PORT MACQUARIE-HASTINGS
COUNCIL

Coast, Estuary & Floodplain Advisory Sub-Committee

Business Paper

date of meeting: Thursday 28 May 2020

location: via Skype

time: 2:00pm

Note: *Council is distributing this agenda on the strict understanding that the publication and/or announcement of any material from the Paper before the meeting not be such as to presume the outcome of consideration of the matters thereon.*

Coast, Estuary & Floodplain Sub-Committee

CHARTER

Adopted: OC 21/08/19

1.0 OBJECTIVES

- Assist Council in undertaking coast, estuary and floodplain management and planning.
- Assist Council in reviewing coast, estuary and floodplain studies, plans, and policies.
- Engage with and provide input to Council on other coast, estuary and floodplain matters and issues which are relevant to the Local Government Area.
- Provide and receive two-way feedback from the community.

2.0 KEY FUNCTIONS

- Advise Council on conditions and management issues for the coast, estuaries and floodplains of the Port Macquarie-Hastings Local Government Area.
- Advise Council on the development of coastal, estuary and floodplain management plans for the Port Macquarie-Hastings Local Government Area.
- Advise Council on the implementation of adopted coastal, estuary and floodplain management plans.
- Act as a Sub- Committee for the purpose of relevant NSW guidelines as they relate to coastal, estuary and floodplain management.

3.0 MEMBERSHIP

3.1 Members

Community Representatives			
Name	**Title**	**Catchment**	**Coast, estuary, flood**
Alan MacIntyre	Community Representative	Camden Haven	Coast and estuary
Vacant	Community Representative	Hastings	Coast and estuary
Bob Jolly	Community Representative	Lake Cathie	Coast and estuary
Kingsley Searle	Oyster Industry	Hastings	Coast and estuary
Tony Troup	Oyster Industry	Camden Haven	Coast and estuary
Paul Hyde	Fishing Industry	Hastings	Coast and estuary
Vacant	Development Industry	Hastings	Flood
Vacant	Development Industry	Camden Haven	Flood
Vacant	Community Representative	Hastings	Flood
Vacant	Community Representative	Camden Haven	Flood
Vacant	Community Representative Revive Lake Cathie (RLC)	Lake Cathie	Flood

Council Representatives	
Name	**Title**
Michael Cusato (Chairperson)	Councillor
	Director, Development & Environment
	Manager, Environmental Services
	Natural Resources Manager
	Environmental Projects Officer

Agency Representatives			
Name	**Title**	**Organisation**	**Coast, estuary, flood**
Tina Clemens	NRM Project Officer	DPI - Lands	All
Mick Northam Scott Anderson (alternative)	Fisheries Officer	DPI - Fisheries	Coast and estuary
Shane Robinson Geoff James (alternative)	Manager, Hastings Macleay Area North Coast Branch	DPIE - NPWS	Coast and estuary
John Schmidt Toong Chin (alternative)	Natural Resource Officer - Water, Floodplains & Coast	DPIE - Biodiversity and Conservation Division	Coast and estuary
Nic Denshire Toong Chin (alternative)	Principal Floodplain Officer - Water, Floodplains & Coast	DPIE - Biodiversity and Conservation Division	Flood
Paul Burg Maria Frazer (alternative)	Local Commander, Hastings Cluster	SES	Flood
Matt Dawson Andre Uljee (alternative)	Boating Safety Officer	RMS	Coast and estuary

3.2 Obligations of Members

- Act honestly and in good faith.
- To act professionally and respectfully.
- Act impartially at all times.
- Participate actively in the work of the Sub-Committee.
- Exercise the care, diligence and skill that would be expected of a reasonable person in comparable circumstances.
- Comply with this Charter at all times.
- Facilitate and encourage community engagement with the Sub-Committee and Council.
- As per Section 226 (c) of the NSW Local Government Act 1993, the Mayor is the principal spokesperson for the governing body and Councillors that are members of a Sub-Committee are to obtain the Mayor's agreement to make media and other statements. Further, only the Mayor, or a Councillor with the Mayor's agreement and otherwise in accordance with Council policies and procedures, may release Council information through media statements or otherwise, and the release of such information must be lawful under the Council adopted Code of Conduct.
- A Councillor as a member of a Sub-Committee or the Sub-Committee itself has no delegation or authority to make decisions on behalf of Council, nor to direct the business of Council. The only decision making power open to Councillors is through formal resolutions of Council.

- A Councillor as a member of a Sub-Committee or the Sub-Committee itself cannot direct staff and must abide by the decisions of Council and the policies of Council.
- Councillors, Council staff and members of this Sub-Committee must comply with the applicable provisions of Council's Code of Conduct in carrying out the functions as Council officials. It is the personal responsibility of Council officials to comply with the standards in the Code of Conduct and regularly review their personal circumstances with this in mind.

3.3 Member Tenure

Sub-Committee members will serve for a period of five (5) years after which Council will call expressions of interest for the next five (5) year period. Existing Sub-Committee members will be eligible to re-apply for a position and serve additional terms. Any changes in the composition of the Sub-Committee requires the approval of Council.

3.4 Appointment of Members

- A formal Expression of Interest process will be undertaken across the Local Government Area as a way of determining the independent representatives on the Sub-Committee.
- Applications from individuals and representatives from interest groups, and who meet the selection criteria will be encouraged.
- Council, by resolution duly passed, will appoint members to the Sub-Committee.

4.0 TIMETABLE OF MEETINGS

Meetings will be held quarterly as a minimum or more regularly if required. Meetings will generally be held at the main administration office of Port Macquarie-Hastings Council.

5.0 MEETING PRACTICES

5.1 Decision Making

- Recommendations of the Sub-Committee shall be by majority of the members present at each Meeting and each member shall have one (1) vote.
- The Chairperson shall not have a casting vote.
- In the event of an equality of votes on any matter, the matter shall be referred directly to Council's Executive Group and then to Council.
- Recommendations from the Sub-Committee are to be made through the relevant Director, who will determine under delegation, the process for implementation.
- The Sub-Committee has no delegation to allocate funding on behalf of Council. The Sub-Committee may make recommendations to Council about how funding should be spent in relation to the above-mentioned objectives, however those funds will only be applied and expended following a formal resolution of Council.
- The Sub-Committee may establish working groups to support actions and activities within the strategies or to assist in the delivery of projects and events as deemed appropriate. All projects are to be aligned with Council's suite of Integrated Planning and Reporting documents.

5.2 Quorum

The quorum for the Sub-Committee will be half of the members plus one. A quorum must include a minimum of one (1) Councillor and one (1) Council staff member being present.

5.3 Chairperson and Deputy Chairperson

- The Chairperson shall be the Councillor, Chair Coast, Estuary and Floodplain Sub-Committee
- At all Meetings of the Sub-Committee, the Chairperson shall occupy the Chair and preside. In the absence of the Chairperson the Director will act as Chairperson for that meeting.

5.4 Secretariat

- The Director is responsible for ensuring the Sub-Committee has adequate secretariat support.
- The secretariat will ensure that the business paper and supporting papers are circulated at least three (3) days prior to each meeting.
- Minutes shall be appropriately approved and circulated to each member within three (3) weeks of a meeting being held.
- All Sub-Committee agendas and minutes will be made available to the public via Council's web site, unless otherwise restricted by legislation.

5.5 Recording of decisions and explicit discussions on risks

The Secretariat shall record all discussions that relate to risks.

6.0 CONVENING OF "OUTCOME SPECIFIC" WORKING GROUPS

- The Sub-Committee can at times request a working group to be convened, for a limited period of time, for a specific action, these specifics will be minuted clearly. The working group will report back to the Sub-Committee with outcomes.
- Any working groups established under this Sub-Committee will be responsible for providing updates to the Sub-Committee. The working groups will be an informal gathering with notes collected and managed by the senior staff member in attendance and will be tabled at the Sub-Committee meetings.

7.0 CONFIDENTIALITY AND CONFLICT OF INTEREST

- Any independent members of the Sub-Committee will be required to complete a confidentiality agreement that will cover the period of their membership of the Sub-Committee.
- Sub-Committee members must declare any conflict of interests at the start of each meeting or before discussion of a relevant item or topic. Details of any conflicts of interest should be appropriately minuted.
- Where members or invitees at Sub-Committee meetings are deemed to have a real or perceived conflict of interest, it may be appropriate that they be excused from Sub-Committee deliberations on the issue where the conflict of interest may exist

Coast, Estuary & Floodplain Sub-Committee

ATTENDANCE REGISTER

Community Representatives	Representing	Catchment	Expertise Area	30/01/20	20/02/20 Working group	28/05/20
Alan MacIntyre	Community	Camden Haven	Coast, Estuary	✓	✓	
Bob Jolly	Community	Lake Cathie	Coast, Estuary	✓	**A**	
Kingsley Searle	Oyster Industry	Hastings	Coast & Estuary	✓	✓	
Tony Troup	Oyster Industry	Camden Haven	Coast & Estuary	✓	**A**	
Paul Hyde	Fishing Industry	Hastings	Coast & Estuary	✓	**X**	
Vacant	Development Industry	Hastings	Flood	-	-	
Vacant	Development Industry	Camden Haven	Flood	-	-	
Vacant	Community	Hastings	Flood	-	-	
Vacant	Community	Camden Haven	Flood	-	-	
Vacant	Community - Revive Lake Cathie	Lake Cathie	Flood	-	-	
Council Representatives						
Councillor Peter Alley (Chair)				✓	✓	
Councillor Lisa Intemann (Deputy Chair)				✓	✓	
Director Development & Environment - Melissa Watkins				✓	**X**	
Group Manager Regulatory & Environment Services - Debbie Archer					✓	
Natural Resources Manager - Blayne West				✓	✓	
Environmental Projects Officer - Jesse Dick				✓	✓	
Agency Representatives	**Title**	**Organisation**	**Expertise Area**			
Tina Clemens	NRM Project Officer	DPI - Lands	Coast, Estuary, Flood	✓	**X**	
Michael Northam Scott Anderson (alt.)	Fisheries Officer	DPI - Fisheries	Coast, Estuary	✓	**A**	
Shane Robinson Geoffrey James (alt.)	Manager, Hastings Macleay Area North Coast Branch	DPIE - NPWS	Coast, Estuary	**A** **A**	**X**	
John Schmidt	Natural Resource Officer - Water, Floodplains & Coast	DPIE - Biodiversity & Conservation Division	Coast, Estuary	**A**	**X**	
Nic Denshire	Principal Floodplain Officer - Water, Floodplains & Coast	DPIE - Biodiversity & Conservation Division	Flood	✓	✓	
Paul Burg	Local Commander, Hastings Cluster	SES	Flood	**X**	**A**	
Maria Fraser (alt.) Anthony Day		SES	Flood	✓ **A**	**A**	
Matt Dawson Andre Uljee (alt.)	Boating Safety Officer	RMS	Coast, Estuary	✓	**A** **A**	

Key: ✓ = Present
A = Absent With Apology
X = Absent Without Apology

Meeting Dates for 2020

30/01/2020	Council Chambers	2:00pm
20/02/2020	Council Chambers	2:00pm
28w/05/2020	Council Chambers	2:00pm
26/08/2020	Council Chambers	2:00pm
26/11/2020	Council Chambers	2:00pm

PORT MACQUARIE HASTINGS COUNCIL

Coast, Estuary & Floodplain Advisory Sub-Committee Meeting

Thursday 28 May 2020

Items of Business

PORT MACQUARIE HASTINGS COUNCIL

Item: **01**

Subject: **ACKNOWLEDGEMENT OF COUNTRY**

"I acknowledge that we are gathered on Birpai Land. I pay respect to the Birpai Elders both past and present. I also extend that respect to all other Aboriginal and Torres Strait Islander people present."

