Lyon/Crossley)

The recommendation was put to the vote and declared carried.

There being no further business the meeting concluded at 1:40 pm.

STAFF REPORTS - INFRASTRUCTURE SERVICES

5 **Report No. 4.1 Community Education Strategy and Review of Flood Options / North Byron Flood Investigations - Projects Update**

Directorate: Infrastructure Services

Report Author: Steve Twohill, Flood and Drainage Engineer

File No: I2024/677

10 **Summary:**

15 This report provides an update to the Floodplain Advisory Committee requested in their recommendation of Report 4.2 tabled at the Friday 8 December 2023 committee meeting. This recommendation has not been ratified with a council resolution. However, Council staff provide this report in good faith to keep the committee informed of the responses to these matters acknowledging that the Committee will end in September under this current Council term.

The list of items is as follows and is discussed in this report: -

- 20 1. **That the Floodplain Management Advisory Committee receive a further update on the 'Community Education Strategy and Review of Flood Options' project and a briefing on ways of further engaging community, for example with animations from existing and future flood models.**

25 Consultants JBP have progressed this assessment and project since the public meeting held on 6 December 2023 and the ensuing Christmas holiday period. Council staff have met with the Consultant JBP in late December 2023 and February 2024 to discuss ways of further engaging the community in relation to improved flood awareness to this region.

In addition, Council sought permission from the NSW Department of Planning & Environment (DPE) to provide and release the confidential 2022 Flood event review report that was presented to the committee late last year. DPE have agreed to that request in late December 2023, this information has been provided to JBP.

30 This project has budgetary constraints that are already committed with an agreed scope. Staff have negotiated with the consultant JBP to undertake a review of the DPE 2022 flood event review report and integrate outcomes where appropriate in this assessment. The report is well underway however too premature to release for this committee meeting.

35 Animation and graphical recreation of the flood event are supported, however that aspect is not included in the scope for this project. Given that DPE has commissioned this review by WMA Water and the fact that it is their report and work, we recommend that DPE

BYRON SHIRE COUNCIL

STAFF REPORTS - INFRASTRUCTURE SERVICES

4.1

commission animation graphic models of the 2022 flood event and provide to Council to assist in future community engagement for this project.

We anticipate that the Final report will be presented to the committee at the next scheduled meeting in May 2024.



5

RECOMMENDATION:

That the Floodplain Management Advisory Committee:-

- 10
- 1. Note the update on the ‘Community Education Strategy and Review of Flood Options’ project which focusses on the Northern Byron Shire communities; and**
 - 2. Recommend that the NSW Department of Planning & Environment (DPE) be requested to commission animation graphic models of the 2022 flood event and provide to Council to assist in future community engagement.**
- 15

Attachments:

- 1 JBP-Review Of Flood Studies North Byron Study Region - Draft Report - Feb 2024, E2024/47658 , page 22 [↓](#) 
- 20 2 JBP-Executive Summary-Review Of Flood Studies North Byron Region - Draft - March 2024, E2024/47660 , page 36 [↓](#) 

Report

This report provides an update to the Floodplain Advisory Committee requested in their recommendation of Report 4.2 tabled at the Friday 8 December 2023 committee meeting.

- 5 This recommendation has not been ratified with a council resolution. However, Council staff provide this report in good faith to keep the committee informed of the responses to these matters acknowledging that the Committee will end in September under this current Council term.

- 10 Background to this project is contained in the previous report table at the 8 December 2023 meeting – refer File I2023/1607.

Consultants JBP have progressed this assessment and project since the public meeting held on 6 December 2023 and the ensuing Christmas holiday period. Council staff have met with the Consultant JBP in late December 2023 and February 2024 to discuss ways of further engaging the community in relation to improved flood awareness to this region.

- 15 Attachments 1 & 2 are provided for the committee's information.

In addition, Council sought permission from the NSW Department of Planning & Environment (DPE) to provide and release the confidential 2022 Flood event review report that was presented to the committee late last year. DPE have agreed to that request in late December 2023, this information has been provided to JBP.

- 20 This project has budgetary constraints that are already committed with an agreed scope. Staff have negotiated with the consultant JBP to undertake a review of the DPE 2022 flood event review report and integrate outcomes where appropriate in this assessment. The report is well underway however too premature to release for this committee meeting.

- 25 Animation and graphical recreation of the flood event are supported, however that aspect is not included in the scope for this project. Given that DPE has commissioned this review by WMA Water and the fact that it is their report and work, we recommend that DPE commission animation graphic models of the 2022 flood event and provide to Council to assist in future community engagement for this project.

- 30 There are eight (8) interrelated flood related investigations in this study area that will be nearing completion. These other projects include: -

PM22_30091 - AGRN1012 - Local Government Recovery Grant Program

PM22_1486 - Flood Warning Systems (Gauges) Upgrade - Shire Wide

PM23_1513 - Flood Pump Generator Power Supply - South Golden Beach

PM23_1514 - Rear Drainage Easements Upgrade - South Golden Beach

- 35 PM23_1516 - Flood Pump Investigation for Western Levee - South Golden Beach

PM23_1517 - Drainage Easement Maintenance Access Upgrade - Narooma Drive

PM23_1519 - Flood Gate Upgrade Options Investigation - South Golden Beach

PM23_##### - Sky Pump Feasibility Investigation - South Golden Beach Canal system

5 Once all these investigations are complete, there is an opportunity to report all of these projects in a consolidated and integrated manner to the community June/July 2024.

Next steps

The Floodplain Advisory Management Committee will be updated as the project progresses. Committee members will be provided an opportunity to be further involved during the later stage of the project at an options workshop (date not yet confirmed).

10 **Strategic Considerations**

Community Strategic Plan and Operational Plan

CSP Objective	CSP Strategy	DP Action	Code	OP Activity
3: Nurtured Environment	3.3: Protect the health of coastline, estuaries, waterways, and catchments	3.3.2: Floodplain management - Mitigate the impact of flooding on private and public property	3.3.2.3	Floodplain Risk Management Committee coordination

Legal/Statutory/Policy Considerations

15 The study will align with the framework established by the NSW Floodplain Development Manual and national best practice as outlined in the Australian Institute for Disaster Resilience Handbook 7: Managing the floodplain: best practice in flood risk management in Australia (AIDR, 2017).

Financial Considerations

This is a grant funded project comprising consultancy fees only of \$37,940 (excl. GST).

Consultation and Engagement

20 A Community and Stakeholder Engagement Plan (CSEP) has been developed for the project for implementation. The CSEP aims to collate community and stakeholder concerns and ideas and address all concerns after reviewing management options and data. The CSEP considers different approaches to communications and engagement,

BYRON SHIRE COUNCIL

STAFF REPORTS - INFRASTRUCTURE SERVICES

4.1

following the IAP2 Public Participation Spectrum. The key outcomes of the project is improved community and stakeholder understanding and education on flood risk and flood risk management, as such the below is proposed:

- Council Staff/DPE representatives are given a steering role (Empowered).
- 5 • Council's Advisory Committees are *Involved*
- The community is *Involved* within the project. This is deliberately not at a level that would allow their request for new mitigation scenarios to be tested without checks from flood engineers to ensure they are viable; however, it will ensure they are a focus on this project.

10



Review of Flood Studies for the North Byron Study Region Summary

Draft

8 March 2024

**Prepared for:
Byron Shire Council**

www.jbpacific.com.au





Document Status

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Revision	S3 P01
Prepared by	Callan Schonrock BEng Graduate Engineer
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Carbon Footprint

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Contract

JBP Project Manager Eoghain O'Hanlon
Address Suite 46, 477 Boundary Street, Spring Hill, Brisbane, QLD 4000
JBP Project Code 2023s0843

This report describes work commissioned by Byron Shire Council, by an instruction dated 21 June 2023. The Client's representative for the contract was Chloe Dowsett of Byron Shire Council. Callan Schonrock and Eoghain O'Hanlon of JB Pacific carried out this work.

Purpose and Disclaimer

Jeremy Benn Pacific ("JBP") has prepared this Report for the sole use Byron Shire Council and its appointed agents in accordance with the Agreement under which our services were performed.

JBP has no liability for any use that is made of this Report except to Byron Shire Council for the purposes for which it was originally commissioned and prepared.

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Contents

1	Introduction	8
2	Flooding in North Byron	9
	2.1 Riverine Flood Risk	9
	2.2 Overland Flow Flood Risk	9
3	Reviewed Flood Studies	10
	3.1 Overview	10
	3.2 Limitations	10
4	Summary	13



Abbreviations

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
ARR2019	Australian Rainfall and Runoff (2019 Version)
ARR87	Australian Rainfall and Runoff (1987 Version)
CL	Continuing Loss
FRMS	Flood Risk Management Study
FRMS&P	Flood Risk Management Study and Plan
FMP	Floodplain Management Plan
IL	Initial Loss
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

Definitions

2022 Flood Event: 25th February - 5th of March 2022 Major Flood.

Australian Rainfall and Runoff: Australian Rainfall and Runoff Guidance, the present-day industry standard for several rainfall runoff estimation methods.

Antecedent Conditions: Properties of soil/ground before an event largely dictating storm rainfall losses and baseflow

Baseflow: The portion of stream flow sourced from below ground moisture flowing into waterways.

Continuing Loss: Rainfall depth that is estimated to be lost throughout an event primarily through soil infiltration.

Calibration: The process to adjust flood simulations to be consistent with real-world flood behaviour

Design Event: A constructed flood event typically simulated to estimate flood hazard.

Evacuation Routes: Drivable corridors that are assessed as critical for community/property evacuation.

Extreme Flood: A flood believed to be representing a near-maximum flood event.

Falling Limb: The tail end of a hydrograph typically following a flood peak, depicting duration of flooding

Flood Behaviour: The characteristics and properties of a flood in a catchment, being out of bank flow, flood wave progression/attenuation, rapid flood response or prolonged flooding .

Floodplain: The land where water flows or is stored in times of flood.



Hydraulic Controls: Real-world structures that modify flood behaviour.

Hydrograph: The rate of flow over time, typically depicting river flows.

Hydrologic Model: Typically, a numerical model to estimate water storage-discharge through a catchment.

Hydrodynamic Model: Typically, a numerical model to estimate hydraulic dispersion/conveyance used to define flood extents/depths/velocities.

Initial Loss: A depth of rainfall that is estimated to infiltrate ground and not convert to runoff at the beginning of a storm.

Isolated Properties: Properties that are considered isolated from communities, evacuation routes.

Mitigation Options: Controls/interventions adopted to reduce (flood) risk.

Modelling: Typically, a simulation of real-world events

Northern Rivers Region: The North Coast of New South Wales.

Hydraulic Roughness: A bed "friction" to hinder conveyance of flow.

Stakeholders: People, groups of people or organizations that have a vested interest in a project, plan or decision

Temporal Pattern: The pattern or distribution of a parameter over time, associated with rainfall over time.

Validation: The process to justify existing flood simulations to be representative of real-world



Executive Summary

Byron Shire Council (BSC) engaged JB Pacific (JBP) to undertake a review of the previous flood studies, flood risk management plans, estuary and coastal studies and all the flood management options that were contained and assessed within them, that are applicable for the North Byron villages of New Brighton, Billinudgel, Ocean Shores and South Golden Beach. This report summarizes these assessments and their findings to support the Byron Shire Council's Community Education Strategy and Flood Review project.

The latest flood study the North Byron Floodplain Risk Management Study and Plan (WMA, 2020) has been the basis for Byron Shire Council's adopted flood risk management plan, from which several management actions have been progressed to varying stages of completion, including submission of grants, design development, construction or implementation underway or already completed.

The findings of this review will be used to confirm the accuracy and completeness previous flood management options assessments and/or identify new and revised options where further analysis may be warranted. The Community and Stakeholder involvement is planned to understand prioritise their concerns and management options, that their either are in favour of implementing and/or further investigation and those which they are not in favour of which should not progress to the next stage analysis or implementation.

This report also summarises investigation gaps for the North Byron flooding behaviour, outlined as in the North Byron Floodplain Risk Management Study and Plan (WMA, 2020).



1 Introduction

Byron Shire Council (BSC) engaged JB Pacific (JBP) to undertake a review of the previously assessed flood mitigation options that are applicable for the North Byron villages of New Brighton, Billinudgel, Ocean Shores and South Golden Beach. This report summarises the works and findings undertaken of the existing flood, estuary and coastal studies for the region, to support the Byron Shire Council Community Education and Flood Review project.

The North Byron region has been subject to several flood risk and flood management studies that have assessed various flood mitigation options. The latest flood study, the North Byron Floodplain Risk Management Study and Plan (WMA, 2020) has been the basis for Byron Shire Council's adopted flood risk management plan, from which several management actions have been progressed to varying stages of completion, including submission of grants, design development, construction or implementation underway or already completed.

The findings of this review, in conjunction with community and stakeholder engagement and education activities, will be used to confirm the accuracy and completeness of previous management/mitigation options assessments and/or identify options where further analysis and/or refinement may be warranted. The Community and Stakeholder involvement is planned to understand their priority concerns and suggested management options. This will include their review of what they are in favour of implementing and their assessment of other options they do not want to progress to the next stage.



2 Flooding in North Byron

2.1 Riverine Flood Risk

The 2022 flood event was estimated to render 837 properties with above floor flooding, and resulted in total tangible damages estimate of \$47 Million. Following this significant flooding, community concern has risen for the Northern Byron Community regarding their existing flood risk, concerns of local hydrology, and ongoing plans and works to reduce flood risk for the region. The North Byron community is built within the Marshalls Creek floodplain, with the creek having significant storage and "bathtub" behaviour during a storm event from the constricted Marshalls Creek drainage at the confluence with Brunswick River. This flood behaviour is observed to inundate significant area including parts of:

- Ocean Shores
- New Brighton
- Back Water causing elevated water levels at South Golden Beach

Billinudgel experiences predominant flood risk from riverine flooding, with significant constriction of Marshalls Creek at Billinudgel Bridge and the Pacific Motorway, however protection of Billinudgel from Marshalls Creek has been previously observed to still exhibit inundation from local overland flow.

2.2 Overland Flow Flood Risk

Further flood risk exists in the north Byron region from stormwater overland flow, particularly South Golden Beach and Ocean Shores.