Item: **02**

Subject: **APOLOGIES**

RECOMMENDATION

That the apologies received be accepted.

Item: **03**

Subject: **CONFIRMATION OF PREVIOUS MINUTES**

RECOMMENDATION

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 30 January 2020 be confirmed.

PRESENT

Community Representatives:

Alan MacIntyre (Community - Camden Haven - Coast, Estuary)
Bob Jolly (Community - Lake Cathie - Coast, Estuary)
Kingsley Searle (Oyster Industry - Hastings - Coast, Estuary)
Tony Troup (Oyster Industry - Camden Haven - Coast, Estuary)
Paul Hyde (Fishing Industry - Hastings - Coast, Estuary)

Council Representatives:

Councillor Peter Alley (Chair)
Councillor Lisa Intemann (Deputy Chair)
Director Development and Environment - Melissa Watkins
Natural Resources Manager - Blayne West
Environmental Projects Officer - Jesse Dick

Agency Representatives:

Tina Clemens (DPI - Lands - Coast, Estuary, Flood) *left the meeting after item 09*
Michael Northam (DPI - Fisheries - Coast, Estuary)
Nic Denshire (DPIE - Biodiversity & Conservation Division - Flood)
Maria Fraser (SES - Flood)
Matt Dawson (RMS - Coast, Estuary)

Other Attendees:
Mayor - Peta Pinson *left the meeting during item 06*
General Manager - Craig Swift-McNair *left the meeting after item 08*
David Curry (Revive Lake Cathie)
Danielle Maltman (Revive Lake Cathie, Camden Haven Chamber of Commerce & Lake Cathie Progress Association)

The meeting opened at 2:03pm.

12 ACKNOWLEDGEMENT OF COUNTRY

The Acknowledgement of Country was delivered.

13 APOLOGIES

CONSENSUS:

That the following apologies received be accepted:

- Shane Robinson (DPIE - NPWS - Coast, Estuary)
- Geoffrey James (DPIE - NPWS - Coast, Estuary)
- John Schmidt (DPIE - Biodiversity & Conservation Division - Coast, Estuary)
- Anthony Day (State Emergency Services)

14 CONFIRMATION OF MINUTES

CONSENSUS:

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 28 March 2019 be confirmed.

11 PASSING OF PATRICK MCENTEE AND LAURIE LARDNER

Alan MacIntyre spoke and paid respects to the memory of Patrick & Laurie.

Councillor Peter Alley moved for a minute of silence.

A minute of silence was observed.

Kingsley Searle and Tony Troup also paid their respects and acknowledge the efforts of Patrick and Laurie's efforts, especially in the management of ASS issues within the LGA.

CONSENSUS:

That the Committee:

1. Acknowledge the important contribution of the late Mr Patrick McEntee and the late Mr Laurie Lardner to the Coast, Estuary and Floodplain advisory subcommittee.
2. Request Council write to the families of Mr McEntee and Mr Lardner to express the appreciation of the committee for their contribution.

04 DISCLOSURES OF INTEREST

There were no disclosures of interest presented.

05 BUSINESS ARISING FROM PREVIOUS MINUTES

CONSENSUS:

That the Business Arising Schedule be noted with the following updates:

Item 11.02 - 28/03/19 - Forestry Operations, Lorne State Forest:
Cr Intemann requested that Council staff continue to attempt to contact NSW State Forests on this matter. Council staff will follow up again and will invite NSW State Forests to attend a future CE&F Committee meeting.

Item 11.03 - 28/03/19 - Personal Watercraft use in local waterways:
Matt Dawson confirmed that TfNSW (formerly RMS) can be contacted at any time using 13 12 36 to report any waterway issues.

06 MEMBERSHIP OF THE COAST, ESTUARY AND FLOODPLAIN ADVISORY SUB-COMMITTEE

There was general discussion on various aspects of the report and the Charter.
Alan MacIntyre queried whether committee members can liaise directly with the community on matters relating to the CE&F committee. Confirmation was provided that this is acceptable so long as confidentiality is maintained and code of conduct values are followed.

The committee requested that section 5.4 of the charter be updated as follows:

- The agenda be distributed a minimum of 14 days prior to the meeting.
- The agenda and attachments be provided separately.

Alan MacIntyre tabled an additional clause that he felt should be incorporated into the charter. Council staff will review the clause and consider the application of the clause in the charter.

There were numerous minor amendments to the Charter that Council staff will update as necessary. These include changes to sections 2.0, 3.2, 5.1, 5.3 & 5.4.

The committee agreed that the Bunyah & Birpai Local Aboriginal Land Councils (LALC) can be invited to join the committee.

Council staff will make a formal request with Birpai LALC and Bunyah LALC to gauge their interest in joining the committee. Advice from both LALC's will determine how the charter shall be updated. Council staff will provide a response to the committee at the meeting to be held on 20 February 2020.

CONSENSUS:

That the Committee:
1. Note the report.
2. Note that Councillor Peter Alley has been appointed as Chair and Deputy Mayor Lisa Intemann has been appointed as Alternate Chair.
3. Recommend to Council to accept the amendments to the Charter, as agreed at the 30 January 2020 Coast, Estuary and Floodplain Advisory Sub-Committee meeting.
4. Agree to extend invitations to the Birpai and Bunya Local Aboriginal Land Council to join the Committee.

07 FLOODPLAIN MANAGEMENT

There was general discussion on various aspects of this item.

There was discussion on funding and resourcing on restarting various projects that have been delayed as a result of the December 2018 Council decision. It was confirmed that staffing levels, competing priorities (i.e. Lake Cathie) and state government legislation changes (Coastal Management Act) have impacted Council's capacity to deliver additional project and it was likely that the delayed projects will not recommence for some time.

CONSENSUS:

That the Committee note the Floodplain Management report.

08 NORTH BROTHER LOCAL CATCHMENTS FLOOD STUDY - STAGE 2 - FLOODPLAIN RISK MANAGEMENT STUDY - INITIAL OPTIONS ASSESSMENT REPORT

Mark Edenborough provided the committee with a summary of the project and answered questions from committee members.

Committee members requested additional time to read the report and consider the options contained within.

The committee agreed that a steering group of committee members should form to discuss the Initial Options Assessment Report before placing the report on public exhibition.

In order to provide the steering group with an opportunity to discuss the options and assist in devising a community engagement strategy, a further meeting will be held on 20 February at 2-4pm. Location TBA.

CONSENSUS:

That the Committee:
1. Note the progress made in commencing the North Brother Local Catchments Floodplain Risk Management Study
2. Endorse the North Brother Local Catchments Flood Study Working Draft Options Report.
3. Recommend that the North Brother Local Catchments Flood Study Working Draft Options Report be deferred until the Committee Meeting to be held on 20 February 2020.
4. That a steering group meeting be held on 20 February to provide feedback on any preferences for location/options to be included in the detailed assessment and prioritisation of options, which will ultimately be utilised to inform the Floodplain Risk Management Study phase of the project.

09 ACTIVE COAST, ESTUARY & FLOODPLAIN PROJECTS STATUS UPDATE

Jesse Dick provided the committee with a summary of this item.

There was general discussion on various aspects of this report.

A copy of the historical Coast, Estuary & Floodplain Action Plan Items will be circulated to committee members.

CONSENSUS:

That the Committee note the status of the active Coast, Estuary & Floodplain projects.

10 LAKE INNES / LAKE CATHIE ESTUARINE SYSTEM - UPDATE

There was frustration and concern from committee members that they were not involved in discussions around the management of the Lake system over the previous 12 months.

Committee members will be involved in the management of the Lake system as the separate stakeholder and community meetings held in 2019 will no longer be occurring and that the CE&F committee will now be the main forum for discussions regarding the management of the Lake system.

CONSENSUS:

That the Committee:
1. Note the Lake Innes / Lake Cathie Estuarine System - Update report.

2. Note the Lake Cathie and Lake Innes Acid Sulphate Soil Risk Assessment (2019).
3. Note the Coastal Management in the Port Macquarie-Hastings timeline document.

Item 11 Passing of Patrick McEntee and Laurie Lardner, has been addressed previously within the meeting.

12 PROPOSED COAST, ESTUARY & FLOODPLAIN ADVISORY SUB-COMMITTEE MEETING DATES FOR ENDORSEMENT

CONSENSUS:

That the Coast, Estuary and Floodplain Advisory Sub-Committee:

1. Endorse the meeting dates for 2020 as listed below:

    - Thursday 20 February, Room TBA, 2-4pm, report prepared by 6 February, Distribution of agenda 13 February.
    - Wednesday 27 May 2020, Council Chambers, 2-4pm, reports prepared by 13 May, distribution of agenda 21 May.
    - Thursday 27 August 2020, Council Chambers, 2-4pm, reports prepared by 13 August, distribution of Agenda 20 August.
    - Thursday 26 November 2020, Council Chambers, 2-4pm, reports prepared by 12 November, distribution of agenda 19 November.

2. Note that the report preparation and agenda distribution dates nominated in this item may be subject to change pending adoption of the recommended changes to the Charter which will be presented to a future Council meeting for consideration.

13 GENERAL BUSINESS

Nil.

The meeting closed at 4:50pm.

Item: **04**

Subject: **DISCLOSURES OF INTEREST**

RECOMMENDATION

That Disclosures of Interest be presented

DISCLOSURE OF INTEREST DECLARATION

Name of Meeting:	
Meeting Date:	
Item Number:	
Subject:	
I, the undersigned, hereby declare the following interest: ☐ **Pecuniary:** Take no part in the consideration and voting and be out of sight of the meeting. ☐ **Non-Pecuniary – Significant Interest:** Take no part in the consideration and voting and be out of sight of the meeting. ☐ **Non-Pecuniary – Less than Significant Interest:** May participate in consideration and voting.	
For the reason that:	
Name: **Signed:**	**Date:**
Please submit to the Governance Support Officer at the Council Meeting.	

(Refer to next page and the Code of Conduct)

Pecuniary Interest

4.1 A pecuniary interest is an interest that you have in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to you or a person referred to in clause 4.3.

4.2 You will 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 you might make in relation to the matter, or if the interest is of a kind specified in clause 4.6.

4.3 For the purposes of this Part, you will have a pecuniary interest in a matter if the pecuniary interest is:

(a) your interest, or
(b) the interest of your spouse or de facto partner, your relative, or your partner or employer, or
(c) a company or other body of which you, or your nominee, partner or employer, is a shareholder or member.

4.4 For the purposes of clause 4.3:

(a) Your "relative" is any of the following:
  i) your parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child
  ii) your spouse's or de facto partner's parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child
  iii) the spouse or de facto partner of a person referred to in paragraphs (i) and (i)
(b) "de facto partner" has the same meaning as defined in section 21C of the *Interpretation Act 1987*.

4.5 You will not have a pecuniary interest in relation to a person referred to in subclauses 4.3(b) or (c)

(a) if you are unaware of the relevant pecuniary interest of your spouse, de facto partner, relative, partner, employer or company or other body, or
(b) just because the person is a member of, or is employed by, a council or a statutory body, or is employed by the Crown, or
(c) just because the person is a member of, or a delegate of a council to, a company or other body that has a pecuniary interest in the matter, so long as the person has no beneficial interest in any shares of the company or body.

Non-Pecuniary

5.1 Non-pecuniary interests are private or personal interests a council official has that do not amount to a pecuniary interest as defined in clause 4.1 of this code. These commonly arise out of family or personal relationships, or out of involvement in sporting, social, religious or other cultural groups and associations, and may include an interest of a financial nature.

5.2 A non-pecuniary conflict of interest exists where a reasonable and informed person would perceive that you could be influenced by a private interest when carrying out your official functions in relation to a matter.

5.3 The personal or political views of a council official do not constitute a private interest for the purposes of clause 5.2.

5.4 Non-pecuniary conflicts of interest must be identified and appropriately managed to uphold community confidence in the probity of council decision-making. The onus is on you to identify any non-pecuniary conflict of interest you may have in matters that you deal with, to disclose the interest fully and in writing, and to take appropriate action to manage the conflict in accordance with this code.

5.5 When considering whether or not you have a non-pecuniary conflict of interest in a matter you are dealing with, it is always important to think about how others would view your situation.

Managing non-pecuniary conflicts of interest

5.6 Where you have a non-pecuniary conflict of interest in a matter for the purposes of clause 5.2, you must disclose the relevant private interest you have in relation to the matter fully and in writing as soon as practicable after becoming aware of the non-pecuniary conflict of interest and on each occasion on which the non-pecuniary conflict of interest arises in relation to the matter. In the case of members of council staff other than the general manager, such a disclosure is to be made to the staff member's manager. In the case of the general manager, such a disclosure is to be made to the mayor.

5.7 If a disclosure is made at a council or committee meeting, both the disclosure and the nature of the interest must be recorded in the minutes on each occasion on which the non-pecuniary conflict of interest arises. This disclosure constitutes disclosure in writing for the purposes of clause 5.6.

5.8 How you manage a non-pecuniary conflict of interest will depend on whether or not it is significant.

5.9 As a general rule, a non-pecuniary conflict of interest will be significant where it does not involve a pecuniary interest for the purposes of clause 4.1, but it involves:

a) a relationship between a council official and another person who is affected by a decision or a matter under consideration that is particularly close, such as a current or former spouse or de facto partner, a relative for the purposes of clause 4.4 or another person from the council official's extended family that the council official has a close personal relationship with, or another person living in the same household
b) other relationships with persons who are affected by a decision or a matter under consideration that are particularly close, such as friendships and business relationships. Closeness is defined by the nature of the friendship or business relationship, the frequency of contact and the duration of the friendship or relationship.
c) an affiliation between the council official and an organisation (such as a sporting body, club, religious, cultural or charitable organisation, corporation or association) that is affected by a decision or a matter under consideration that is particularly strong. The strength of a council official's affiliation with an organisation is to be determined by the extent to which they actively participate in the management, administration or other activities of the organisation.
d) membership, as the council's representative, of the board or management committee of an organisation that is affected by a decision or a matter under consideration, in circumstances where the interests of the council and the organisation are potentially in conflict in relation to the particular matter
e) a financial interest (other than an interest of a type referred to in clause 4.6) that is not a pecuniary interest for the purposes of clause 4.1
f) the conferral or loss of a personal benefit other than one conferred or lost as a member of the community or a broader class of people affected by a decision.

5.10 Significant non-pecuniary conflicts of interest must be managed in one of two ways:

a) by not participating in consideration of, or decision making in relation to, the matter in which you have the significant non-pecuniary conflict of interest and the matter being allocated to another person for consideration or determination, or
b) if the significant non-pecuniary conflict of interest arises in relation to a matter under consideration at a council or committee meeting, by managing the conflict of interest as if you had a pecuniary interest in the matter by complying with clauses 4.28 and 4.29.

5.11 If you determine that you have a non-pecuniary conflict of interest in a matter that is not significant and does not require further action, when disclosing the interest you must also explain in writing why you consider that the non-pecuniary conflict of interest is not significant and does not require further action in the circumstances.

5.12 If you are a member of staff of council other than the general manager, the decision on which option should be taken to manage a non-pecuniary conflict of interest must be made in consultation with and at the direction of your manager. In the case of the general manager, the decision on which option should be taken to manage a non-pecuniary conflict of interest must be made in consultation with and at the direction of the mayor.

5.13 Despite clause 5.10(b), a councillor who has a significant non-pecuniary conflict of interest in a matter, may participate in a decision to delegate consideration of the matter in question to another body or person.

5.14 Council committee members are not required to declare and manage a non-pecuniary conflict of interest in accordance with the requirements of this Part where it arises from an interest they have as a person chosen to represent the community, or as a member of a non-profit organisation or other community or special interest group, if they have been appointed to represent the organisation or group on the council committee.

PORT MACQUARIE HASTINGS COUNCIL

SPECIAL DISCLOSURE OF PECUNIARY INTEREST DECLARATION

This form must be completed using block letters or typed.
If there is insufficient space for all the information you are required to disclose, you must attach an appendix which is to be properly identified and signed by you.

By *[insert full name of councillor]*	
In the matter of *[insert name of environmental planning instrument]*	
Which is to be considered at a meeting of the *[insert name of meeting]*	
Held on *[insert date of meeting]*	

PECUNIARY INTEREST	
Address of the affected principal place of residence of the councillor or an associated person, company or body (*the **identified land)***	
Relationship of identified land to councillor *[Tick or cross one box.]*	□ The councillor has interest in the land (e.g. is owner or has other interest arising out of a mortgage, lease, trust, option or contract, or otherwise). □ An associated person of the councillor has an interest in the land. □ An associated company or body of the councillor has interest in the land.
MATTER GIVING RISE TO PECUNIARY INTEREST[1]	
Nature of land that is subject to a change in zone/planning control by proposed LEP *(the **subject land***[2] *[Tick or cross one box]*	□ The identified land. □ Land that adjoins or is adjacent to or is in proximity to the identified land.
Current zone/planning control *[Insert name of current planning instrument and identify relevant zone/planning control applying to the subject land]*	
Proposed change of zone/planning control *[Insert name of proposed LEP and identify proposed change of zone/planning control applying to the subject land]*	
Effect of proposed change of zone/planning control on councillor or associated person *[Tick or cross one box]*	□ Appreciable financial gain. □ Appreciable financial loss.

[If more than one pecuniary interest is to be declared, reprint the above box and fill in for each additional interest]

Councillor's Signature: …… Date: ……..

This form is to be retained by the council's general manager and included in full in the minutes of the meeting

Last Updated: 3 June 2019

PORT MACQUARIE HASTINGS COUNCIL

Important Information

This information is being collected for the purpose of making a special disclosure of pecuniary interests under clause 4.36(c) of the Model Code of Conduct for Local Councils in NSW (the Model Code of Conduct).

The special disclosure must relate only to a pecuniary interest that a councillor has in the councillor's principal place of residence, or an interest another person (whose interests are relevant under clause 4.3 of the Model Code of Conduct) has in that person's principal place of residence.

Clause 4.3 of the Model Code of Conduct states that you will have a pecuniary interest in a matter because of the pecuniary interest of your spouse or your de facto partner or your relative or because your business partner or employer has a pecuniary interest. You will also have a pecuniary interest in a matter because you, your nominee, your business partner or your employer is a member of a company or other body that has a pecuniary interest in the matter.

"Relative" is defined by clause 4.4 of the Model Code of Conduct as meaning your, your spouse's or your de facto partner's parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child and the spouse or de facto partner of any of those persons.

You must not make a special disclosure that you know or ought reasonably to know is false or misleading in a material particular. Complaints about breaches of these requirements are to be referred to the Office of Local Government and may result in disciplinary action by the Chief Executive of the Office of Local Government or the NSW Civil and Administrative Tribunal.

This form must be completed by you before the commencement of the council or council committee meeting at which the special disclosure is being made. The completed form must be tabled at the meeting. Everyone is entitled to inspect it. The special disclosure must be recorded in the minutes of the meeting.

[1] Clause 4.1 of the Model Code of Conduct provides that a pecuniary interest is 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. 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 the matter, or if the interest is of a kind specified in clause 4.6 of the Model Code of Conduct.

[2] A pecuniary interest may arise by way of a change of permissible use of land adjoining, adjacent to or in proximity to land in which a councillor or a person, company or body referred to in clause 4.3 of the Model Code of Conduct has a proprietary interest

Item: **05**

Subject: **BUSINESS ARISING FROM PREVIOUS MINUTES**

Item:	11.02	**Date:**	28/03/2019
Subject:	Forestry Operations, Lorne State Forest		
Action Required:	Tony Troup expressed his concern over the management of land under the control of NSW State Forests, particularly within the Lorne State Forest. 30/01/2020: Cr Intemann requested that Council staff continue to attempt to contact NSW State Forests on this matter.		
Current Status:	Council staff have followed up with NSW State Forests. Council staff will follow up again and will invite NSW State Forests to attend a future CE&F Committee meeting.		

Item: **06**

Subject: **MEMBERSHIP OF THE COAST, ESTUARY & FLOODPLAIN ADVISORY SUB-COMMITTEE**

Presented by: **Development and Environment, Melissa Watkins**

RECOMMENDATION

That the Committee note the report.

Discussion

Since the CE&F Committee meeting held on January 2020 the following tasks have been undertaken:

1. A revised EOI recruitment form was produced to reflect the vacancy created by the non-attendance of the former Fishing Rep - Paul Hyde.

2. The Birpai LALC was contacted (via letter, email & phone) to obtain their interest in joining the committee. No response has been received to date.

3. The revised EOI form was forwarded to all committee members (via email) and comments were sought on the revised EOI approach.

4. Comments were received from four members with these suggestions being considered by Council staff.

5. Incorporating Committee member's feedback, Council staff began reviewing the EOI process.

Unfortunately, the recruitment process has been delayed, primarily due to a number of other pressing matters. Lake Cathie initiatives such as the Lake Cathie opening (low and high level), the Coastal Management Program scoping study, grant application priorities (Bushfire recovery) and responding to the numerous submissions, enquiries and suggestions regarding Lake Cathie have all taken up considerable amounts of staff time.

However, as detailed above, we have commenced our review of the application process and sought input from the sub-committee on this with the intent to make the application process less cumbersome/detailed and not such a barrier to expressing an interest.

The revised EOI package has therefore not been finalised, but it is now being given a high priority. It will be likely that the EOI package will be completed within coming weeks. It is envisaged that the EOI package will be advertised for 4 weeks. With the intention of providing ample time for community members express an initial interest and received feedback before proceeding with a full application.

As part of the EOI we have also begun discussions with our in-house media team to create short videos to assist us in reaching a wider target audience. One video will be

to target a more technical audience, whilst the another will be aimed at community representatives. We are also contemplating dividing the application process between the Development Industry Representatives and the Community Representatives. This would enable us to soften the language in the application questions that may otherwise deter suitable community minded applicants from applying.

In addition to the EOI process, the suggested changes to the Committee Charter that were discussed at the previous meeting have not been undertaken. However, the comments and suggestions by Committee members from the January 2020 sub-committee meeting are still on file and will be considered in more detail by Council staff before a report is prepared to Council. It is anticipated that the charter will be updated once the EOI recruitment phase has closed, and both will be reported to Council in the hope that the new charter and committee membership matters are resolved at the same time.