South Golden Beach is protected from a levee up to the 1% AEP canal water level. However, from community consultation the South Golden Beach community experience significant local rainfall observed to inundate parts of the community. While a flood pump services the Western Side of South Golden Beach, to limit risk of elevated water levels within the South Golden Beach Canals preventing effective drainage, East South Golden Beach does not have this functionality. Ocean Shores is susceptible to coincident overland flow, and riverine flood risk. Several community members have testified of flooding from Water Lily Park, and elevated water levels within Marshalls Creek.

From community consultation these communities are extremely susceptible to stormwater network blockage.



3 Reviewed Flood Studies

3.1 Overview

Several significant flood studies have been identified and reviewed as part of this detailed review including:

- North Byron Sky Pumps Study (JBPacific, 2024)
- Post 2022 Event Flood Behaviour Analysis - Brunswick River (WMAwater, 2024)
- Characterisation of the 2022 Floods in the Northern Rivers Region (CSIRO, 2022)
- North Byron Floodplain Risk Management Study and Plan (WMAwater, 2020)
- North Byron Flood Study (BMT, 2016)
- Tweed Byron Coastal Creeks Flood Study (BMT, 2010)
- Marshalls Creek Floodplain Management Plan (Paterson Consultants, 1997)
- Brunswick River Flood Study (WMAwater, 1986)
- Brunswick Valley Flood Plain Management Study Hydrology Report (WMAwater 1984)

Other previous flood studies were identified from the latest North Byron Floodplain Risk Management Study and Plan (WMAwater, 2020). Several of these studies were summarized by the 2020 North Byron FRMS&P including:

- Marshalls Creek Flood Study (1986)
- Flood mitigation Options for Billinudgel (1988)
- Brunswick River Floodplain Management Investigation (1989)
- Proposed Levees and South Golden Beach (1989)
- Report on Feasibility of an EIS for North Ocean Shores Flood Outlet (1992)
- Mullumbimby Floodplain Management Plan (1993)

Additional reports were identified to exist; however, they are not summarized by the FRMS&P or this flood study review. These include:

- Brunswick River Tidal Data Collection (2008)
- Kallaroo Circuit Bund Culver Amplification Hydraulic Impact Assessment (1996)
- Marshalls Creek Dredging Investigations Stage 1 Report (1992)
- Mullumbimby Floodplain Management Study Re-evaluation of Options (1992)

3.2 Limitations

In 2020, flood risk management experts at WMAwater released the latest Flood Risk Management Study and Plan (FRMS&P) for the North Byron region, building on top of the 2016 BMT study. This study investigated the flood risk for the North Byron community by undertaking numerical modelling of simulated river and creek flood events. Notably this study had key limitations including:



- It did not simulate overland flow flooding caused by intense rainfall across land.
- It builds upon and adopts dated industry modelling methodologies.

The existing study additionally utilized community consultation to provide several recommendations for drainage improvements where the modelling results were not practical for drainage assessment. Following the study, as an intermediate intervention, the Byron Shire Council has undertaken several works projects and plans to maintain and improve drainage in the North Byron community. However there remains a high-level of residual community concern about inadequate stormwater drainage and maintenance, which needs better planned and communicated to the community, along with undertaking a catchment wide overland flow path study to better understand the areas of concern.

Several mitigation options have been considered by the FRMS&P and Council to reduce the bathtub effect of Marshalls Creek including but not limited to:

- Marshalls Creek Ocean Outfalls
 - Simulated by carving coastal dunes out of the existing model, shown to reduce the 1-in-100 year peak flood level by 0.1m at Ocean Shores. Not greatly reducing flood risk for Marshalls Creek.
 - Ocean Outfalls are limited in their effectiveness by sizing (width) and through minimizing the risk of elevated ocean levels and waves flowing into Marshalls Creek. Additionally, they require significant clearing to construct and maintenance to ensure their conveyance capacity when needed.
- Pumping floodwater to the Ocean
 - This has been shown to be effective at reducing local and widespread peak flood levels, however there is limited technology to pump the required flow rates. This has also been used to provide a better understanding of the flow rate required for the ocean outfalls.
- Brunswick Heads Rock Wall Removal
 - Simulated by removing the Marshalls Creek Rock Walls out of the existing model, shown to not greatly reduce the 1-in-100 year peak flood level.
 - A limitation of this investigation is the increased tidal flushing of Marshalls Creek believed to increase sediment transport and reduce siltation in Marshalls Creek, having a similar but permanent effect that dredging provides.
 - The 1-in-100 year event was seen to significantly overtop the rock walls, however during more frequent events, the creek conveyance is believed to be a greater portion of total flow.
 - While this option could improve drainage of catchment dominated events, ocean dominated events are believed to propagate further upstream including wave setup, storm surge and peak tide levels. Low lying communities such as New Brighton and South Golden Beach and portions of Ocean Shores, would have to be investigated further for this option to be considered further.
- Brunswick Heads Training Walls Removal



- Simulated by removing the Marshalls Creek Rock Walls out of the existing model, shown to not greatly reduce the 1-in-100 year peak flood level
- Marshalls Creek Dredging
 - Simulated by removing the Marshalls Creek Rock Walls out of the model, shown to not greatly reduce the 1-in-100 year peak flood level
- Billinudgel Levee
 - Simulated to assist keeping Marshalls Creek floodwaters out of the Billinudgel township, however Billinudgel was still observed to be flood affected from local catchment overland flow.
- South Golden Beach Levee Modifications
 - Following an audit several recommendations were made for South Golden Beach Levee modifications
- House Raising
 - Proposed as part of the Voluntary House Raising Scheme
- House Purchasing Scheme
 - Proposed as part of the Voluntary House Raising Scheme
- Kallaroo Circuit Bund Modification
 - Not simulated independently however modelled simultaneous to Dredging, dune openings, rock wall modifications, with lowering of the bund by 1m to - 0.025mAHD. Simultaneous modelling indicated a reduction of 0.15m at South Golden Beach.

It was further identified that little previous studies have considered flood mitigation options for Water Lily Park and surrounds at Ocean Shores.

While the options assessment modelling to date, has not been able to exhibit great benefits in flood reduction for the region, Byron Shire Council has undertaken further community consultation of residents, seeking their opinions on the issues and potential mitigation that they are likely to support. It was identified at the latest community consultation that the support for particular mitigation options (ocean outfalls) varies across the region, with those who are potentially closest and likely to benefit the most, being against there installation.



4 Summary

This review has identified several different mitigation options that have been assessed for their effectiveness and their cost to benefit ratio. Mitigation measures that have been suggested range from structural such as levees, dune openings, stormwater drainage upgrades and channel diversions, voluntary resumptions, planning scheme amendments and flood planning levels, to forecasting, flood warning and community education programs.

Council has implemented and is in the process of implementing several of the recommended measures. Measures that Council has already implemented include drainage and maintenance programs, flood forecasting and a flood forecasting and warning system, updates to the planning scheme and the flood planning levels, portal for individual property flood risk information.

Stormwater drainage has been identified as a major consideration for flood risk in the North Byron region it is recommended that future investigations consider flood risk sensitivity to near 100% structural blockage of stormwater infrastructure, siltation blockage of bridges (Orana Road, and Billinudgel Bridge), and alternatives/priority maintenance to be undertaken regularly to avoid blockage induced flood risk. It is expected that this will be assessed as part of the overland flow assessment.

Many of the major structural options were observed to reduce peak water level but were not found to be cost effective and/or resulted in impacts to other areas. However, strong community support for further investigation and to implement mitigation options has been observed at the several previous community consultations and during this study, particularly for ocean outfalls. It was however noted that community support is not unanimous for any mitigation option, with some people who would most benefit being the strongest opposed to the option. It is recommended that further investigation considers flood mitigation effectiveness for events more frequent than the 1% AEP.



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Review of Flood Studies for the North Byron Study Region

Draft

8 February 2024

**Prepared for:
Byron Shire Council**

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Contract

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This report describes work commissioned by Byron Shire Council, by an instruction dated 21 June 2023. The Client's representative for the contract was Chloe Dowsett of Byron Shire Council. Callan Schonrock and Eoghain O'Hanlon of JB Pacific carried out this work.

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Contents

1	Introduction	1
2	Reviewed Flood Studies	2
2.1	Overview	2
2.2	Brunswick Valley Flood Plain Management Study Hydrology Report (WMAwater Formerly Webb, McKeown & Associates, 1984)	2
2.3	Brunswick River Flood Study (WMAwater Formerly Webb, McKeown & Associates, 1986)	10
2.4	Tweed-Byron Coastal Creeks Flood Study (BMT, 2009)	11
2.5	Marshalls Creek Floodplain Management Plan (Paterson Consultants, 1997)	15
2.6	North Byron Flood Study (BMT, 2016)	18
2.7	North Byron Floodplain Risk Management Study and Plan (WMA, 2020)	33
2.8	Post Flood Discussion With South Golden Beach Community Members West of Capricornia Canal (BSC, 2022)	64
2.9	MAYDAY Community Flood Debrief and Disaster Preparedness Event Report (2022)	65
2.10	Characterisation of the 2022 floods in the Northern Rivers region (CSIRO, 2022)	70
3	Reviewed Estuary Studies	86
3.1	Overview	86
3.2	Marshalls Creek Dredging Investigation (Planning Workshop and Web McKeown Associates, 1992)	86
3.3	Brunswick River Estuary Study (MHL, 2002)	88
3.4	Brunswick Estuary Management Study and Plan (Patterson Britton, 2007)	89
3.5	Brunswick Estuary Management Plan (Byron Shire Council, 2008)	91
4	Reviewed Coastal Studies	92
4.1	Overview	92
4.2	Byron Shire Coastal Hazards Assessment Update (BMT, 2013)	92
4.3	Coastal Zone Management Plan for the Brunswick Estuary (Byron Shire Council, 2018)	92

2023s0843-JBAP-00-00-RP-00-0002-S3-P01.02-Existing Study Review.docx

iv



5	Marshalls Creek Sedimentation	93
5.1	Introduction	93
5.2	Sediment Dynamics	96
5.3	Summary	102
6	Identified Investigation Gaps	103
6.1	Community Perception and Communications	105
7	Community Consultation	106
7.1	Community Survey	106
7.2	Community Workshop	109
8	Options Review	111
8.1	Overview	111
8.2	Detailed Option Assessment	112
9	Summary	137

List of Figures

Figure 2-1: Brunswick Valley FMS (1984) 1974 Event Calibration Comparison at Durrumbul	4
Figure 2-2: Brunswick Valley FMS (1984) 1978 Event Calibration Comparison at Durrumbul	5
Figure 2-3: Brunswick Valley FMS (1984) Validation Results	6
Figure 2-4: Brunswick Valley FMS (1984) Modelled 4.9% AEP Design Discharge	7
Figure 2-5: Brunswick Valley FMS (1984) Modelled 1% AEP Design Discharge	8
Figure 2-6: Brunswick Valley FMS (1984) Modelled "Extreme" Design Discharge	9
Figure 2-7: Brunswick River FS (1986) Brunswick River Design Peak Level contours	11
Figure 2-10: North Byron Flood Study (BMT, 2016) Model Schematization	21
Figure 2-11: January 2012 Calibration Results at Durrumbul	23
Figure 2-12: June 2005 Calibration Results at Durrumbul	23
Figure 2-13: May 1987 Calibration Results at Durrumbul	24
Figure 2-14: March 1978 Calibration Results at Durrumbul	24
Figure 2-15: North Byron Flood Study (BMT, 2016) Billinudgel Falling Limb	25
Figure 2-16: North Byron Flood Study (BMT, 2016) 2005 Event Comparison at Federation	

2023s0843-JBAP-00-00-RP-00-0002-S3-P01.02-Existing Study Review.docx v



Bridge	26
Figure 2-17: North Byron Flood Study (BMT, 2016) 1987 Event Comparison at Federation Bridge	26
Figure 2-18: North Byron Flood Study (BMT, 2016) 2005 Event Flood Marks Comparisons	28
Figure 2-19: North Byron Flood Study (BMT, 2016) Community Identified Degree of Flooding	29
Figure 2-20: North Byron Flood Study (BMT, 2016) Community identified flood hazards	30
Figure 2-21: North Byron FRMS March 2017 Level Calibration Brunswick River at Durrumbul Gauge	39
Figure 2-22: North Byron FRMS March 2017 Flow Calibration Brunswick River at Durrumbul Gauge	40
Figure 2-23: North Byron FRMS March 2017 Level Calibration Brunswick River at Federation Bridge	40
Figure 2-24: North Byron FRMS March 2017 Level Calibration Marshalls Creek at Billinudgel	41
Figure 2-25: North Byron FRMS March 2017 Level Calibration Marshalls Creek at Orana Bridge	42
Figure 2-26: North Byron FRMS March 2017 Level Calibration Brunswick River at Brunswick Heads	42
Figure 2-27: North Byron FRMS January 2012 Level Calibration Brunswick River at Durrumbul Gauge	43
Figure 2-28: North Byron FRMS January 2012 Flow Calibration Brunswick River at Durrumbul Gauge	43
Figure 2-29: North Byron FRMS January 2012 Level Calibration Brunswick River at Federation Bridge	44
Figure 2-30: North Byron FRMS January 2012 Level Calibration Marshalls Creek at Billinudgel	44
Figure 2-31: North Byron FRMS January 2012 Level Calibration Marshalls Creek at Orana Bridge	45
Figure 2-32: North Byron FRMS March 2012 Level Calibration Brunswick River at Brunswick Heads	45
Figure 2-33: South Golden Beach Levee Location	50
Figure 2-37: North Byron FRMS&P Flood Behaviour at Billinudgel	62
Figure 2-38: North Byron FRMS&P Flood Behaviour at New Brighton	63
Figure 2-39: North Byron FRMS&P Modelled Bridge Structure Deck	63
<hr/>	
2023s0843-JBAP-00-00-RP-00-0002-S3-P01.02-Existing Study Review.docx	vi