Attachments

Nil

Item: **07**

Subject: **NORTH BROTHER LOCAL CATCHMENTS FLOOD STUDY - DRAFT OPTIONS ASSESSMENT REPORT**

Presented by: **Development and Environment, Melissa Watkins**

RECOMMENDATION

That the Committee:

1. **Endorse the North Brother Local Catchments Flood Study - Draft Options Assessment Report.**
2. **Recommend that the North Brother Local Catchments Flood Study - Draft Options Assessment Report be placed on public exhibition for a minimum of 28 days.**
3. **Request Committee feedback on the North Brother Local Catchments Flood Study - Draft Options Assessment Report.**

Discussion

At the January 2020 Coast, Estuary and Floodplain Advisory Committee meeting, the *North Brother Local Catchments Flood Study Working Draft Options Report* was presented for consideration and endorsement by the Sub-Committee prior to proceeding to planned community consultation.

At that time, the Committee resolved to defer a review of the report and its contents until a further Committee meeting was held. This meeting was held on 20 February 2020, with the Committee recommendations as follows:

CONSENSUS:
That the Committee:

1. *Endorse the North Brother Local Catchments Flood Study Working Draft Options Report.*
2. *Recommend that those options assessed as high priority plus the Tunis Street options (Option 6), as defined in table 3-5 of the Working Draft Options Report, be shortlisted for further detailed assessment and modelling by Jacobs.*
3. *That a Sub-Committee meeting be held upon receipt of the detailed modelling required under item 2.*

At the 20 February 2020 Committee meeting, the options outlined in the Working Draft Options Report were discussed and the high priority options outlined in Table 3-5 of that report were recommended for further testing, including testing of options associated with Tunis Street.

Council coordinated with Jacobs regarding the configuration of options for further detailed assessment in accordance with that recommendation.

The high priority and Tunis Street options have now been modelled by Jacobs.

PORT MACQUARIE HASTINGS COUNCIL

The revised report (**attachment 1**), includes the outcomes of the detailed modelling of structural management options as previously requested by Council and the Committee, along with numerous non-structural measures.

In particular, the attached report details the hydraulic benefits, constraints and approximate costs of each of the modelled options as a first stage in assessing their feasibility for inclusion in a future Floodplain Risk Management Plan.

Prior to formal adoption of these (or any other alternate options), community consultation is required to be undertaken to ensure that the assessed high priority outcomes align with community expectations.

Following consultation and review of the options, refined modelling will be undertaken. Preparation of detailed costings, assessment of social and environmental impacts of those options and the completion of a Multi Criteria Analysis and ultimately a Cost Benefit Analysis to assess the overall feasibility of the proposals will be undertaken.

Similarly, to the above, the updated version of the Options Report includes a number of consultant recommendations regarding non-structural measures for consideration as part of the development of the Floodplain Risk Management Study.

Key non-structural measures listed for consideration in the report include the following:

- Voluntary purchase of High Hazard Properties
- Update Council's LEP 2011 to include The North Brother Local Catchments Flood Mapping
- Section 10.7 Certificates to include notation regarding flood hazard identified by the Flood Study phase of this project
- Update the Council's Flood Policy to both refer to the North Brother Local Catchments Flood Study and to update the policy to include provisions relating to overland flooding
- Implementation of flood depth signage within the catchment
- Development of a flood education program for the catchment
- Consultation with high flood risk facilities and occupants of dwellings subject to high flood hazard regarding management of flood risk on the site

Community Engagement and Internal Consultation

Discussions at the January 2020 Committee meeting included Council's proposed community engagement strategy for the proposed upcoming public exhibition and review period.

In particular, the Committee sought information regarding Council's proposed approach in order to ensure that all affected/interested residents and landowners were informed and given the best opportunity to contribute.

In this regard and given the current restrictions around COVID-19 and public gatherings, a traditional community meeting/drop in session approach to consultation may not be appropriate at this point in time. Instead, Council staff are continuing to monitor the current situation and are investigating opportunities to undertake consultation utilising the following:

PORT MACQUARIE HASTINGS COUNCIL

- Targeted mail out to community members who have been previously involved in the project and those landowners/residents of properties impacted by modelled flood flows.
- Mail out to local chamber of commerce, Aboriginal Land Council and relevant state emergency agencies.
- Advertising of the exhibition period via notices, including via Council's social media channels.
- Updated project website and survey. Website to invite users to contact project staff directly to arrange a skype meeting (or similar) to review and discuss the options report.
- Attending various targeted site meetings/discussions with individual residents/landowners on a sub-catchment/neighbourhood basis.

Internal consultation has been undertaken throughout the project. DPIE have also been consulted on the Working Draft Options Report. Further consultation will be held prior to community consultation occurring.

Council intends to place the *North Brother Local Catchments Flood Study - Draft Options Assessment Report* on public exhibition for the community to have its say. A detailed community consultation strategy is yet to be developed, however will be prepared prior to exhibition of the report and having regard to Committee input.

Attachments

1⇩. North Brother Local Catchments Flood Study - Draft Options Assessment Report

JACOBS

North Brother Local Catchments Flood Study

Port Macquarie Hastings Council

Draft Options Assessment Report

Revision A

8 May 2020

IA157500

North Brother Local Catchments Flood Study

Project no:	IA157500
Document title:	Draft Options Assessment Report
Document No.:	1
Revision:	A
Date:	8 May 2020
Client name:	Port Macquarie Hastings Council
Project manager:	Lih Chong
Author:	Lih Chong
File name:	J:\IE\Projects\04_Eastern\IA157500\21 Deliverables\R05_DraftOptionsAssessment\IA157500 NB_R05_DraftOptionsAssessment.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
A	8/05/2020	Draft Options Assessment Report	L Chong	A Hossain	A Hossain

Contents

Foreword

The primary objective of the New South Wales Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods, wherever possible. Under the Policy, the management of flood prone land remains the responsibility of local government.

The policy provides for a floodplain management system comprising the following five sequential stages:

1.	**Data Collection**	Involves compilation of existing data and collection of additional data
2.	**Flood Study**	Determines the nature and extent of the flood problem
3.	**Floodplain Risk Management Study**	Evaluates management options in consideration of social, ecological and economic factors relating to flood risk with respect to both existing and future development
4.	**Floodplain Risk Management Plan**	Involves formal adoption by Council of a plan of management for the floodplain
5.	**Implementation of the Plan**	Implementation of flood, response and property modification measures (including mitigation works, planning controls, flood warnings, flood preparedness, environmental rehabilitation, ongoing data collection and monitoring by Council

Port Macquarie Hastings Council is undertaking this study for the North Brother Local Catchments study area to investigate the existing and future flood risks in accordance with the NSW Government's *Floodplain Development Manual*. The study identifies and assesses potential flood mitigation options and guides land use planning and future development on the floodplain in the study area.

This study represents stages 1 to 4 of the management process and has been prepared for Council by Jacobs. This report is a progress report documenting the draft options assessment of the floodplain risk management stage of the study.

Important note about this report

The sole purpose of this report and the associated services performed by Jacobs is to undertake a flood study for the North Brother Local Catchments study area located in New South Wales in accordance with the scope of services set out in the contract between Jacobs and Port Macquarie Hastings Council (the Client). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client, third parties, and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

Topographic data used in this study included that sourced from a LiDAR survey and ground survey which were undertaken by third parties. Undertaking independent checks on the accuracy of the data was outside Jacobs's scope of work for this study.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 General

This report discusses the hydraulic assessment results of the draft flood mitigation options for the North Brother local catchments study area for consideration by Port Macquarie Hastings Council and the floodplain advisory sub-committee ("committee"). The options presented in this report were short-listed by Council and the committee from a long-list of options for 16 flooding locations and aim to alleviate flooding at identified flooding trouble spots particularly where properties are at risk to flooding of elevated hazard. The results will assist with further refinement of the options and facilitate consultation with stakeholders and landowners affected by implementation of the options.

This report also investigates non-structural options for managing the flood risk, including property modification and response modification measures.

The content of this report will be included in the subsequent Options Evaluation Report and Draft Floodplain Risk Management Study (FRMS) reports.

1.2 Consultation

The findings in this report are to be discussed with Council, the committee and stakeholders and landowners as a part of the options development process. Public exhibition of this report is also proposed to enable early feedback on the proposed options.

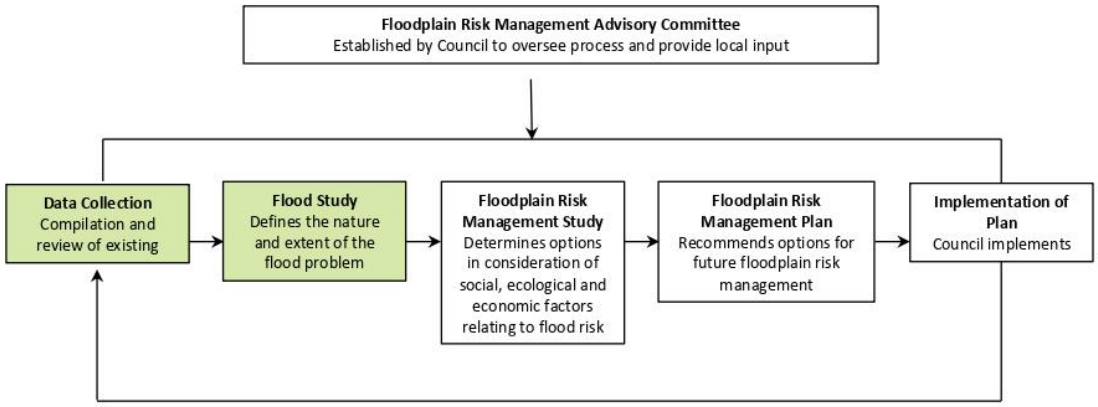
Community consultation is also scheduled to occur on a finalised list of the options during public exhibition.

1.3 Floodplain Risk Management

Council is responsible for managing the existing, continuing and future flood risk for its Local Government Area (LGA). The floodplain risk management planning process, as set out in the *Floodplain Development Manual* (NSW Government, 2005) has a number of steps which are illustrated in Figure 1-1. The current Flood Study phase of this study defines the flooding problem. Once the Flood Study has been endorsed by Council, the study moves to the Floodplain Risk Management Study and Plan phase, which seeks to identify and prioritise feasible options for mitigating the flood risk.

The Floodplain Risk Management Advisory Committee for Council was established in 2018 and includes a number of Council Representatives, staff from the Department of Planning Industry and Environment (DPIE, formerly Office of Environment and Heritage), the State Emergency Services (SES), in addition to local stakeholders including community representatives.

Figure 1-1 Floodplain Risk Management Process



1.4 Structure of this Report

This report is structured by the following sections:

- Section 2 provides background on the existing flood behaviour and flooding problems.
- Section 3 describes the general types of floodplain risk management measures in addition to providing a detailed assessment of the selected structural mitigation options.
- Section 4 provides an appraisal of non-structural flood risk management measures.
- Section 5 provides conclusions and recommendations based on the assessments made in this report.

2. The Existing Flooding Problem

2.1 Description of Flooding Conditions

2.1.1 Flood behaviour

Flooding behaviour was defined based on numerical modelling of hydrology and hydraulics, estimating catchment flood flows and the flooding patterns and behaviour. Modelling was undertaken in DRAINS software (hydrology) and TUFLOW software (hydraulics), as documented in the North Brother Local Catchments Flood Study – Final Flood Study Report (Jacobs, 2020). Flood depth mapping based on the modelling results is presented in Appendix A.

Overland flooding in the steeper parts of the study area, generally upstream of Ocean Drive and Bold Street, is typically a result of runoff from North Brother Mountain concentrating in natural gullies which discharge towards receiving waterways including Queens Lake, Stingray Creek, Camden Haven River and Watsons Taylor Lake. Issues arise when the gullies and flows encounter existing development, which in some instances at the larger gullies have considered the drainage conditions and provided substantial set-back from the gullies such that there is minimal interaction between floodwaters and development.

At most of the smaller gullies and flow paths, attempts have been made to manage the overland flows by use of diversion drains and underground drainage. The natural flow paths have mainly been filled in for development although shallow flow paths may have been retained. The diversion drains and drainage network have limited capacity so begin to surcharge and overflow in relatively frequent flooding events, causing flooding through properties and into buildings with substantial damage. In a number of locations the existing roads form the main flow path for floodwaters.

Most of the overland flow paths cross Ocean Drive and Bold Street, which traverse the foot of the Mountain. The cross drainage culverts are also limited in capacity and prone to blockage by flood debris including rocks and vegetation, causing overflows over the road. These are two main roads in the study area and traffic is significantly impeded or roads become cut-off during floods. The roads are raised which results in ponding upstream of the road crossings.

The areas downstream of Ocean Drive and Bold Street are mainly low-lying and relatively flat. Development patterns have resulted in a number of low points being formed in roads and through properties, causing overland flows to pond to significant depths. In some areas attempts have been made to provide a continuous overland flow path to the receiving waterways, however, their capacity is also limited which causes hazardous flooding through roads and on properties. Underground and open channel drainage systems are present but are often exceeded. Drainage in these low-lying areas may also be impeded by high water levels in the receiving waters due to floods or storm surge, and mainstream flooding may also affect these areas. These issues are expected to worsen with climate change and sea level rise.

2.1.2 Flood Depth

Overland flow depths on properties are typically up to 0.3m in up to the 1% AEP event. Depths exceed 0.5m in a number of locations in the 0.2EY event, and exceed 1m in the 5% and 1% AEP events. Areas of deeper flows include main flow paths and drainage low points in a number of roads.

During the PMF event, property and road flooding exceeding 0.5m depth is widespread, with property and road flooding of 1m depth also common. Depths of flooding exceeding 2m occur on approximately 20 properties in the study area.

The flood depth mapping shows relatively high depths of ponding on the upstream sides of many buildings. In most cases this is due to the model terrain not allowing free drainage of water around the buildings. In real life the ground surface around buildings is usually graded to allow water to drain off and not form trapped points. There may also be property stormwater drainage present which is not included in the model. Some care therefore needs to be taken in the review of the flood depth mapping.

2.1.3 Duration of Flooding

Overland flooding in the study area is generally a result of intense short-duration rainfall events. As a result, the duration of inundation of roads and built areas is typically short, limited to 1 – 2 hours in up to the 0.5% AEP event. Storage areas such as road sag points in Sirius Drive and Lilli Pilli Close in Lakewood may be inundated for longer durations of up to 3hrs due to constrained capacity of stormwater drainage servicing these areas.

Durations of inundation are likely to be up to 4 hours in the PMF event particularly in some flood storage locations, affecting roads including Botanic Drive and Ocean Drive west of Lakewood shopping centre.

Note that the duration of flooding for depths greater than 0.3m, at which stage floodwaters become impassable for most passenger vehicles, is generally limited to approximately 1 hour duration in most roads.

A river flooding event may occur shortly after overland flooding in the study area, in which case the lower-lying areas of the study area may experience more extensive durations of flooding. River flooding was not assessed in this study.

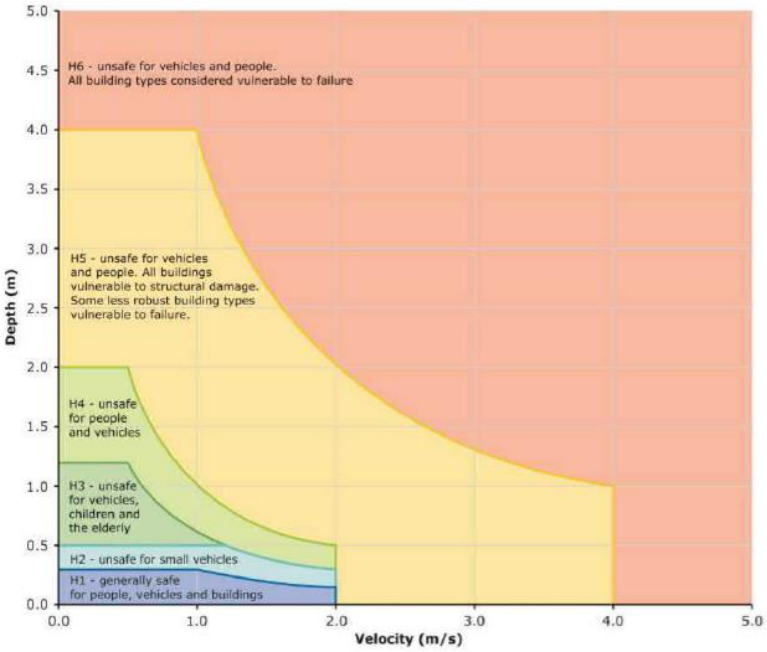
Flood hazard mapping was prepared for the 1% AEP event for current climate conditions and for the 1% AEP event under the adopted climate change scenario (increased rainfall intensity by 10% and with 0.9m sea level rise). Recent research has been undertaken into the hazard that flooding poses and the vulnerability of the public and assets when interacting with floodwaters. A combined flood hazard classification is presented in *Australian Disaster Resilience Handbook 7. Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017a) and *Guideline 7-3 Flood Hazard* (AIDR, 2017b) based on this research, and is illustrated in Figure 2-1. The flood hazard categories according to the AIDR definition are:

- H1 – Generally safe for people, vehicles and buildings;
- H2 – Unsafe for small vehicles;
- H3 - Unsafe for vehicles, children and the elderly;
- H4 - Unsafe for people and vehicles;
- H5 - Unsafe for people and vehicles. Buildings require special engineering design and construction; and
- H6 – Unsafe for people or vehicles. All buildings types considered vulnerable to failure.

The flood hazard classification is more discrete and provides guidance on flood hazard thresholds to different members of the community (e.g. children and elderly) and different assets (small versus larger vehicles, standard versus specialised engineered buildings). The AIDR flood hazard definition potentially provides a more suitable guideline for assessing flood hazard on the floodplain from an emergency management perspective.

The flood hazard mapping is provided in Appendix A and is denoted provisional. The provisional mapping is based on direct flood modelling outputs and was not updated to reflect the “true” flood hazard to take into consideration evacuation, isolation and other emergency management aspects. There are numerous areas of high flood hazard (>H5) typically reflect the swift overland flows in watercourses and flow paths including roadways.

Figure 2-1 General flood hazard vulnerability curves, Australian Institute for Disaster Resilience (AIDR) definition. Reproduced from Figure 6 in *Guideline 7-3: Flood Hazard* (AIDR, 2017b)



2.1.4 Provisional Hydraulic Categories Mapping

Three flood hydraulic categories identified in the *Floodplain Development Manual* (NSW Government, 2005). These are also defined in Council's Flood Policy (2015):

- Floodway, where significant discharge of water occurs during floods and blockage could cause redirection of flows. Generally characterised by relatively high flow rates; depths and velocities;
- Flood storage, characterised by relatively deep areas of floodwater and low flow velocities. Floodplain filling of these areas can cause adverse impacts to flood levels in adjacent areas; and
- Flood fringe, areas of the floodplain characterised by shallow flows at low velocity.

There is no firm guidance on hydraulic parameter values for defining these hydraulic categories, and appropriate parameter values may differ from catchment to catchment. For example, the minimum threshold flows and depths which might define a floodway in an overland flow catchment may be markedly lower than those for a large lowland river due to the different scale of flooding. The category definition adopted in the Hastings River Flood Study (PBP, 2006) and Hastings River Floodplain Risk Management Study (Worley Parsons, 2012) was initially considered for this study. For the Hastings River the floodways were defined as areas in the 1% AEP flood with flows greater than 2m, velocities greater than 0.5m/s and velocity x depth greater than 1m^2/s. This does not agree with the flooding conditions in the North Brother study area, where 1% AEP flows are generally less than 1.5m deep. Hence, an alternative hydraulic category system is required.

Howells et. al. (2003) suggest that consideration of flow depths, velocities and velocity x depth of flood flows can be used to help define the hydraulic category areas. Various combinations of flow, depth and velocity were trialled for appropriate threshold values for the hydraulic categories. For the purposes of this study, the hydraulic categories were defined as per the criteria in Table 2-1, which were selected following trials of different criteria values and categorisation methods. These criteria are consistent with those adopted by a number of other councils in NSW for overland flooding.

Table 2-1 Hydraulic Categories Criteria

Hydraulic Category	Criteria
Floodway	Area within the flood extent where: • Velocity x Depth > 0.3m²/s AND • Velocity > 0.5m/s AND • Depth > 0.15m.
Flood Storage	Remaining area within 1% AEP flood extent where Depth > 0.15m
Flood Fringe	Remaining area in the floodplain (i.e. area within PMF extent) outside the Floodway and Flood Storage areas.

The provisional hydraulic categories mapping is presented in Appendix A for both the 1% AEP design flood for current climate, and for the 1% AEP event with climate change. The mapping is treated as provisional and may need to be considered in further detail to ensure a continuous floodway strip (where appropriate) and to remove/reclassify isolated areas which currently meet the floodway criteria to either flood storage or flood fringe categories. This would be achieved by manual inspection and adjustment of the mapped floodway areas.

Floodway areas are generally located within the natural watercourses and flow paths, although there are a number of roads which contain floodways throughout the study area. Floodways pass through properties on Black Swan Terrace, Koonwarra Street, Pelican Court, Elouera Place, Flinders Drive, St Joseph's School, Peach Grove, Gow Place, Kew Road and in Laurieton between Quarry Place and Bold Street, among others.

2.2 Summary of Flood Problem Areas

Flooding hot spots are identified in the flood study, confirming problem areas previously identified by Council. The hot spots are summarised in Table 2-2 below. Critical areas with consideration of high flood depths, velocities or hazard are highlighted with orange cell or text shading. In summary, the identified critical locations include:

- Black Swan Terrace, West Haven.
- Kirmington Terrace, Koonwarra Street, Captain Cook Bicentennial Drive villas and Ocean Street property and Pelican Court, West Haven.
- Bold Street, Laurieton
  - Laurieton Hotel and adjoining areas
  - Harbourside Crescent villas.
- Lake Street property, Laurieton. Corner Seymour Street.
- St Joseph's School, Laurieton.
- Lilli Pilli Close, Lakewood (road flooding).
- Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood (road flooding).
- Ocean Drive between Fairwinds Avenue and Mission Terrace (road flooding).
- Pelican Court, West Haven (road flooding).
- Waterview Crescent, Kirmington Terrace and Koonwarra Drive, West Haven (road flooding).
- Bold Street between Laurie Street and Mill Street (road flooding).
- Lord Street at Seymour Street, Laurieton (road flooding).