Figure 2-40: North Byron FRMS&P Flood Behaviour at Brunswick Heads	64
Figure 2-41: AWRA-L event antecedent conditions	73
Figure 2-42: 2022 Event Root Zone Soil Moisture store filling level (%)	73
Figure 2-43: CSIRO 2022 Rainfall Analysis	74
Figure 2-44: CSIRO 2022 flood event rainfall Annual Exceedance Probability	74
Figure 2-45: Water Levels for Brunswick River	75
Figure 2-46: 2022 Water Levels against historic water levels at Brunswick Heads	75
Figure 5-1: Selected historical aerial and satellite imagery. Historical images 1958-1997 available on https://portal.spatial.nsw.gov.au/ . Satellite images 2009-2022 available from Google Earth.	95
Figure 2-1: Oblique photographs of Marshalls Creek entrance pre- and post-training wall construction (source: 1997 Marshalls Creek Floodplain Management Plan).	97
Figure 7-1: Community Survey Supported Mitigation Options (Multiple Choice)	106
Figure 7-2: Billinudgel Community Survey Responses	107
Figure 7-3: Ocean Shores and New Brighton Community Survey Responses	107
Figure 7-4: South Golden Beach Community Survey Responses	108
Figure 7-5: Brunswick Heads Community Survey Responses	108

List of Tables

Table 2-1: Brunswick Valley FMS (1984) Calibration parameters	3
Table 2-2: Brunswick Valley FMS (1984) Parameter validation to the 1976 flood	5
Table 2-3: Tweed-Byron FS Modelled Scenarios and Events	14
Table 2-4: Marshalls Creek FMP General Flood Mitigation Controls	16
Table 2-5: Marshalls Creek FMP Local Flood Mitigation Controls	17
Table 2-6: North Byron Flood Study (BMT, 2016) Roughness Values	22
Table 2-7: North Byron Flood Study (BMT, 2016) Community Management Options	31
Table 2-8: North Byron FRM Study (2020) Scenarios and Events	47
Table 2-9: North Byron Flood Study Identified Flood Hazards	48
Table 2-10: North Byron FRMS isolated houses	49
Table 2-11: North Byron Floodplain Risk Management Study potential mitigation measures	53
Table 2-13: North Byron FRMS&P Hydraulic Controls at Billinudgel	61

2023s0843-JBAP-00-00-RP-00-0002-S3-P01.02-Existing Study Review.docx	vii
----------------------------------------------------------------------	-----



Table 2-14: MAYDAY Community Suggested Solutions	65
Table 2-15: List of Major flood events in the Northern Rivers region	71

Abbreviations

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
ARR2019	Australian Rainfall and Runoff (2019 Version)
ARR87	Australian Rainfall and Runoff (1987 Version)
CL	Continuing Loss
FRMS	Flood Risk Management Study
FRMS&P	Flood Risk Management Study and Plan
FMP	Floodplain Management Plan
IL	Initial Loss
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

Definitions

2022 Flood Event: 25th February - 5th of March 2022 Major Flood.

Australian Rainfall and Runoff: Australian Rainfall and Runoff Guidance, the present-day industry standard for several rainfall runoff estimation methods.

Antecedent Conditions: Properties of soil/ground before an event largely dictating storm rainfall losses and baseflow

Baseflow: The portion of stream flow sourced from below ground moisture flowing into waterways

Continuing Loss: Rainfall depth that is estimated to be lost throughout an event primarily through soil infiltration.

Calibration: The process to adjust flood simulations to be consistent with real-world flood behaviour

Design Event: A constructed flood event typically simulated to estimate flood hazard.

Evacuation Routes: Drivable corridors that are assessed as critical for community/property evacuation.

Extreme Flood: A flood believed to be representing a near-maximum flood event.



Falling Limb: The tail end of a hydrograph typically following a flood peak, depicting duration of flooding

Flood Behaviour: The characteristics and properties of a flood in a catchment, being out of bank flow, flood wave progression/attenuation, rapid flood response or prolonged flooding .

Floodplain: The land where water flows or is stored in times of flood.

Hydraulic Controls: Real-world structures that modify flood behaviour.

Hydrograph: The rate of flow over time, typically depicting river flows.

Hydrologic Model: Typically, a numerical model to estimate water storage-discharge through a catchment.

Hydrodynamic Model: Typically, a numerical model to estimate hydraulic dispersion/conveyance used to define flood extents/depths/velocities.

Initial Loss: A depth of rainfall that is estimated to infiltrate ground and not convert to runoff at the beginning of a storm.

Isolated Properties: Properties that are considered isolated from communities, evacuation routes.

Mitigation Options: Controls/interventions adopted to reduce (flood) risk.

Modelling: Typically, a simulation of real-world events

Northern Rivers Region: The North Coast of New South Wales.

Hydraulic Roughness: A bed "friction" to hinder conveyance of flow.

Stakeholders: People, groups of people or organizations that have a vested interest in a project, plan or decision

Temporal Pattern: The pattern or distribution of a parameter over time, associated with rainfall over time.

Validation: The process to justify existing flood simulations to be representative of real-world



Executive Summary

Byron Shire Council (BSC) engaged JB Pacific (JBP) to undertake a review of the previous flood studies, flood risk management plans, estuary and coastal studies and all the flood management options that were contained and assessed within them, that are applicable for the North Byron villages of New Brighton, Billinudgel, Ocean Shores and South Golden Beach. This report summarizes these assessments and their findings to support the Byron Shire Council's Community Education Strategy and Flood Review project. ON outcome of this review is to determine whether any of the options that have previously been assessed require further assessment or if any options have been overlooked that should also be considered.

The latest flood study the North Byron Floodplain Risk Management Study and Plan (WMA, 2020) has been the basis for Byron Shire Council's adopted flood risk management plan, from which several management actions have been progressed to varying stages of completion, including submission of grants, design development, construction or implementation underway or already completed. Further investigation has been undertaken on the sedimentation of Marshalls Creek to inform future estuary management decisions and monitoring.

The findings of this review are used to confirm the accuracy and completeness previous flood management options assessments and/or identify new and revised options where further analysis may be warranted. The Community and Stakeholder involvement was undertaken to prioritise their concerns and management options, that their either are in favour of implementing and/or further investigation and those which they are not in favour of which should not progress to the next stage analysis or implementation.

Community engagement both undertaken historically and as part of this study, identified that there is strong community support to:

- Alleviate the bath tubbing effect of Marshalls Creek with increasing the capacity of ocean outfalls through new high flow openings and/or the removal of Brunswick Heads rock walls or increasing its capacity.
- Improvement of stormwater drainage networks (Particularly South Golden Beach and Ocean Shores) combined with increased maintenance of the networks.

Support of particular options can be varying depending on the location of the residents in relation to the option, particularly the ocean outfall. With residents who live upstream and away from the actual outfall locations being more supportive than residents who live nearer to the outfalls. The residents who level nearest to the outfalls are the residents that are most likely to receive the greatest amount of benefit from the improved outfall capacity.

However, historical modelling results combined with cost benefit analyses, indicated that there was limited benefit from ocean outfalls and/or the removal of Brunswick Heads rock walls. As a result, this study recommends future studies consider flood mitigation benefit for more frequent events than the 1% AEP event. This study also recommends future studies consider sensitivity to stormwater network blockage to aid council maintenance priorities.

2023s0843-JBAP-00-00-RP-00-0002-S3-P01.02-Existing Study Review.docx

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1 Introduction

Byron Shire Council (BSC) engaged JB Pacific (JBP) to undertake a review of the previously assessed flood mitigation options that are applicable for the North Byron villages of New Brighton, Billinudgel, Ocean Shores and South Golden Beach. This report summarises the works and findings undertaken during the existing flood, estuary and coastal studies for the region, to support the Byron Shire Council Community Education and Flood Review project.

The North Byron region has been subject to several flood risk and flood management studies that have assessed various flood mitigation options. The latest flood study, the North Byron Floodplain Risk Management Study and Plan (WMA, 2020) has been the basis for Byron Shire Council's adopted flood risk management plan, from which several management actions have been progressed to varying stages of completion, including submission of grants, design development, construction or implementation underway or already completed.

The findings of this review, in conjunction with community and stakeholder engagement and education activities, will be used to confirm the accuracy and completeness of previous management/mitigation options assessments and/or identify options where further analysis and/or refinement may be warranted. The Community and Stakeholder involvement is planned to understand their priority concerns and suggested management options. This will include their review of what they are in favour of implementing and their assessment of other options they do not want to progress to the next stage.

Further investigation has been undertaken on the sedimentation of Marshalls Creek to inform future estuary management decisions and monitoring.



2 Reviewed Flood Studies

2.1 Overview

Several significant flood studies have been identified and reviewed as part of this detailed review including:

- Post 2022 Event Flood Behaviour Analysis - Brunswick River (WMAwater, 2024)
- Characterisation of the 2022 Floods in the Northern Rivers Region (CSIRO, 2022)
- North Byron Floodplain Risk Management Study and Plan (WMAwater, 2020)
- North Byron Flood Study (BMT, 2016)
- Tweed Byron Coastal Creeks Flood Study (BMT, 2010)
- Marshalls Creek Floodplain Management Plan (Paterson Consultants, 1997)
- Brunswick River Flood Study (WMAwater, 1986)
- Brunswick Valley Flood Plain Management Study Hydrology Report (WMAwater 1984)

Other previous flood studies were identified from the latest North Byron Floodplain Risk Management Study and Plan (WMAwater, 2020). Several of these studies were summarized by the 2020 North Byron FRMS&P including:

- Marshalls Creek Flood Study (1986)
- Flood mitigation Options for Billinudgel (1988)
- Brunswick River Floodplain Management Investigation (1989)
- Proposed Levees and South Golden Beach (1989)
- Report on Feasibility of an EIS for North Ocean Shores Flood Outlet (1992)
- Mullumbimby Floodplain Management Plan (1993)

Additional reports were identified to exist; however, they are not summarized by the FRMS&P or this flood study review. These include:

- Brunswick River Tidal Data Collection (2008)
- Kallaroo Circuit Bund Culver Amplification Hydraulic Impact Assessment (1996)
- Marshalls Creek Dredging Investigations Stage 1 Report (1992)
- Mullumbimby Floodplain Management Study Re-evaluation of Options (1992)

2.2 Brunswick Valley Flood Plain Management Study Hydrology Report (WMAwater Formerly Webb, McKeown & Associates, 1984)

2.2.1 Overview

This study was undertaken by WMAwater on behalf of Byron Shire Council. The scope of the study was limited to defining the hydrologic input parameters of the 20-year, 100-year and extreme floods within the Brunswick Valley for later use in hydraulic model development. A key limitation of this study included its timing. The study was conducted



almost 30 years ago, meaning it was conducted with less sophisticated industry standards resulting in limited storm pattern modelling, but also less available rainfall data for design rainfall estimation and now outdated modelling software.

2.2.2 Modelling Methodology

2.2.2.1 Hydrology Model

This study undertook development of a Boyd Hydrologic rainfall runoff model, similar to WBNM. Estimates of design rainfall depths were derived from ARR1977. "Extreme rainfall depths" were also provided by BoM for consideration in this study.

2.2.2.2 Calibration and validation

The hydrologic model was calibrated to several events. Calibration efforts included variation of "C" value for the Boyd Model to best fit historical events. IL and CL were identified from the rainfall and runoff volumes. The model parameters for each event identified are as shown in Table 2-1, where the 1972 event could not be accurately represented by available data and it is believed to be a localised event. Figure 2-1 and Figure 2-2 represent the hydrograph comparisons between the modelled and the recorded flood events for the March 1974 and March 1978 flood events respectively.

Table 2-1: Brunswick Valley FMS (1984) Calibration parameters

Event	"C" Parameter	IL	CL	Modelled Peak (m ³ /s)	Observed Peak (m ³ /s)	Comparison
October 1972	-	-	-	-	-	-
March 1974	2.2	0	4	296	299	Figure 2-1
March 1978	2.2	0	4	285	279	Figure 2-2

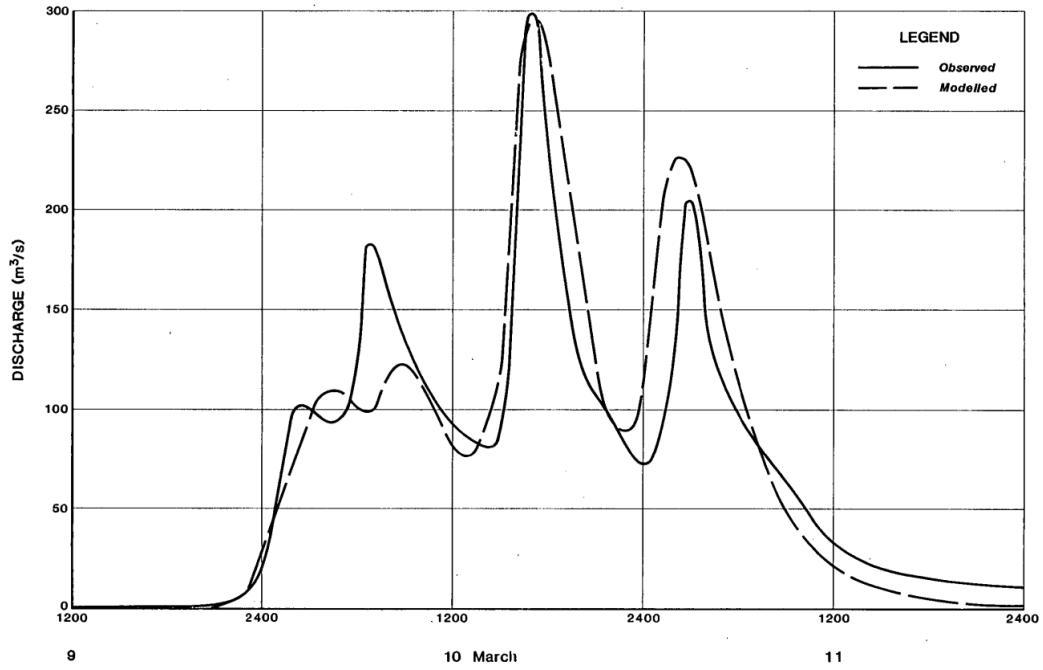


Figure 2-1: Brunswick Valley FMS (1984) 1974 Event Calibration Comparison at Durrumbul

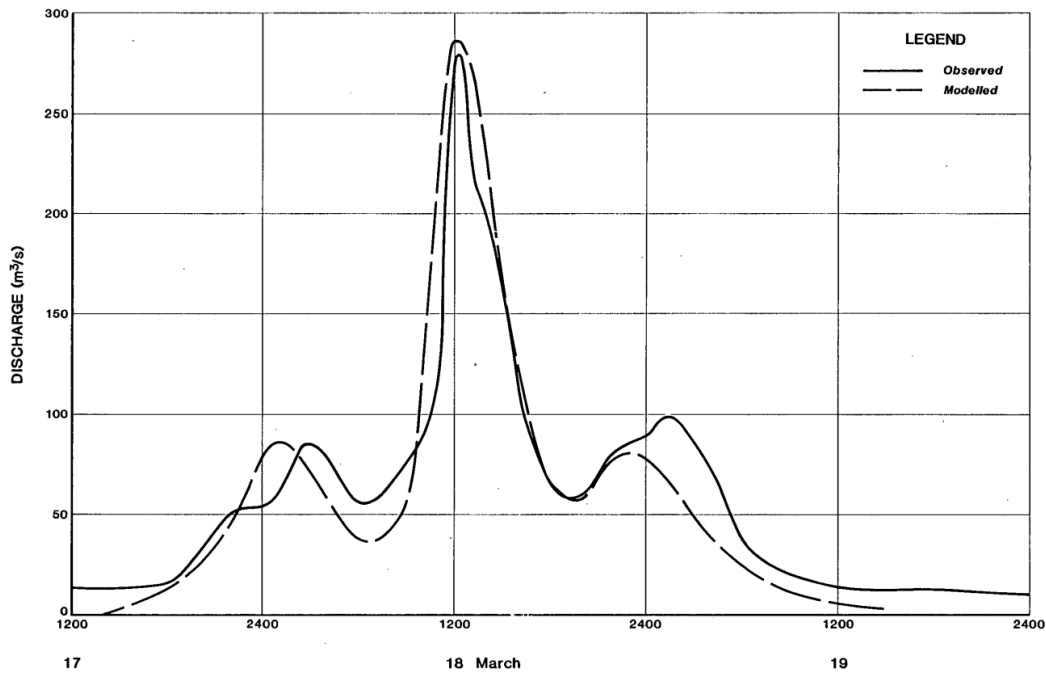


Figure 2-2: Brunswick Valley FMS (1984) 1978 Event Calibration Comparison at Durrumbul

The parameters derived from the calibration were then validated for the 1976 event and achieved a reasonable comparison to the 1976 flood hydrograph at Durrumbul, shown in Table 2-2 and Figure 2-3. The modelled results, however, appear to have missed the initial peak and has the major peak lining up with the third peak, which was the second largest peak for the observed event and occurred several hours after the major observed peak.

Table 2-2: Brunswick Valley FMS (1984) Parameter validation to the 1976 flood

	Observed	Modelled	Percentage Difference
Volume (ML)	6300	5650	-10%
Peak (m ³ /s)	144	170	+18%

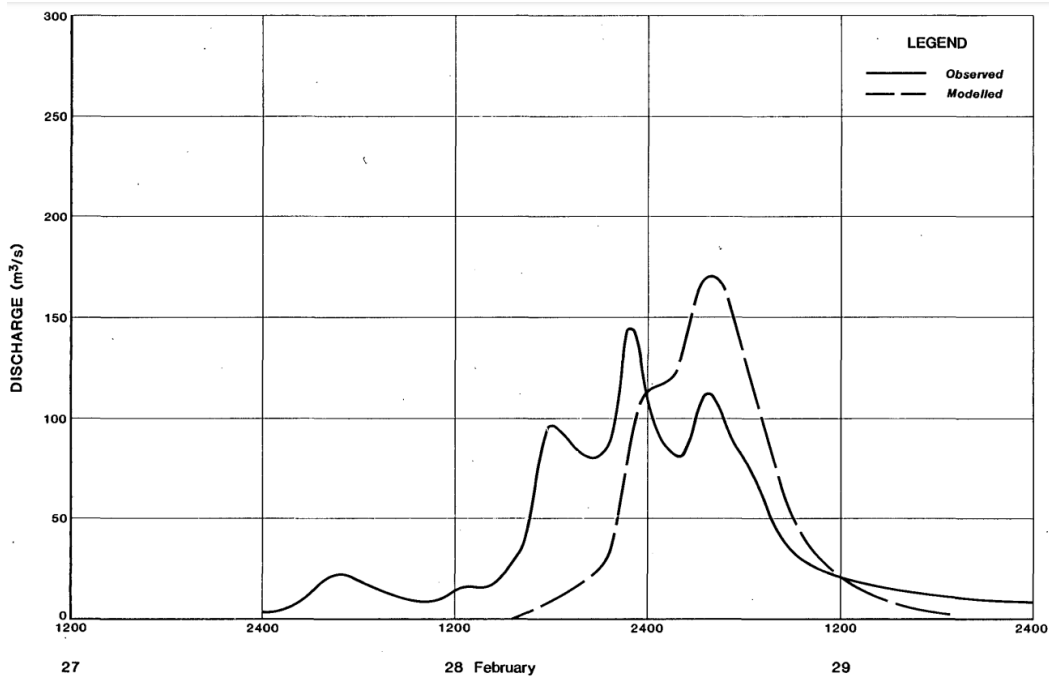


Figure 2-3: Brunswick Valley FMS (1984) Validation Results

2.2.2.3 Design Scenarios and Events

Rainfall depths were derived from local gauge analysis after identifying significant differences to generalised IFDs. A critical duration of 12 hours was identified for the study and a design temporal pattern was produced from observed storm behaviours. Following this the design hydrographs were produced for the 20, 100, and extreme events for the 12-hour critical duration. Resulting hydrographs for the 4.9%, 1% and "extreme" events are presented in Figure 2-4 to Figure 2-6