Table 2-2 Description of Flooding Hot Spots

Location	Description
Property flooding	
Black Swan Terrace, West Haven	Flow depths on properties up to 0.5m in the 0.2EY event and up to 0.7m in the 1% AEP event. Swift flows of 2m/s. Flood hazard up to H5 rating in the 1% AEP event.
Ringtail Cl, Lakewood	Overflows from open channel onto properties with flooding in backyards to depths 0.2 – 0.3m in the 1% AEP event. Relatively low flooding impact.
Lilli Pilli Cl, Lakewood	Flooding in backyards to depths of 0.3 – 0.5m in the 1% AEP event from open drain overflows. Flooding in cul-de-sac to depths up to 0.8m. Also significant flooding of car park around Lakewood shopping centre.
Mission Terrace, Lakewood	Overflows with depths of 0.1 – 0.3m in the 1% AEP event from cul-de-sac onto downhill property. Overflows from the overland flow path running through properties on the uphill side of the road with depths up to 0.2m
Kirmington Terrace to Pelican Court, West Haven	Flows through properties on low side of Koonwarra Street of 0.3m in the 0.2EY event and exceeding 0.5m in the 1% AEP event. Velocities up to 2m/s in the 1% AEP event. Flood hazard up to H4 (some localised H5) rating in the 1% AEP event. Flow depths 0.5m in the 0.2EY event and up to 0.8m in the 1% AEP event on Captain Cook Bicentennial Drive villas and Ocean Drive property, at dwellings. Flood hazard up to H4 rating in the 1% AEP event. Flood depths of 0.6 – 0.8m in the 0.2EY event within Pelican Court roadway and pedestrian walkway. Depths up to 0.6m at dwellings in 1% AEP event. Flood hazard up to H4 rating on properties and H5 on roadway in the 1% AEP event. Groundwater springs occur in this area but are not directly related to the surface water flood risk. These springs appear to be a spatially random occurrence.
Flinders Dr Estate, Laurieton	Overflows from drainage easement swale onto properties with depths to 0.3m in the 0.2EY event and 0.5m in the 1% AEP event. Overflows from Reliance Crescent sag point onto properties to depths of 0.2m in the 0.2EY event and 0.4m in the 1% AEP event.
Bold Street area, Laurieton	Significant flows through Laurieton Hotel with H4 hazard rating. Trapped drainage point on western side of commercial properties with significant depths, though local drainage may be present which would mitigate the flood depths. Overflows down fire trail at Norman Street/ Mill Street affecting properties with depths up to 0.3m in the 1% AEP. Overflows onto units on Harbourside Crescent from trunk drainage channel to depths exceeding 0.5m in the 1% AEP event, with H5 hazard rating.

Quarry Way, Laurieton	Overflows from flow diversion drain to depths of 0.5m in the 1% AEP event on properties. The drain is reported to be affected by significant debris blockage.
Lake Street, Laurieton	Flood depths up to 1m in the 1% AEP event affecting dwelling on the corner of Lake Street and Seymour Street. Overflows from Lake Street onto properties between Ocean Drive and Castle Street to depths of 0.3m in the 1% AEP.
St Joseph's School, Laurieton.	Swift flows in overland flow paths to depths of 0.8m and velocities exceeding 2m/s in the 1% AEP event. Flows between buildings are 0.4m in the 0.2EY event and 0.6m in the 1% AEP event, with velocities up to 2m/s. Flood hazard rating of H4 in pedestrian walkways and H5 in overland flow paths in the 1% AEP event.
Properties adjacent to Stingray Creek and Camden Haven River, Laurieton	Numerous properties on low-lying land at risk of oceanic inundation during storm surge events. Estimated depths on the flood mapping expected to be conservative due to likely attenuation of ocean inflows through the river mouth.
Blackbutt Crescent and Peach Grove, Laurieton	Overflows from flow diversion drain to depths of 0.5m in the 1% AEP event on properties. The drain cross-sectional profile and capacity significantly reduces near its discharge point onto Peach Grove at Tunis Street. Flows into the drain originate from natural watercourse further uphill, which is significantly affected by rubble and debris blockage.
Elouera Place, West Haven	Overflows from watercourse and diversion drain. Depths over 0.3m in the 0.2EY event and 0.5m in the 1% AEP event.
Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood	Flood depths on properties 0.3 – 0.5m in the 1% AEP event, built up from road ponding areas.
Sirius Drive and Oak Close, Lakewood	Depths 0.3 – 0.4m and velocities 1m/s in the 1% AEP event.
Sandpiper Close	Overflows from concrete channel along Ocean Drive. Depths 0.3 – 0.4m and velocities 1m/s in the 1% AEP event.
Properties on lower side of Ocean Drive, 200m east of Hoschke Road, West Haven	Road low point overflows onto properties with depths of 0.5m and velocities of 1m/s in the 1% AEP event.
Roads	
Ocean Drive west of Lakewood shopping centre	5% AEP event flood depths of 0.4m 1% AEP event flood depths of 0.5m, H3 hazard rating
Botanic Drive, Lakewood	1% AEP event flood depths of 0.4m, H2 hazard rating
Lilli Pilli Close, Lakewood	5% AEP event flood depths of 0.6m 1% AEP event flood depths of 0.7m, H3 hazard rating
Ocean Drive east of Lakewood shopping centre	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.35m, >H4 hazard rating
Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood	0.2EY event flood depths of 0.6 – 0.7m 1% AEP flood depths 1m, H3 hazard rating
Ocean Drive between Fairwinds Avenue and Mission Terrace	0.2EY event flood depths of 0.5m 1% AEP event flood depths of 0.7m, >H4 hazard rating
Ocean Drive and Mission Terrace intersection	0.2EY event flood depths of 0.4m

	1% AEP event flood depths of 0.6m, H3 hazard rating
Ocean Drive near Waterview Crescent	5% AEP event flood depths of 0.2 – 0.3m 1% AEP event flood depths of 0.3m, low hazard rating but long section of flooding
Ocean Drive near Pelican Court	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.4m, H3 hazard rating
Pelican Court, West Haven	0.2EY event flood depths 0.6m 1% AEP event flood depths of 1m, H5 hazard rating
Waterview Crescent, Kirmington Terrace and Koonwarra Drive, West Haven	0.2EY event flood depths of 0.2m with 2m/s velocity; max 0.6m depths (low velocity) 1% AEP event flood depths up to 0.7m, H5 – H6 hazard rating
Ocean Drive east of Hoshcke Road	0.2EY event flood depths of 0.4m 1% AEP event flood depths of 0.5m, H3 hazard rating
Ocean Drive east of Flinders Drive	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.4m, H3 hazard rating
Kew Road/Bold Street near Tunis Street, Laurieton	1% AEP event flood depths of 0.5m, H2 hazard rating
Bold Street between Laurie Street and Mill Street	0.2EY event flood depths over 0.5m 1% AEP event flood depths 0.6 – 0.8m, H5 hazard rating
Bold Street north of Hanley Street, Laurieton	0.2EY event flood depths of 0.3m with 1m/s velocity 1% AEP event flood depths up to 0.5m, H3 hazard rating
Lord Street at Seymour Street, Laurieton	0.2EY event flood depths of 0.5m 1% AEP event flood depths up to 0.7m, H3 hazard rating
Flinders Drive, Laurieton Tunis Street, Laurieton Rosewood Court and Mission Terrace, Lakewood Diamentina Way, Lakewood	H5 hazard rating on steep sections of road (1% AEP event)

2.3 Above-Floor Property Flooding

A floor level survey was undertaken in October 2019 for selected properties in the study area, which were identified based on presence of high hazard flooding at the dwelling in the 1% AEP event. The minimum habitable floor level was surveyed at a total of approximately 270 buildings. Floor levels for the remaining 2,000 (approximately) properties in the study area were estimated based on an assumed 0.2m height above the maximum ground level at the dwelling.

Above-floor flooding in the 0.2EY, 5%, 2% and 1% AEP and PMF flood events is mapped on Figure 2-2. The buildings shown on the map were selected as those affected by main flow paths and bodies of flooding, and exclude those affected by minor ponding. This selection process was done for each flood AEP and was also used in the flood damages assessment (see Section 2.6).

Above-floor flooding is expected to incur significantly greater flood damages to the building and contents compared to yard (i.e. below floor level) flooding. The map indicates the spatial distribution of properties with above-floor flooding and their relative vulnerability, with properties affected in frequent events such as the 0.2EY event being more vulnerable than those affected only in rarer events such as the 1% AEP event.

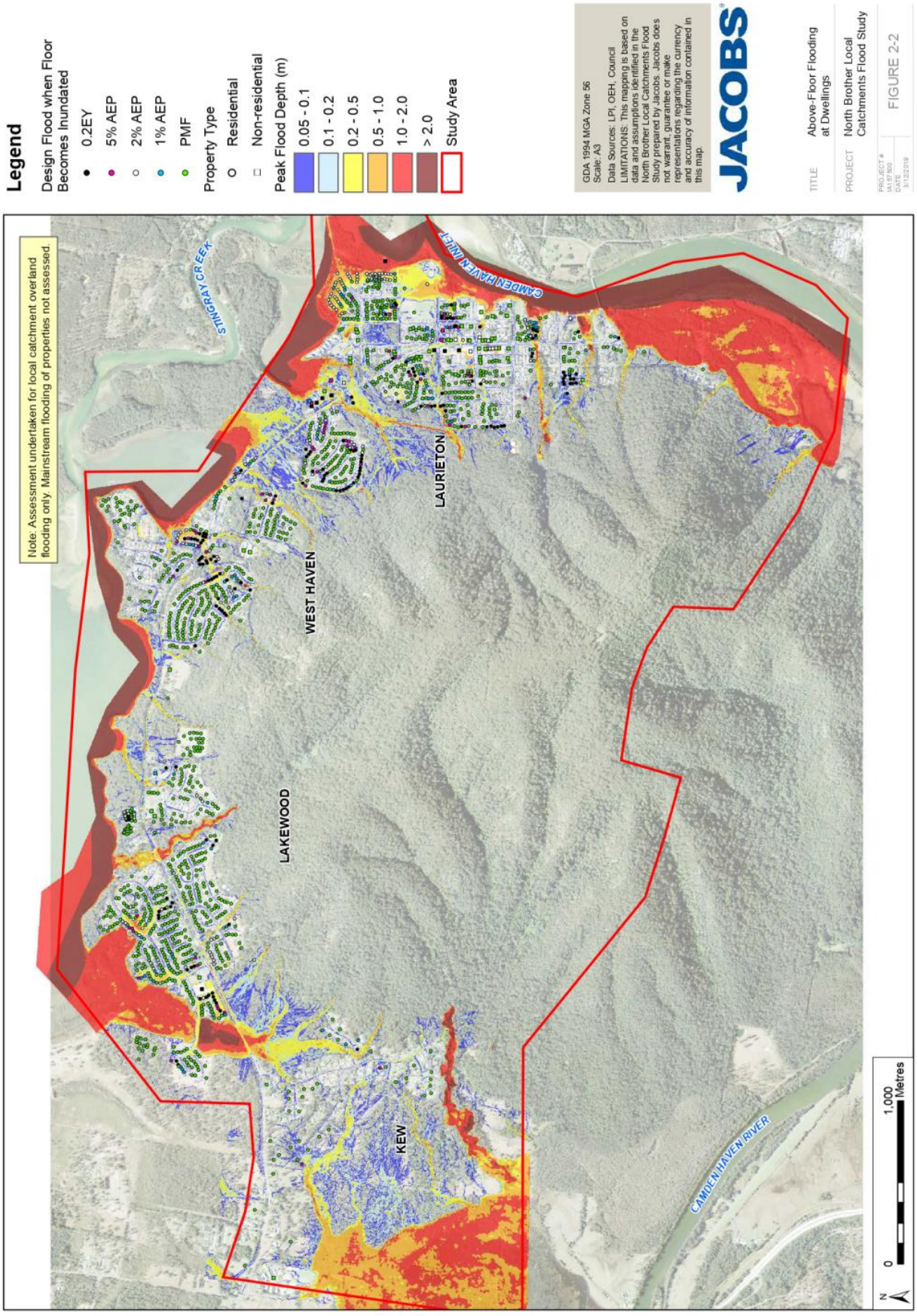
2.4 Very High Hazard Residential Properties