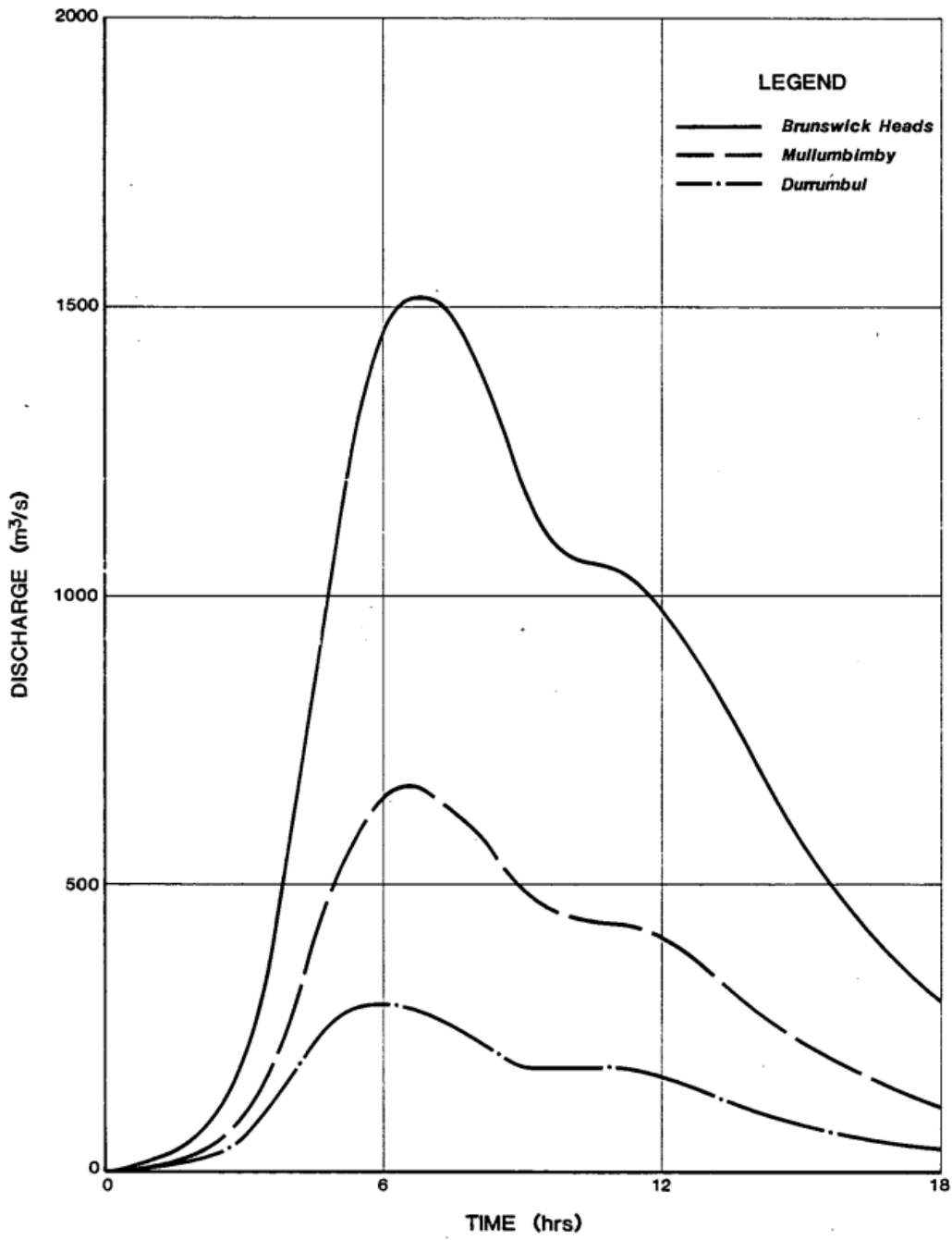


Figure 2-4: Brunswick Valley FMS (1984) Modelled 4.9% AEP Design Discharge

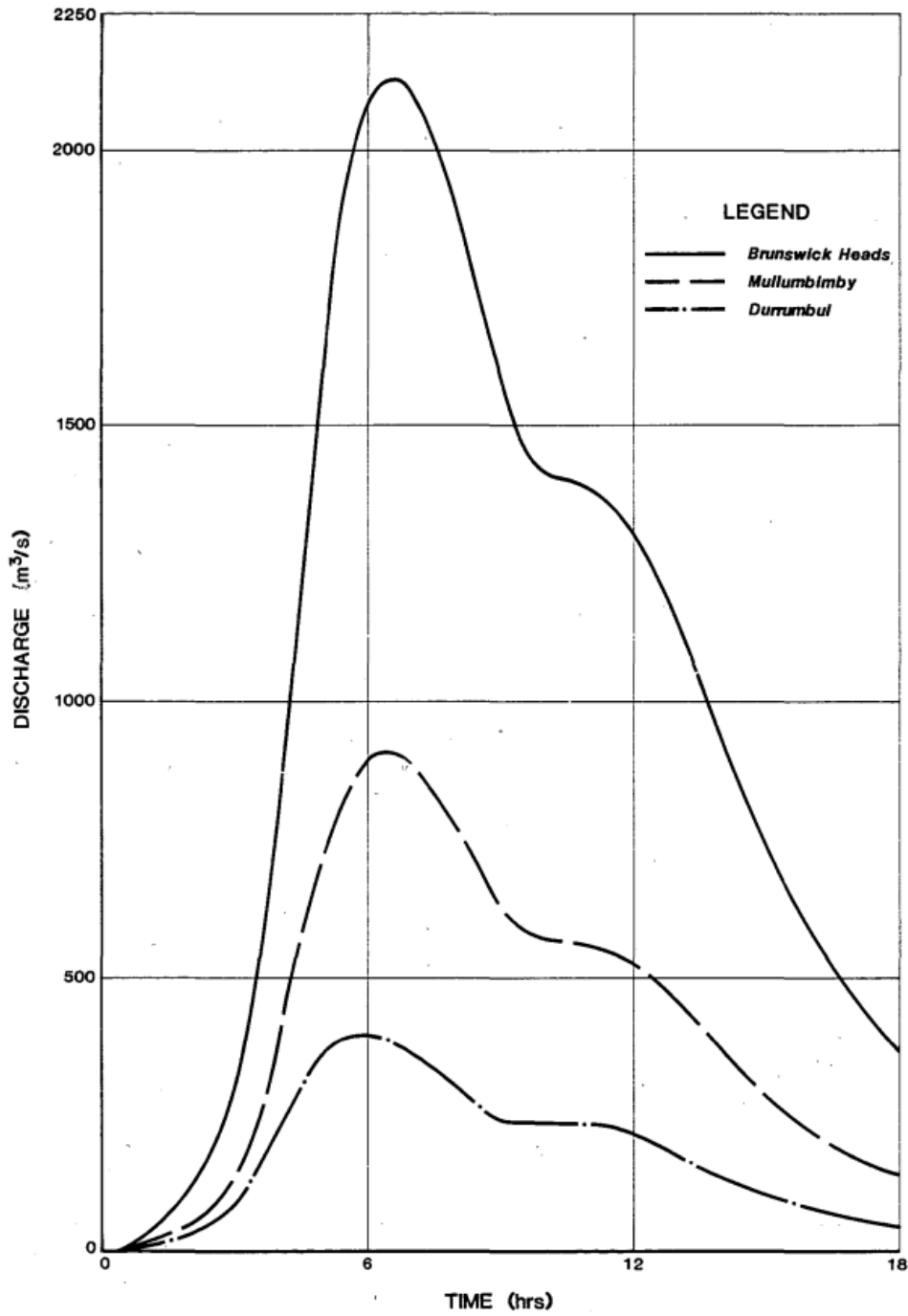


Figure 2-5: Brunswick Valley FMS (1984) Modelled 1% AEP Design Discharge

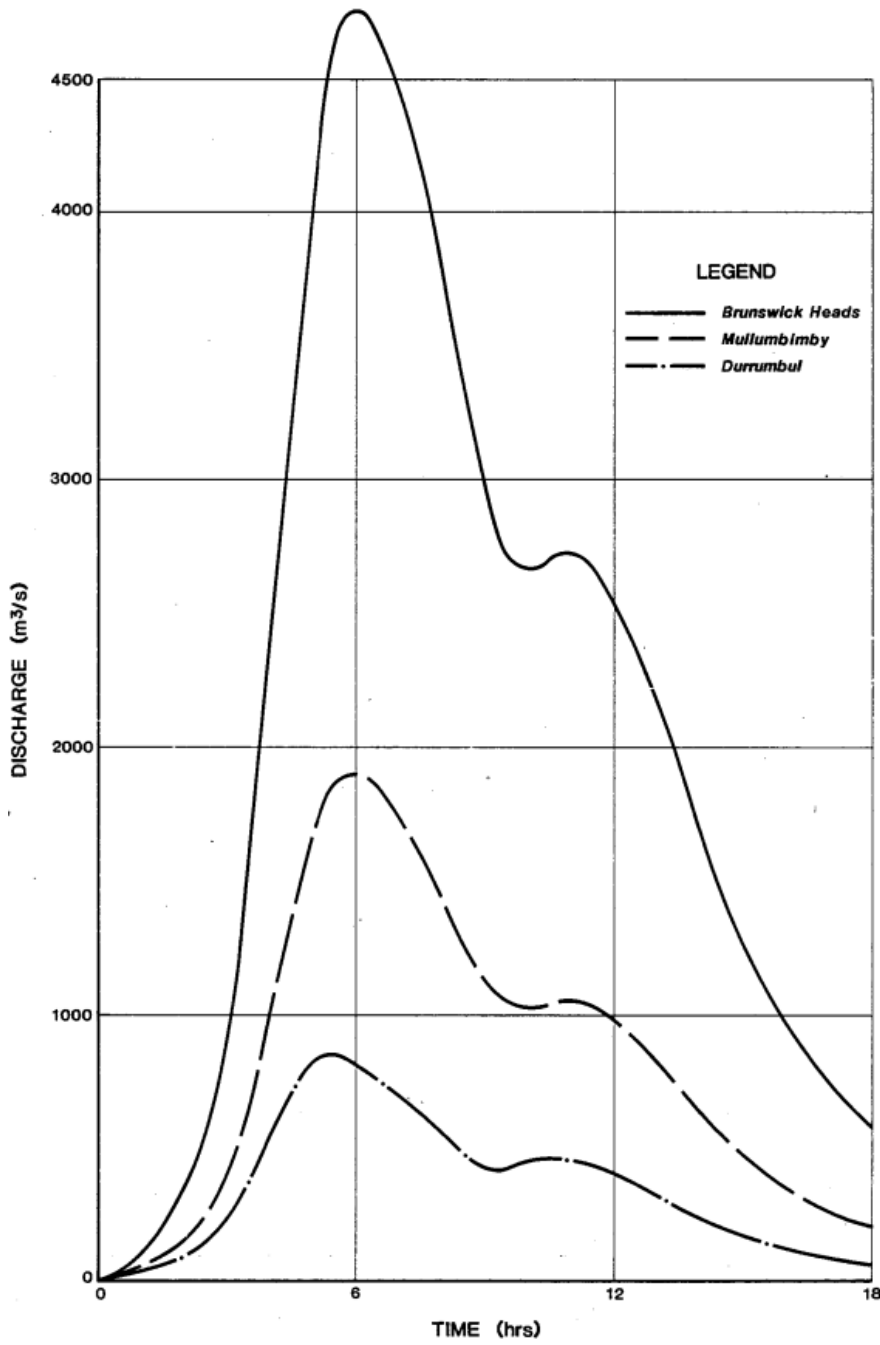


Figure 2-6: Brunswick Valley FMS (1984) Modelled "Extreme" Design Discharge



2.3 Brunswick River Flood Study (WMAwater Formerly Webb, McKeown & Associates, 1986)

2.3.1 Overview

This study was undertaken by WMAwater on behalf of Byron Shire Council. The scope of the study was limited to determining flood behaviour in the Brunswick River and adjacent floodplain from the mouth at Brunswick Heads to a point approximately 3km upstream of Mullumbimby. Peak flood levels were also obtained in the main southern tributary, Simpsons Creek. Key limitations of this study included limited established industry standards, quasi-two-dimensional (one dimensional) hydraulic model.

2.3.2 Modelling Methodology

2.3.2.1 Hydrologic Inflows

This study adopted hydrologic inflows produced by the Brunswick Valley FMS Hydrology study (WMAwater, 1984).

2.3.2.2 Hydrodynamic Model

This study undertook development of a quasi-two-dimensional hydraulic model, consisting of four sources of hydrographic and topographic data of varying quality, as follows:

- 1:4000 orthophoto maps derived from photogrammetry
- Hydrographic survey (PWD, 1983)
 - A contour plan of the riverbed from the entrance to the Pacific Highway bridge
 - 50 Cross-sections on the Brunswick River between the Highway bridge and a point upstream of Mullumbimby
 - 27 cross-sections on Marshalls Creek
 - 18 cross-sections on Simpsons Creek
 - 6 cross-sections on Kings Creek
- A survey of the floodplain carried out by Council in 1983, specifically for this study.
- An additional survey carried out by Council in 1984, which defined areas in and to the south of Mullumbimby in more detail.

2.3.2.3 Calibration/Validation/Sensitivity

The hydrodynamic model was calibrated to the 1978 flood event. Calibration efforts included variation of manning's roughness. This resulted in adopting roughness by cross section, ranging from 0.020 - 0.130 Mannings 'n' values. Calibration efforts resulting in fair model calibration from the timing of the study, with results generally falling within $\pm 0.2m$ difference to observed flood markers.

2.3.2.4 Scenarios and Events

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Similarly, to the hydrology study, the 5%, 1% and "extreme" design storm events were modelled, these were paired with the 5% and 1% design ocean levels of 2.3mAHD and 2.6mAHD, from previous investigations. This produced peak water level contours and Brunswick River peak water level profiles shown in Figure 2-7.

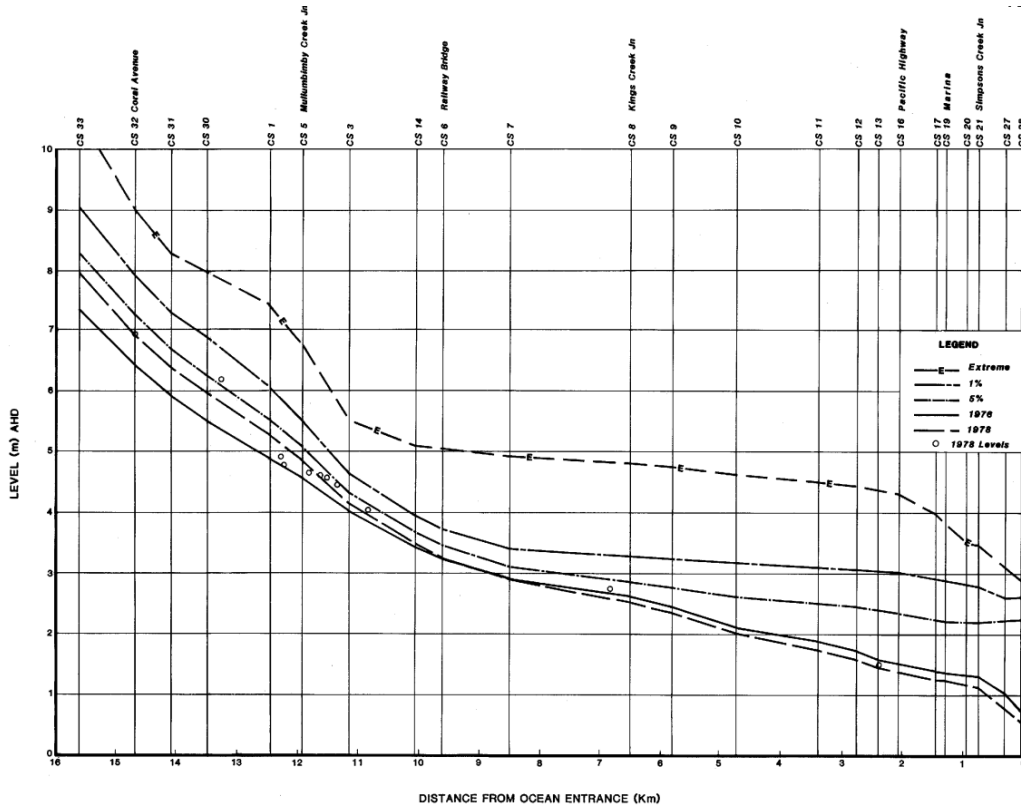


Figure 2-7: Brunswick River FS (1986) Brunswick River Design Peak Level contours

2.4 Tweed-Byron Coastal Creeks Flood Study (BMT, 2009)

2.4.1 Overview

This study was undertaken by BMT on behalf of Tweed Shire Council, and due to the interactions of Yelgun/Marshalls Creek with Mooball Creek, Byron Shire Council took the opportunity to update Marshalls Creek Floodplain Management Plan as part of the study.

The primary objective of the study was to define flood behaviour of several coastal creeks, including the two creeks within the Byron Shire Council LGA, Yelgun Creek and Marshalls Creek. Key limitations of this study included the adoption of ARR87 methodology, outdated land-use, and limited data availability.



2.4.2 Modelling Methodology

2.4.2.1 Hydrology Model

This study undertook refinement of previously developed XP-RAFTS model developed by SMEC in 2006 for the Assessment of Flooding Behaviour in the Marshalls Creek Catchment Study. The hydrologic model extended over several local tributaries including, Burringbar, Sheens, Crabbes, Yelgun and Marshalls Creeks.

2.4.2.2 Hydrodynamic Model

This study undertook development of the Marshalls Creek TUFLOW hydraulic model. A two-dimensional model using a 15 metre grid resolution was adopted to represent the Marshalls Creek floodplain. The TUFLOW FV morphological model was utilized in the study to estimate bathymetry conditions at creek mouths.

2.4.2.3 Calibration/Validation/Sensitivity

The hydrodynamic and hydrologic models were calibrated to the June 2005 event and validated against the May 1987 event.

The calibration effort included the survey of several flood marks, undertaken by Council to provide peak water levels across the catchment, with the modelled peak water levels generally falling within 0.15m of the observed for the June 2005 event. Several recorded flood marks were located outside of the creek at relatively low levels such as 2.2mAHD at New Brighton, 2.6mAHD at Ocean Shores, and 3.9mAHD at Billinudgel, with the peak downstream level peaking at above 1.5mAHD catchment conditions are believed to account for only a portion of the resulting water levels. However, the available peak flood markers do generally support the peak flood levels observed.

A validation of the model was undertaken using the May 1987 event which had several flood markers, with the modelled results generally within 0.2m of the observed peak flood level.

The June 2005 event, had recorded water levels available for Billinudgel Gauge, and periodic recordings at Kallaroo Circuit culverts, the modelled results for the event are shown in Figure 2-8 and Figure 2-9. These indicate a fair calibration to flood peak level at Billinudgel, however falling limb indicates a misrepresentation of low storage-discharge relationships. Recorded water levels at the Kallaroo Circuit culverts were recorded at irregular and sparse intervals and are believed to not capture the timing of the peak, limiting the value of recorded results, however a comparison can be made to the progression of the flood wave, which indicates a fair validation for the falling limb.

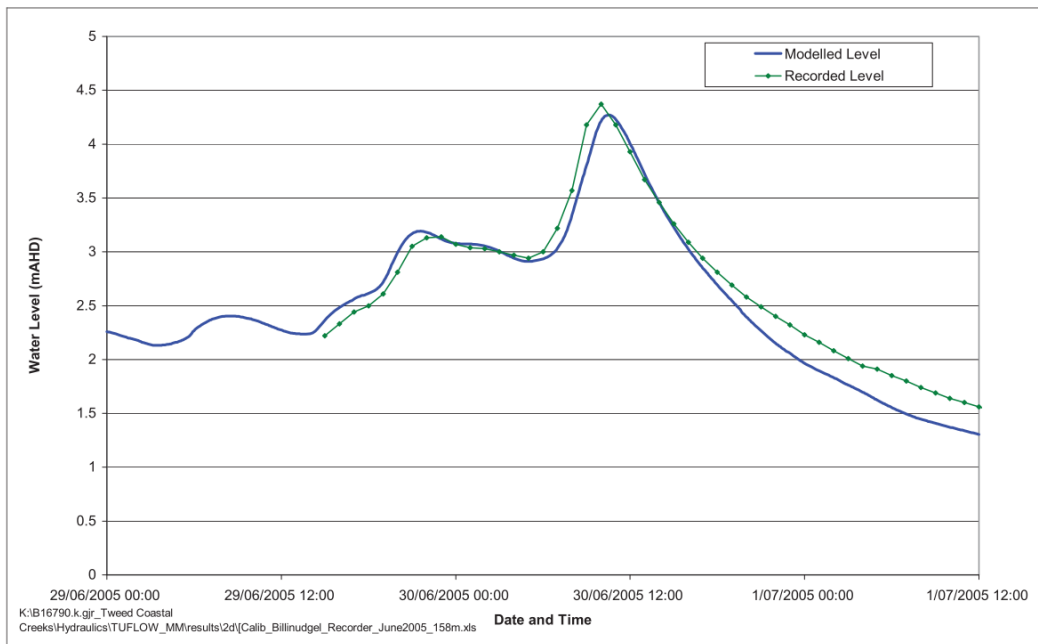


Figure 2-8: Tweed-Byron Coastal Creeks FS June 2005 Event Calibration at Billinudgel gauge

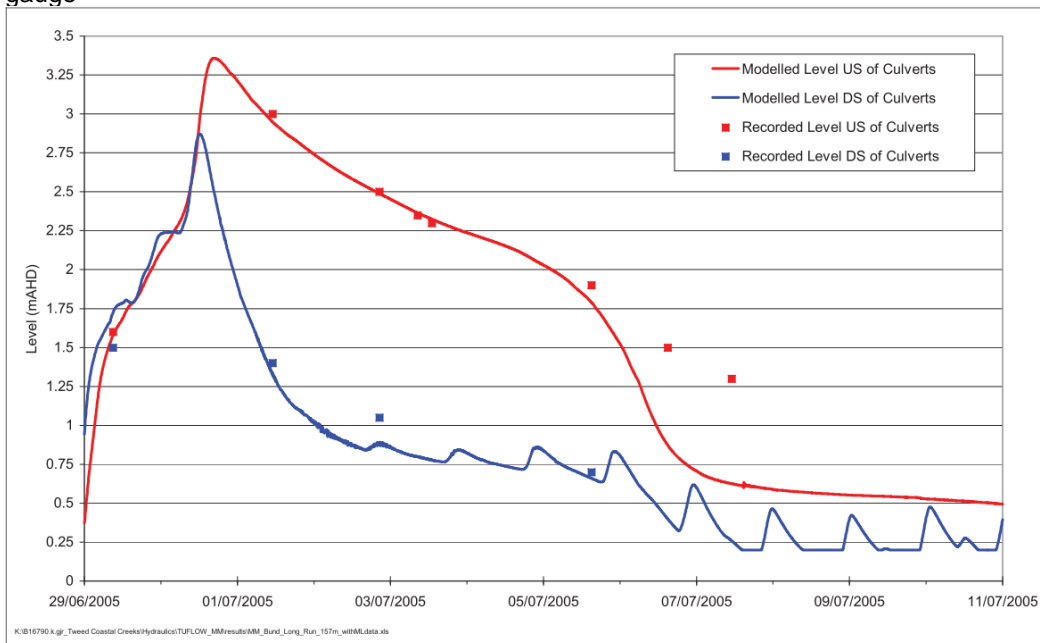




Figure 2-9: Tweed-Byron Coastal Creeks FS June 2005 Event Calibration at Kallaroo Circuit Culverts

2.4.2.4 Scenarios and Events

Several scenarios and events were modelled and have been summarized in Table 2-3.

Table 2-3: Tweed-Byron FS Modelled Scenarios and Events

Design Event	Catchment Inflow	Ocean Boundary	Ocean Boundary
	Rainfall Event	Storm Surge Event	Peak Tailwater Level (mAHD)
5 year ARI	5 year ARI	5 year ARI	0.8
10 year ARI	10 year ARI	10 year ARI	1.5
20 year ARI (envelope)	20 year ARI	10 year ARI	1.5
	10 year ARI	20 year ARI	2.2
50 year ARI (envelope)	50 year ARI	10 year ARI	1.5
	10 year ARI	50 year ARI	2.4
100 year ARI (envelope)	100 year ARI	20 year ARI	2.2
	10 year ARI	100 year ARI	2.6
500 year ARI	500 year ARI	100 year ARI	2.6
PMF	PMF	100 year ARI	2.6

2.4.3 Mitigation Measures

The report provided several recommendations to be assessed in the floodplain risk management plan, which was to be completed at a later stage. These recommendations included:

- Update Flood Planning Levels based on the results of this Flood Study, as well as Local Environmental Plans and Development Control Plans as appropriate.
- Update Councils GIS systems with the flood mapping from the Flood Study.
- Update S149 certificates for properties affected by flooding.
- Proceed to the preparation of the Floodplain Risk Management Study, to determine options to manage and/or reduce the flood risk taking into consideration social, ecological, and economic factors.
- The flooding interactions between Marshalls Creek and the Brunswick River should be considered prior to undertaking the Floodplain Risk Management Study for the area. The results of the Coastal Creeks Flood Study didn't consider coincident Brunswick River and Marshalls Creek flooding nor storm surge propagation.
- It was noted that the Floodplain Risk Management Study could be undertaken separately by each Council for their respective area. However, both Councils



should ensure that management and mitigation options do not adversely impact on flooding behaviour where the floodplains are connected.

- On completion of the Floodplain Risk Management Study, a list of preferred options that were recommended by each Council would be presented in an overall Floodplain Risk Management Plan to be publicly exhibited for comment by the community and subsequently approved and implemented by Council.

2.5 Marshalls Creek Floodplain Management Plan (Paterson Consultants, 1997)

2.5.1 Overview

This study was undertaken by Paterson Consultants on behalf of Byron Shire Council. The scope of the study was limited to the development of the floodplain management plan for Marshalls Creek, and tributaries of Yelgun Creek and Billinudgel Creek, and did not undertake any modelling, at the timing of the study Council had adopted the Brunswick River Flood Study (Webb, McKeown & Associates, 1986). Key limitations of this study include the timing of the study as several new developments and changes in land use have occurred since the timing of the study, however many of the recommendations remain valid and are similar to present day council adopted floodplain risk management plans.

2.5.2 Identified Hazards/Risks

2.5.3 Mitigation Measures

Several floodplain management objectives were identified for this study including:

- Alerting the community to the extent and hazard of flood prone land in the Marshalls Creek area.
- Informing the community of Council's policies in relation to the development and use of flood prone land.
- Definition of a flood standard to be used for planning purposes.
- Reduction of the risk to human life and damage to property caused by flooding by appropriate works and measures and by controlling development on flood prone land.
- Adoption of requirements for development and for the use of land which is compatible with the land's flood hazard.
- Reduction of the impact of flooding on existing development by a series of works and measures.
- Prevention of flood losses in future development areas by application of effective planning and development controls.
- Provision of controls regarding flooding such that applications for development (including sub-division, rezoning development and building applications) can be assessed both consistently and on merit in accordance with the NSW Floodplain Development Manual (published by NSW Government, 1986)



- Incorporation of plan provisions into planning policy provisions

The study proposed several general mitigation measures which are summarised in Table 2-4, as well as local mitigation measures summarised in Table 2-5.

Table 2-4: Marshalls Creek FMP General Flood Mitigation Controls

Category	Controls
New sub-divisions of Flood-liable Lands	A moratorium for development of flood-liable land and filling of flood liable lands.
Development of Existing Lots and existing sub-divisions	A building application process
	Effluent disposal mounds where appropriate shall be located to provide minimal obstruction to local drainage and flood flows
Public Information and Education Programs	Byron Council and the SES should monitor the distribution of public information
	Public information should be reviewed after each major flood and amended where necessary
Flood Warning	Improvements to the warning system be investigated principally covering water level gauges to provide public information use of local area "Wardens" to assist in distribution of warnings
	Review of the Flood Plan be undertaken to ensure the consistency of damage and risk areas between all documents and the flood evacuation centres are located on flood free sites
	Investigation if established computer models can be used to improve flood prediction systems downstream of Billinudgel
	Funding to be sought to improve SES capacity to manage flood emergencies
Individual Lot Landscaping provisions	Building and development application provisions to be modified to promote open fencing and prevent traditional high "closed" style fencing
	Building and development controls such that flood protection measures on any particular block do not adversely affect the drainage and flooding characteristics on the surrounding blocks
Trunk Drainage Operations	A trunk drainage plan through the study area is required to identify works and measures to improve the efficiency of the system and to improve water quality
	Council's building and development conditions be reviewed to ensure they require and enforce the provision of overland flow



Category	Controls
	paths for safe discharge of runoff if the trunk drainage system should become blocked
Infrastructure Crossings	Byron Council should develop a set procedure for assessing the impacts of infrastructure crossings of the floodplain
	The established procedure should be applied to all works including those undertaken by Council
	Byron Council should notify the various government bodies authorities and construction groups of the intention to apply the principles of the Floodplain Management Plan to all land within the study area.
Integrated Catchment Management	Applications for development approval or change in land use shall be required to demonstrate that such development or change in land use will not increase runoff flowrates or pollution loadings within the Plan Area.

Table 2-5: Marshalls Creek FMP Local Flood Mitigation Controls

Region	Controls
Billinudgel	Building controls allowing setting of minimum floor levels for new buildings, infill development and building extensions
	The storage of all toxic or hazardous substances or other products which in the opinion of Council may be hazardous or polluted flood waters, must be a minimum of 0.5m above designated flood level
	Development controls to allow filling of existing sub-divisions within the village
	Prohibition of further sub-division of flood liable land adjacent to the existing village boundaries
South Golden Beach and Ocean Shores North	Building controls allowing setting of minimum habitable floor levels for new buildings, infill development and major building extensions at RL 3.6m AHD
New Brighton	Building controls to be developed to
	Landscaping directions to be developed regarding fencing, flood access indicators, effluent disposal mounds



	An interim measure was proposed to adopt the building material and detail guidelines in Appendix F of the NSW floodplain development manual
Ocean Shores	Building controls to set minimum floor levels flood compatible building materials and design of buildings to promote flood compatibility
	Prohibit subdivision or filling of undeveloped "High Hazard" areas.
Ocean Shores North/South Golden Beach/New Brighton Non-Urban Area	Prohibit non-compatible development of "High Hazard - Flood Storage classed land
	Prohibition of further fill or sub-division of the area
Yelgun/Wooyung Area	Building Controls to set minimum floor levels, Flood compatible building restraints, design of buildings to provide flood compatibility flood mounds to provide adequate flood refuge area

2.5.4 Other Findings

The study identified 28 houses in New Brighton and 1 house in Ocean Shores that would be suitable for house raising and a further 21 houses in New Brighton and 95 houses in Ocean Shores which would be appropriate for flood proofing. The study identified funding for house raising through joint Federal, State Governments and Council funded Flood Mitigation Programme to cover the full cost of house raising. The study estimated potential costs at the timing of the study for these works being:

- **House-raising (29 Houses) \$ 1,015,000**
- **Flood Proofing (116 houses) \$ 342,000**

There is some difference between number of houses suggested for flood proofing in the text and in the tables and summary.

2.6 North Byron Flood Study (BMT, 2016)

2.6.1 Overview

This study was undertaken by BMT on behalf of Byron Shire Council. It included the development of detailed hydrological and hydraulic models for Brunswick River to investigate flood risk for the catchment, for use in subsequent floodplain risk management studies.



The scope of the study was limited to the Brunswick River, Simpsons Creek, and Marshalls Creek Catchments. Key limitations of this study included the poor calibration results to catchment response and the use of the ARR87 methodology.



2.6.2 Modelling Methodology

2.6.2.1 Hydrologic Model

This study undertook the development of an XP-RAFTS hydrological model for Brunswick River, Simpsons Creek, Marshalls Creek and Yelgun Creek. The XP-RAFTS model included several sub catchments to represent each of the major catchments, Brunswick River, Marshalls Creek, Simpson Creek and Yelgun Creek. Upstream sub catchments utilized an external routing methodology with no attenuation of peak flow and specification of travel time in attempt to minimize steep catchment's peak flow attenuation, remaining sub catchments utilized XP-RAFTS Muskingum routing methodology.

2.6.2.2 Hydrodynamic Model

This study undertook development of detailed TUFLOW hydrodynamic models that covered Ocean Shores, Brunswick Heads, Mullumbimby, and Brunswick River Estuary. In the upper areas of the floodplain a significant portion of major creeks and rivers were represented as one dimensional network, as shown in Figure 2-10. The Mannings' roughness values adopted for the design event modelling are presented in Table 2-6. Some of these roughness values are considered to be in the lower end of the range for roughness for typical the land use/vegetation types, however they are considered within reason.

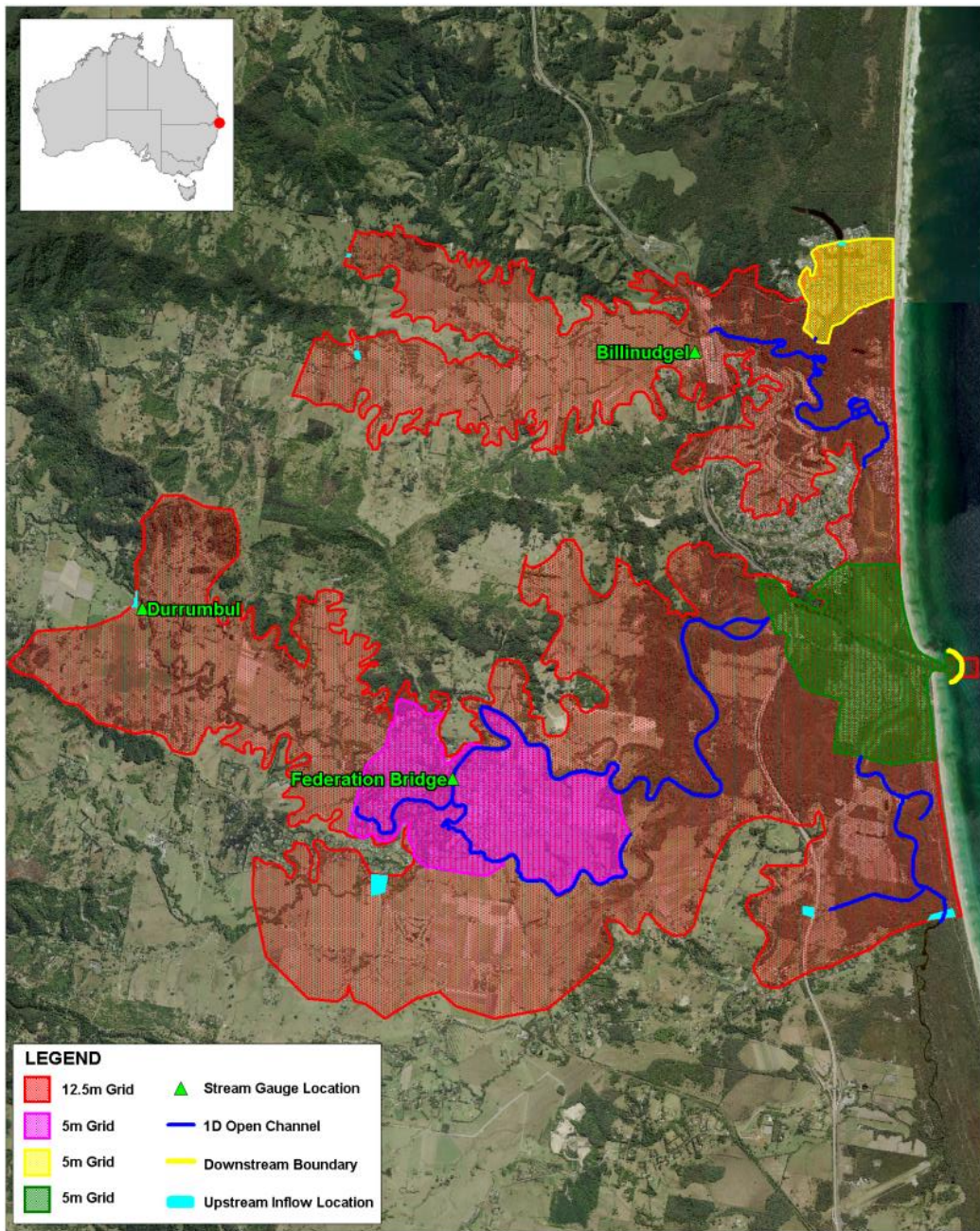


Figure 2-10: North Byron Flood Study (BMT, 2016) Model Schematization



Table 2-6: North Byron Flood Study (BMT, 2016) Roughness Values

Land Use Type	Mannings' n Value
Pasture / Grass	0.04
Scattered Trees	0.05
Medium Trees	0.07
Thick Trees / Forest	0.09
Sandy River Bed	0.03
River Bed	0.04
Dams	0.07
Rock Walls	0.04
Urban Block	0.1
Golf Course	0.04
Sugar Cane	0.2
Bitumen Road	0.02
Gravel Road	0.025
Large Building Footprints	1.00

2.6.2.3 Calibration and Validation Overview

The hydrodynamic and hydrologic models were calibrated to the June 2005 and January 2012 flood events. Calibration efforts included hydrologic and hydrodynamic model calibration. Hydrologic model calibration included variation of; storm losses (IL and CL), roughness, and lag time for upstream sub catchments routing methodology as described in 2.6.2.1. Hydrodynamic model calibration included variation of roughness and structure losses. The calibration efforts results in a varying accuracy in the representation of the events throughout the catchment, the study identified that some of the discrepancies between the observed and the modelled results could be attributed to ever-changing catchment characteristics (including the Pacific Highway Upgrade) and data availability and accuracy, structure blockages and sub-daily rainfall data. Several observations were made on review of the resulting calibration comparisons.