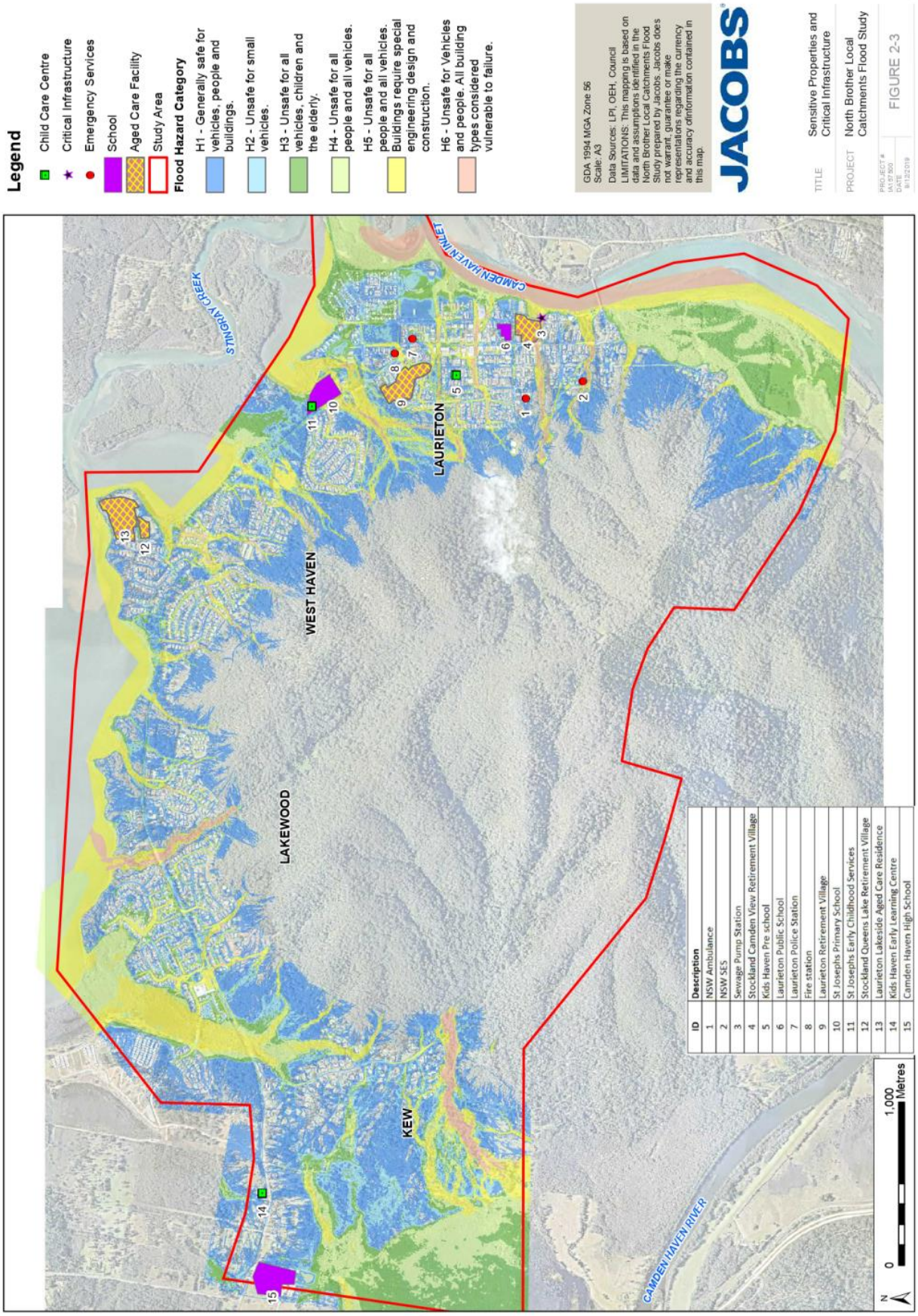
A count of properties with very high hazard flooding conditions at the dwelling was undertaken based on the flood hazard mapping in Appendix A, with the review identifying 20 residential properties with a flood hazard rating of H5 or H6 in the 1% AEP event, whereby damage to the building may result due to floodwaters. The properties are located within the flood problem areas as discussed in 2.2 and may be candidates for management measures including voluntary purchase and redevelopment by Council, as discussed in Section 4.1.1 and Section 4.1.4, respectively.

2.5 Sensitive Properties and Critical Infrastructure

Sensitive properties and critical infrastructure have been identified in the catchment. Certain types of properties may require specific evacuation considerations due to the vulnerability of their occupants, such as schools and pre-schools, and aged care facilities. Critical infrastructure impacted by flooding may have effects on the recovery and functioning of the community following a flood event.

The sensitive properties and critical infrastructure are mapped on Figure 2-3. The flood hazard in the PMF event is mapped on the figure. Note that centrally-operated facilities are listed. Properties which include apartments, villa estates etc. have not been identified.


Legend
Design Flood when Floor Becomes Inundated
0.2EY
5% AEP
2% AEP
1% AEP
PMF
Property Type
Residential
Non-residential
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Note: Assessment undertaken for local catchment overland flooding only. Mainstream flooding of properties not assessed.
STINGRAY CREEK
CAMDEN HAVEN INLET
LAURIETON
WEST HAVEN
LAKEWOOD
KEW
CAMDEN HAVEN RIVER
0
1,000
Metres
N
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE
Above-Floor Flooding at Dwellings
PROJECT
North Brother Local Catchments Flood Study
FIGURE 2-2


Legend
Child Care Centre
Critical Infrastructure
Emergency Services
School
Aged Care Facility
Study Area
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE Sensitive Properties and Critical Infrastructure
PROJECT North Brother Local Catchments Flood Study
FIGURE 2-3
LAKEWOOD
WEST HAVEN
LAURIETON
KEW
CAMDEN HAVEN RIVER
CAMDEN HAVEN INLET
ID Description
1 NSW Ambulance
2 NSW SES
3 Sewage Pump Station
4 Stockland Camden View Retirement Village
5 Kids Haven Pre school
6 Laurieton Public School
7 Laurieton Police Station
8 Fire station
9 Laurieton Retirement Village
10 St Josephs Primary School
11 St Josephs Early Childhood Services
12 Stockland Queens Lake Retirement Village
13 Laurieton Lakeside Aged Care Residence
14 Kids Haven Early Learning Centre
15 Camden Haven High School
0
1,000
Metres

The sensitive properties and critical infrastructure identified as being directly affected by overland flooding are summarised in Table 2-3 with the flood hazard on each site indicated. Note that the list is based on the overland flood modelling in this study, and a number of sites are impacted by mainstream flooding which is not assessed.

Table 2-3 List of flood-affected sensitive properties and critical infrastructure

Name	Overland Flow Flood Hazard* (Existing case, no climate change)		Hydraulic Category (1% AEP, climate change)
	1% AEP	PMF	
Sensitive Properties			
Stockland Camden View Retirement Village	Mostly H1/H2 Up to H5	H6	Flood Fringe/Flood Storage/Floodway
Kids Haven Pre School	H1	H1	Flood Fringe
Laurieton Public School	H1	H4	Flood Fringe
Laurieton Retirement Village	Mostly H1 – H2 Localised H3	H6	Mostly Flood Fringe/Flood Storage. Some Floodway areas
St Josephs Primary School	Mostly H1/H2 Up to H5	H5-H6	Flood Fringe/Flood Storage/Floodway
St Josephs Early Childhood Services	Mostly H1/H2 Up to H4	H5	Flood Fringe/Flood Storage/Floodway
Stockland Queens Lake Retirement Village	Mostly H1/H2	H4	Mostly Flood Fringe. Some Flood Storage areas
Laurieton Lakeside Aged Care Residence	Mostly H1	Mostly H1- H3	Flood Fringe
Kids Haven Early Learning Centre	H1	H1	Flood Fringe
Camden Haven High School	Mostly H1	Mostly H1, up to H4 in low-lying southern part of school	Mostly Flood Fringe
Critical Facilities and Infrastructure			
NSW Ambulance Laurieton	H1	H3	Flood Fringe/Flood Storage
NSW SES Camden Haven unit	H1	H3	Flood Fringe
Laurieton Police Station	H1	H2	Flood Fringe
Fire station Laurieton	H3	H4	Flood Fringe/Flood Storage
Laurieton sewage pumping station	H4	H6	Flood Storage/Floodway

* Note, overland flood hazard indicated. Some properties are also affected by mainstream flooding.

2.6 Flood Damages Assessment

2.6.1 Overview

Flood events may cause damage to property with significant costs to property owners and insurers. The damage may occur due to floodwaters affecting the building façade and interior (weatherboard exterior, gyprock interior walls, carpets), electrical wiring and building contents and other property outside the dwelling (vehicles,

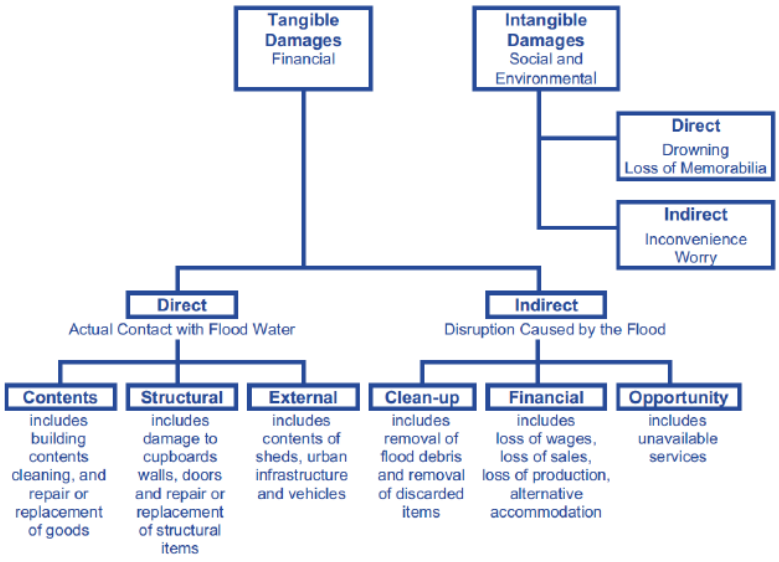
contents of sheds and garages, etc). Structural damage to the dwelling can also occur due to extreme flood hazard conditions.

The cost of flooding is estimated to identify the magnitude of the event to a community, and subsequently provide a benchmark for the viability of potential measures for mitigating the impacts of flooding. This section describes the estimation of flood damage costs in the study area, focussing on residential and commercial properties.