2.6.2.4 Calibration results at Durrumbul

Model results of the Brunswick River Upstream of Durrumbul indicates that there is a misrepresentation of catchment response and falling hydrograph limbs, which is indicative of lower lag or attenuation and misrepresentative of storage - discharge relationships. Examples taken from the report of these comparisons of recorded data at Durrumbul to modelled data are provided in Figure 2-11, Figure 2-12, Figure 2-13, Figure 2-14.

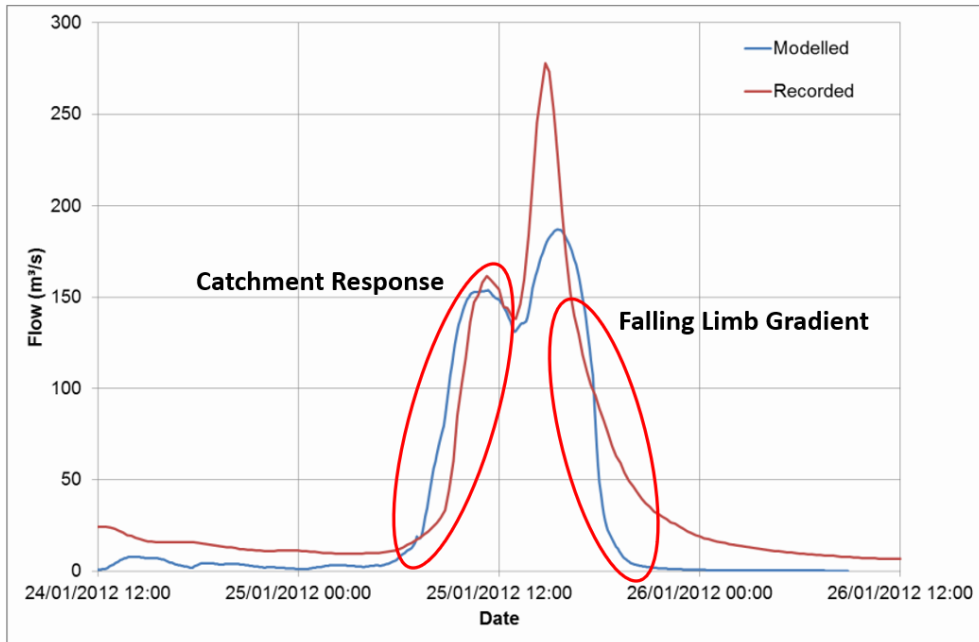


Figure 2-11: January 2012 Calibration Results at Durrumbul

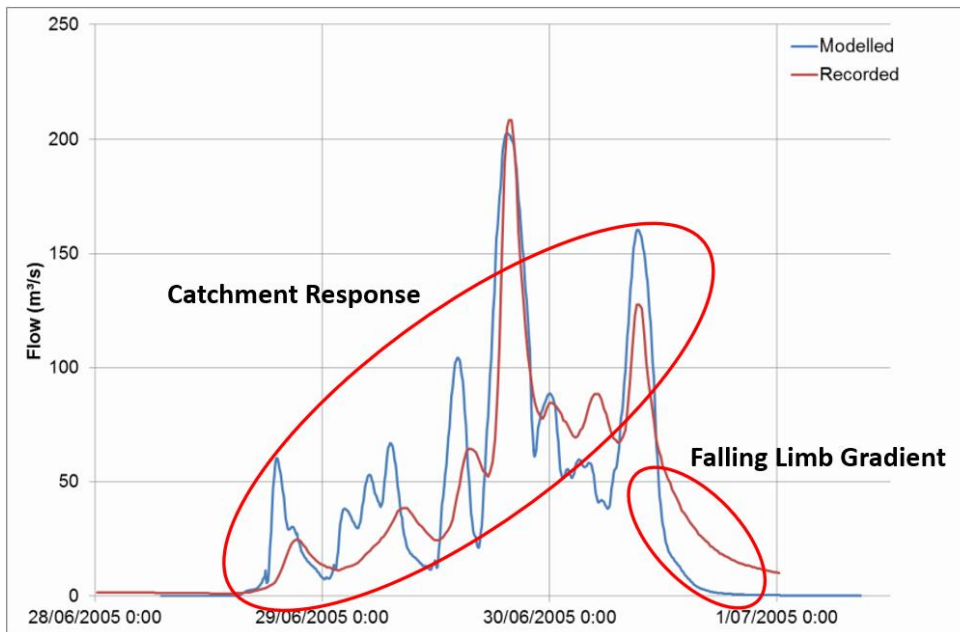


Figure 2-12: June 2005 Calibration Results at Durrumbul

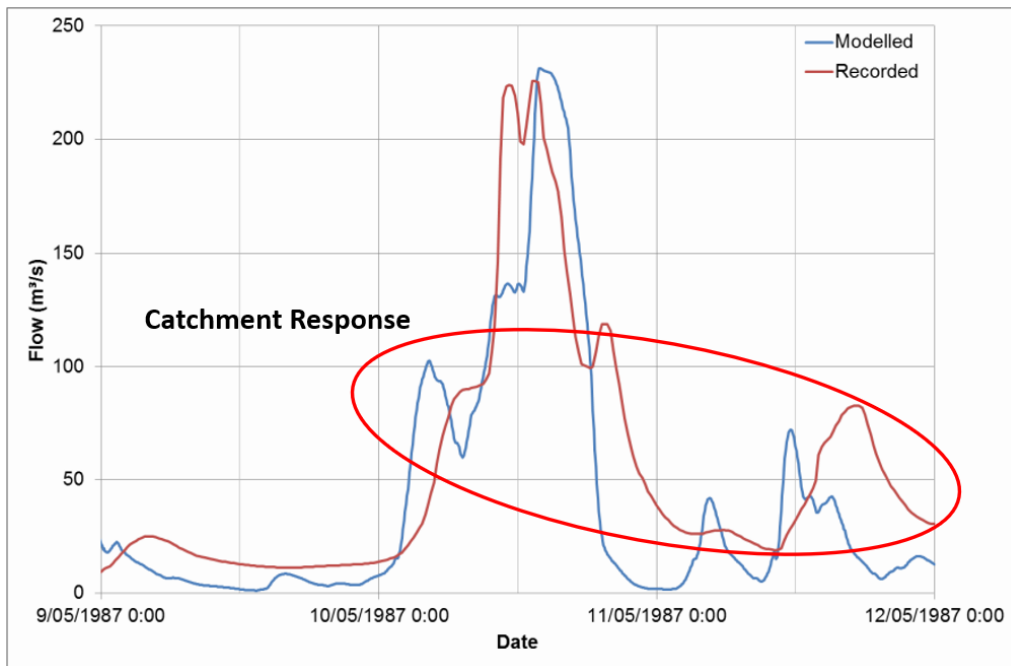


Figure 2-13: May 1987 Calibration Results at Durrumbul

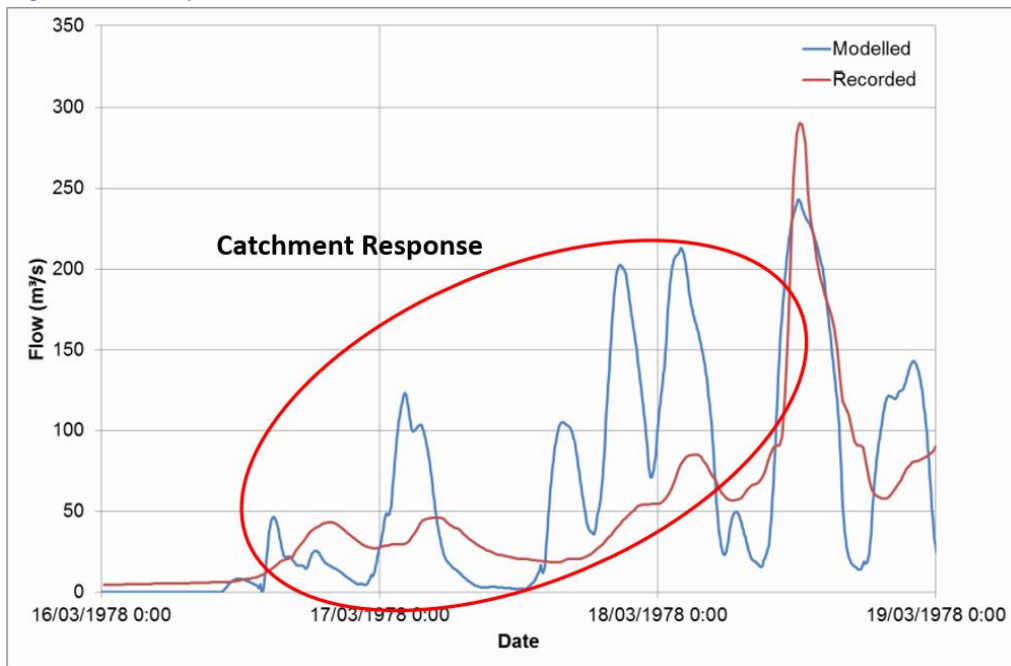


Figure 2-14: March 1978 Calibration Results at Durrumbul



2.6.2.5 Calibration Results at Billinudgel

The hydraulic modelling results at Billinudgel gauge resulted in fair peak level comparisons, however a minor discrepancy was observed to the falling limb of the hydrograph shown in Figure 2-15. This discrepancy is relevant in assessing duration of inundation, which may be important to cropping lands or duration of closure to inundated roads.

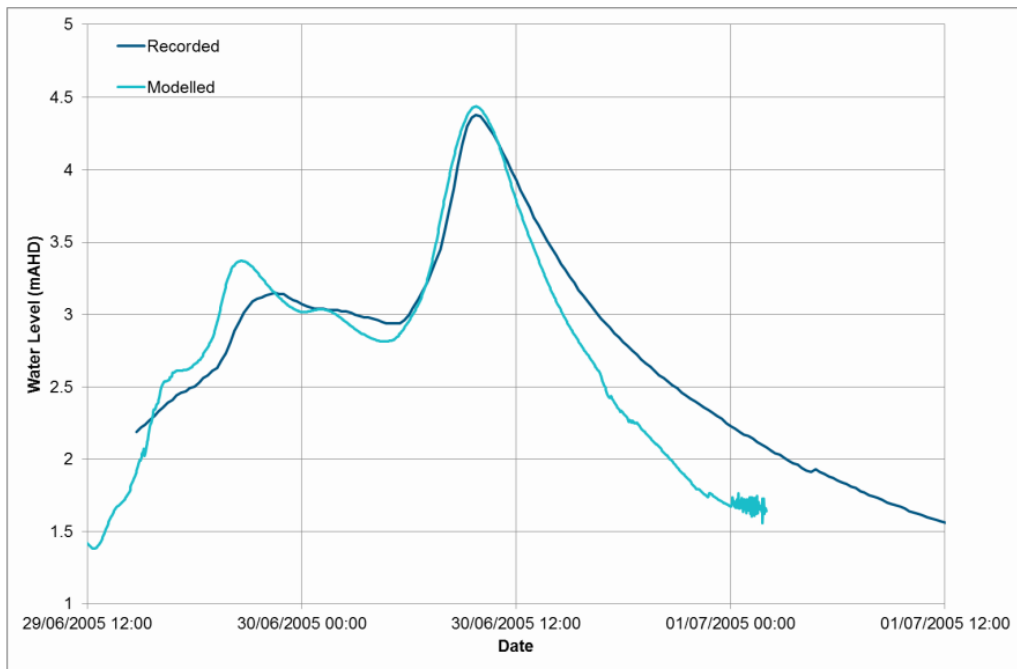


Figure 2-15: North Byron Flood Study (BMT, 2016) Billinudgel Falling Limb

2.6.2.6 Calibration Results at Federation Bridge

Federation Bridge hydraulic model results indicate an overestimation of catchment volumetric response; however, the study believed a significant portion of the observed differences could be due to the data limitation of the sub-daily rainfall. Comparisons are shown in Figure 2-16 and Figure 2-17.

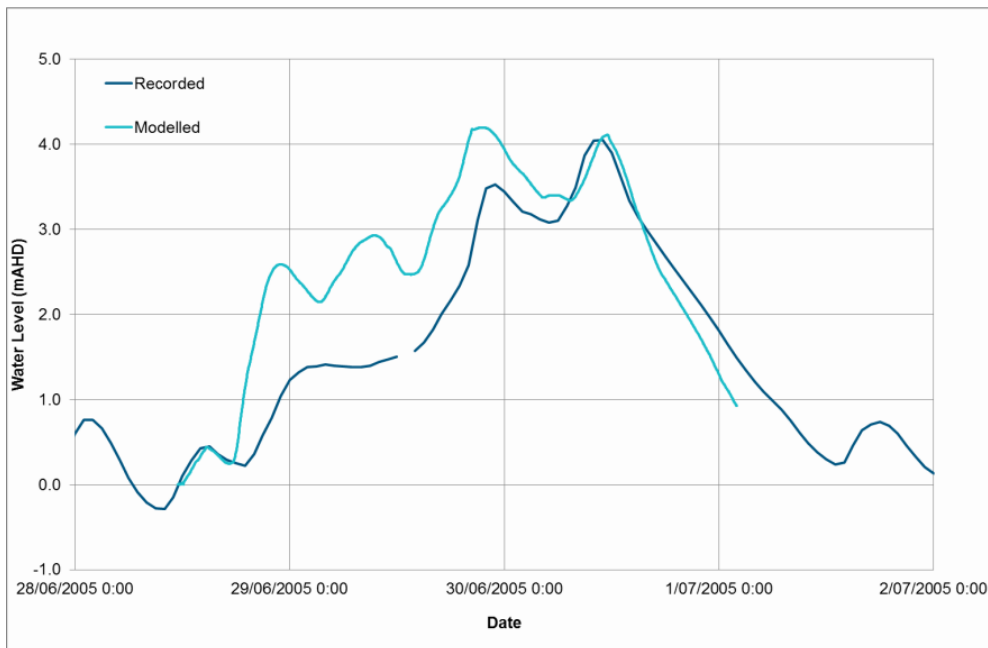


Figure 2-16: North Byron Flood Study (BMT, 2016) 2005 Event Comparison at Federation Bridge

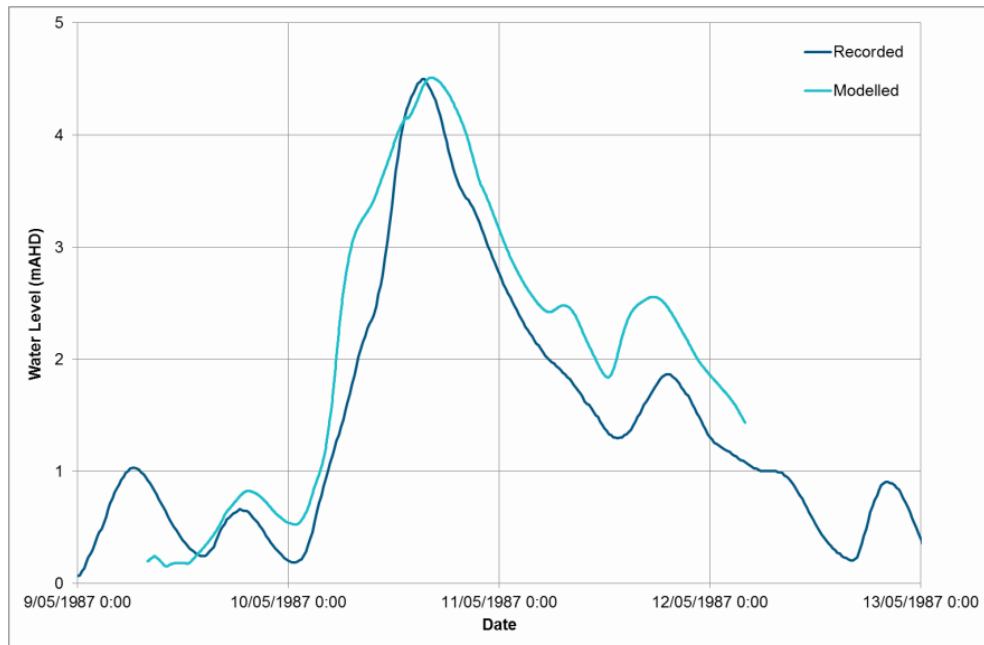


Figure 2-17: North Byron Flood Study (BMT, 2016) 1987 Event Comparison at Federation Bridge



2.6.2.7 Flood marks validation

Recorded flood marks are considered to generally align with model results, with relatively small absolute differences as shown in Figure 2-18 supporting the model calibration. However, it is believed that several recorded flood marks are believed to be located in shallow/sheet flow areas, which generally result in minor absolute differences and are not well related to the main flood flows, limiting the conclusions that can be drawn from these flood marks. It is noted that there is an approximately 1m difference between the recorded and the modelled for a flood mark near Mullumbimby.

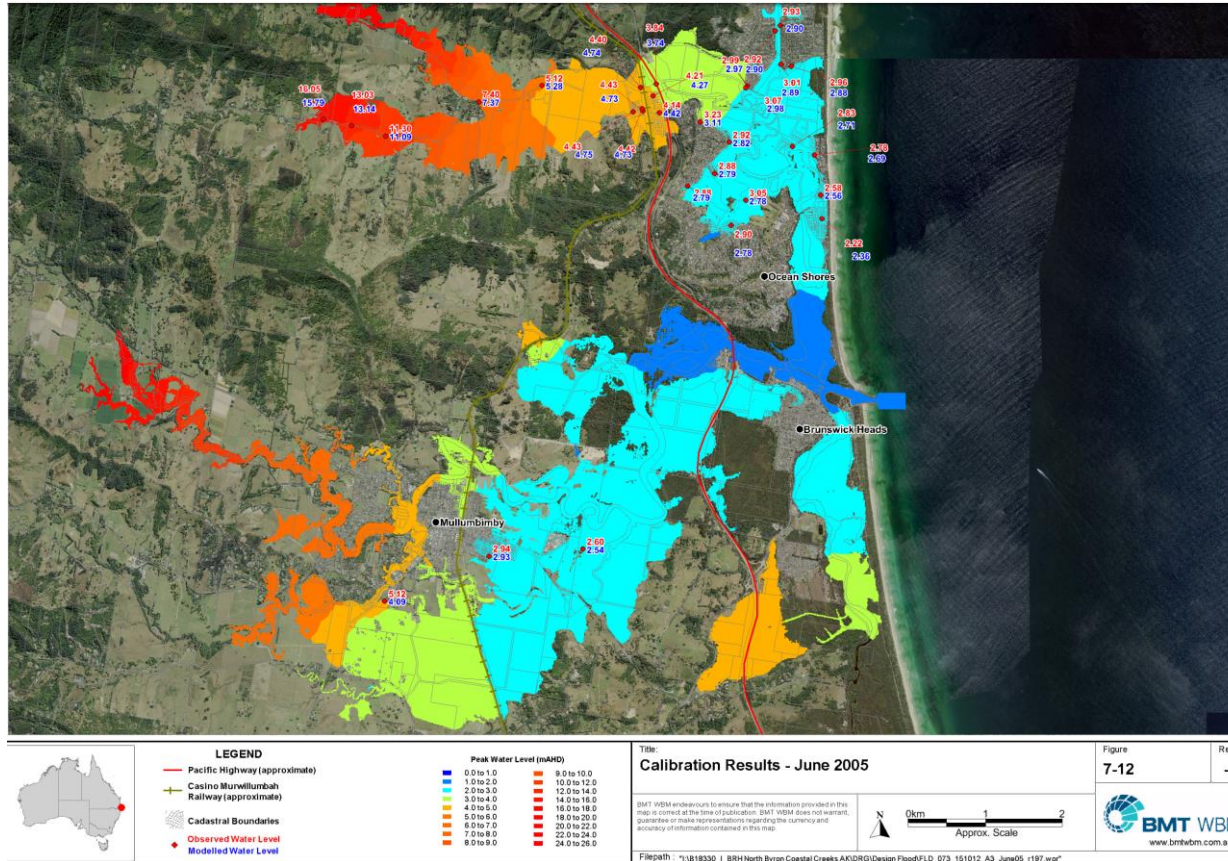


Figure 2-18: North Byron Flood Study (BMT, 2016) 2005 Event Flood Marks Comparisons



2.6.2.8 Scenarios and Events

Several scenarios and events were modelled, including both rainfall and ocean storm surge dominated flood events, for the 5, 10, 20, 50, 100, and 500 year Average Recurrence Interval (ARI), and the PMF events. In addition, climate change sensitivity scenarios were modelled which included, sea level rise and increased rainfall intensity.

2.6.3 Identified Hazards

The flood study undertook community engagement in aims to quantify hazards and concerns facing the community. Results from the community engagement are presented in Figure 2-19 and Figure 2-20

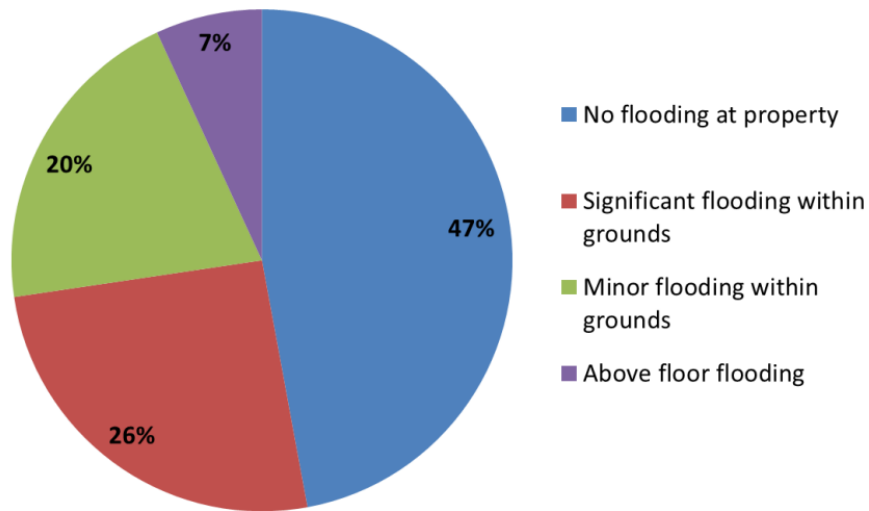


Figure 2-19: North Byron Flood Study (BMT, 2016) Community Identified Degree of Flooding

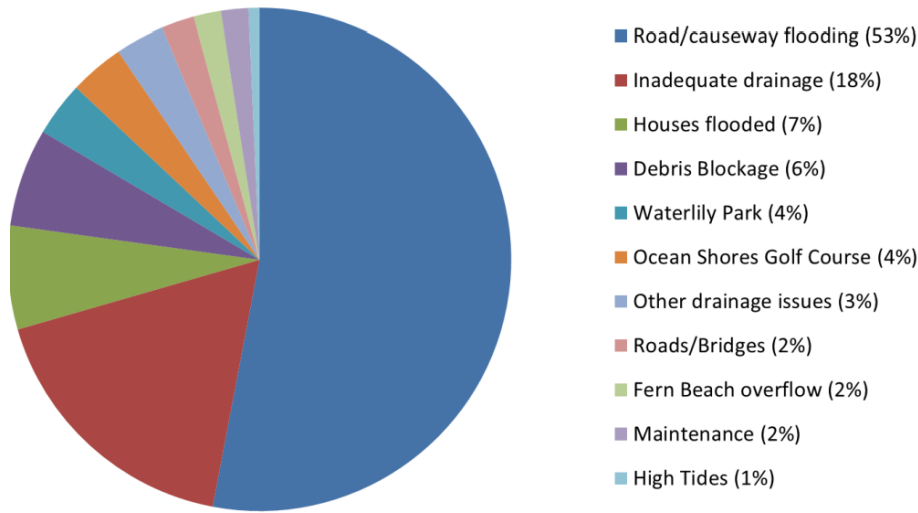


Figure 2-20: North Byron Flood Study (BMT, 2016) Community identified flood hazards

2.6.4 Flood Risk Management Measures

From the conducted community engagement survey several flood risk management options were proposed by the community, presented in Table 2-7. From the community responses a significant portion of management options proposed were attributed to:

- Improve Road Drainage (26%)
- Increase maintenance (23%)
- Dredge creeks and river (19%)
- Remove vegetation/debris/silt (11%)

Similarly, responses to "Flooding issues that should be considered" were largely attributed to:

- Dredge river (25%)
- Restrict / Regulate development in floodplain (21%)
- Storm water drainage (12%)
- Brunswick River Mouth (10%)
- Clean and maintain drainage (7%)



Table 2-7: North Byron Flood Study (BMT, 2016) Community Management Options

Ideas to Improve Flooding		Flooding Issues that Should be Considered	
Improve road drainage	26%	Dredge river	25%
Increase maintenance	23%	Restrict / regulate development in floodplain	21%
Dredge creeks and river	19%	Storm water drainage	12%
Remove vegetation/debris/silt	11%	Brunswick River mouth	10%
Open ocean outlets	3%	Clean and maintain drainage	7%
Levees / bunds	3%	Better flood warning / education	4%
Modify road/rail structures	3%	Modify road / rail structures	3%
Look at Marshalls Creek confluence with Brunswick River	2%	Other	3%
House Raising	2%	Substation at Waterlily Park	2%
Modify Waterlily Lake	2%	Tsunami alerts	1%
Raise causeways/keep clear of debris	2%	Increase in mosquitos	1%
Raise / monitor easements	1%	Sewage in Brunswick River	1%
Remove rock wall	1%	Climate change	1%
Fern Beach resulted in flooding of South Golden Beach	1%	Height of causeway on Main Arm Road	1%
Use wetland areas for mitigation	1%	Insurance	1%
Open flood gates on Golf Course	1%	Sand bar in Marshalls Creek	1%
Traffic management during flood	0%	Traffic management	1%
		Extra span in bridge	1%

Several actions were recommended following the adoption of this flood study including:

- Update the flood planning levels inclusive of the local environmental plans and DCP.
- Update Council's GIS systems with the flood mapping outputs from the flood study.
- Update S149 certificates for the properties affected by flooding.
- Undertake a condition survey of the gauge at Federation Bridge.
- Prepare a drainage strategy to reduce storm water flooding in Mullumbimby.
- Prepare a drainage strategy to reduce storm water flooding in Brunswick Heads.
- Proceed to the preparation of the Floodplain Risk Management Study and Plan to determine options to manage and/or reduce flood risk, taking into consideration social ecological and economic factors. This should consider the following:
 - The flood risk and hazard for extreme events.