2.6.2 Flood Damages Categories

The type of damages associated with floods is shown in Figure 2-4 (*Floodplain Development Manual, NSW Government 2005*). The cost of damage caused by floods may include tangible and intangible components. Tangible damage costs include the direct material damage and rebuilding costs to existing homes, property and infrastructure, and also the indirect costs associated with the social disruption of the floods, such as: clean-up; lost income during and after the flood event; and the cost of alternative accommodation for people displaced by the floods. A monetary value can be readily placed on the direct damages, which are the focus of this assessment.

Figure 2-4 Types of Flood Damage



Other social and environmental damages to which a monetary value cannot readily be placed are intangible damages, which include emotional stress of the flood event, injury and loss of life. While these damages cannot readily be incorporated into an economic feasibility assessment of mitigation options, it is still important to consider the potential for these intangible damages, particularly if there is an elevated risk of loss of life.

2.6.3 Estimation of Direct Tangible Flood Damage Costs

2.6.3.1 Property Information

Residential and commercial properties were identified and characterised based on knowledge and site observations of the study area.

Residential house types in the study area are generally a mixture of one and two storey houses, in addition to a number of villa and apartment complexes. In floodplains with deep flooding (riverine floodplains) two storey

houses would experience a second increment of flood damages as floodwaters rise and affect the second storey. While some properties in the low-lying areas adjacent to the rivers and lakes would be affected by riverine flooding, the focus of this study is on overland flows from the local catchments, affecting up to the first storey of the house only. For the purposes of this assessment all houses were assumed to be single storey.

Flood damages are estimated based on flood level in relation to building floor level, with the damages increasing as the flood levels increase. The floor levels of approximately 270 buildings, selected based on high hazard flooding in the 1% AEP event, were surveyed. The floor levels of remaining buildings were estimated based on LiDAR ground levels plus and assumed 0.2m above the highest ground level at the building.

Affected buildings for the flood damages assessment were selected based on interpretation of overland flood extents from the flood mapping, to include only those properties affected by main flow paths and significant ponding shown on the mapping so as not to overestimate the flood damages. The affected properties were selected for each event assessed in the flood damages estimation, i.e. the 0.2EY, 5%, 2% and 1% AEP and PMF events. This approach was taken so as not to overestimate the flood damages.

2.6.3.2 Residential Property Damages

Residential flood damages guidelines and a calculation spreadsheet was developed by the NSW Office of Environment and Heritage (OEH, 2016b). The calculation spreadsheet includes a representative stage-damage curve derived for typical house types in the study area to estimate structural, contents and external damage. The amount of damage is based on the flood inundation depth, for a suite of annual exceedance probability events ranging from the 20% AEP event up to the PMF. These values are then summed to provide a total damage for each flood event analysed. The AEP of the PMF in the study area is assumed to be 1 in 10,000,000.

The stage-damage curves assume some flood damages for flood levels below the floor level. A minimum damage value of $12,060 (2018 dollars) is assumed to occur at a level 0.5m below the floor level. This approach accounts for flood damages to parts of the dwelling and property below the floor level and ensures that damages are not underestimated.

Various input parameters are used to define the flooding and location characteristics which derive a location specific damage curve. The parameters adopted for the study area are presented in Table 2-4.. Unless otherwise stated, default parameters have been used (as recommended in the *Residential Flood Damage Guidelines* (OEH, 2016b)).

The DECCW stage-damage curves within the spreadsheet are derived for late 2001, and have been updated using an Average Weekly Earnings (AWE) factor to the current day values. AWE is used to update residential flood damage curves rather than the inflation rate measured by the Consumer Price Index (CPI). The most recent AWE value from the Australian Bureau of Statistics (ABS, 2019) at the time of the assessment was November 2018, however, this resulted in a multiplication factor on 2001 dollars of 2.37, which was significantly out of step from the factor value derived from November 2017 AWE of 1.76 and from previous recent years. On this basis, a factor of 1.9 was assumed for up to August 2019 to keep in trend with AWE increases for the years prior to November 2017.

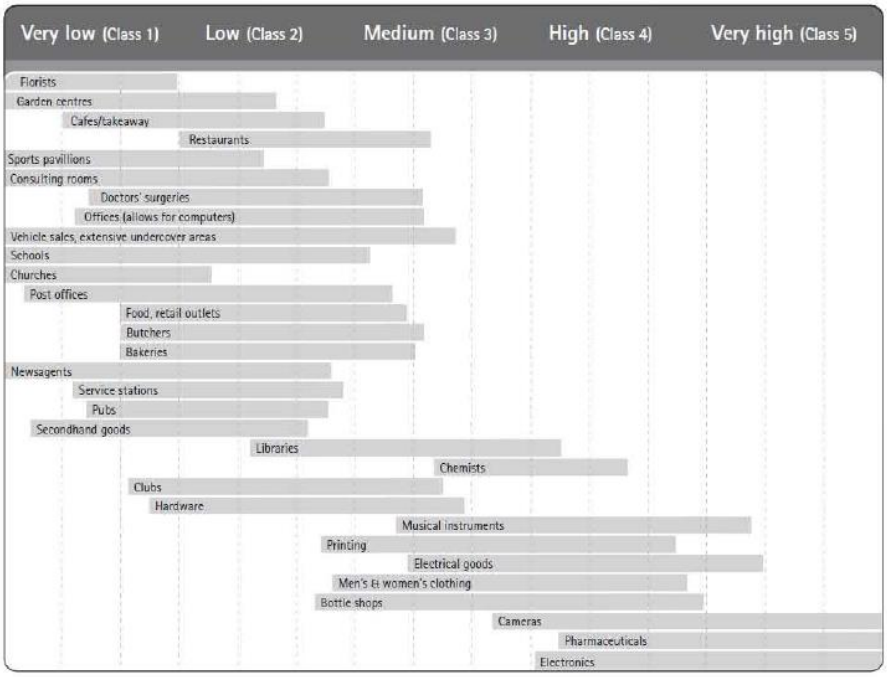
Table 2-4 Input parameters for damage calculations

Parameter	Value	Comment
Regional Cost Variation Factor	1.0	Appropriate value for a major city (Sydney) and surrounds. Similar value assumed for major regional city.
Post flood inflation factor	1.15	
Typical duration of immersion	1 hour	
Building damage repair limitation Factor	0.85	Represents short duration flood (<12 hours) where some materials can recover from short periods of flooding and may not need replacement
Typical free-standing house size	240m²	
Contents damage repair limitation Factor	0.75	Guidelines suggest a value of 0.75 for short duration floods
Effective warning time (hrs)	0	Only marginal improvement in damages cost when effective warning time is increased to 1 hour as a sensitivity assessment
Level of flood awareness	Low	Flood warning times are nil, and it is assumed that residents are typically not aware of potential damage of flood waters and the measures to minimise damages (e.g. elevated storage of goods).

2.6.3.3 Commercial Property Damages

No information on commercial property flood damage costs in NSW was found during a literature search. The most relevant information obtained was published in the Queensland Government Natural Resources and Management Department's *Guidance on the Assessment of Tangible Flood Damages* (2002). This document contains flood damage curves for commercial properties over a range of property footprint areas and degrees of susceptibility to flooding and is based on information published in *ANUFLOOD: A Field Guide* (Centre for Resource and Environmental Studies (Australian National University), 1992). Different types of commercial and non-residential properties were assigned a susceptibility rating, as illustrated in Figure 2-5.

Figure 2-5 Damage categories for commercial properties (reproduced from *Guidance on the Assessment of Tangible Flood Damages* (Qld. Government, 2002)



The stage-damage data were factored up by a value of 1.9 from late 2001 dollars to current values based on Average Weekly Earnings (AWE), similar to the approach adopted for the residential flood damages.

An additional multiplication factor of 1.6 was applied based on guidance in *Rapid-Appraisal Method (RAM) for Floodplain Management* (Victorian Government Natural Resources and Environment, 2000), which suggests that the ANUFLOOD values are underestimated and should be increased by 60%.

A total of 89 commercial and non-residential premises/buildings which are potentially flood-affected were identified. Detached buildings on non-residential properties were assessed individually e.g. on school grounds. Individual shops within an overall commercial building complex were also assessed separately where possible. The results of the commercial and non-residential property flood damages assessment are provided in Section 2.6.3.5.

2.6.3.4 Damages to Utilities and Infrastructure

Utilities and infrastructure in the study area which are susceptible to flooding may include roads and other public infrastructure such as sewage pumping stations, electrical transformer boxes, etc.

The potential cost of damage to roads is difficult to estimate for the study area, as the nature of flooding in a significant portion of study area is typically due to relatively shallow, short-duration flows, although road damage is possible for roads conveying higher velocity flows.

The roads damages guidance published in the references cited in this study are based on longer-duration mainstream flooding damages and hence are likely to overestimate the flood damages to roads in the study area. Hence these costs have not been included in this assessment.

2.6.3.5 Damage Assessment Results

The most convenient way to express flood damage for a range of flood events is by calculating the Annual Average Damage (AAD). The AAD is equal to the total damage caused by all floods over a long period of time divided by the number of years in that period. The AAD for the existing case then provides a benchmark by which to assess the merit of flood management options.

The AAD value is determined by multiplying the damages that can occur in a given flood by the probability of that flood actually occurring in a given year and then summing across a range of floods. This method allows smaller floods, which occur more frequently to be given a greater weighting than the rarer catastrophic floods.

Table 2-5 summarises the residential damages and the commercial and non-residential damages. The residential and commercial property flood damages include direct damages to property such as structural, external and contents damage, and indirect damages such as clean up costs and accommodation/ loss of rent costs. Infrastructure damage, vehicular damage and intangible damages are not included.

The OEH (2016b) guidelines recommend that the adopted freeboard in the flood planning level (0.5m) be considered in the flood damages estimation. This gives the "Protection Level" which reduces the floor level relative to the flood levels in the calculations which are adopted as the damages estimates. Calculations of damages based on floor level (no freeboard adjustment applied) are also provided as a sensitivity check.

The flood damages here are "potential flood damages", which may be reduced with increased flood awareness and preparedness in the community. The Net Present Value of the flood damages assumes a 7% discount rate over a 50 year life, as per the OEH (2016b) guidelines. The damages are in 2019 dollar values

Table 2-5 Estimated Tangible Flood Damages due to Overland Flooding

Event	Based on Floor Level*		Based on Protection Level (Floor Levels minus Freeboard)*	
	Number of properties flooded above floor level	Estimated Flood Damage	Number of properties flooded above protection level	Estimated Flood Damage
Residential				
20% AEP	161	$18.9M	344	$40.3M
5% AEP	222	$25.6M	429	$50.8M
2% AEP	380	$42.7M	679	$80.6M
1% AEP	492	$54.1M	839	$100.0M
PMF	1,616	$193.9M	2,062	$274.5M
AAD		**$8.9M**		**$17.6M**
Commercial/Non-Residential				
20% AEP	10	$1.0M	34	$4.4M
5% AEP	16	$1.5M	44	$6.1M
2% AEP	27	$2.3M	59	$8.3M
1% AEP	31	$2.5M	63	$8.9M
PMF	83	**$12.9M**	98	$22.7M
AAD		**$0.5M**		**$1.9M**

* Damages estimate based on Protection Level is to be adopted. Estimate based on floor level used as a sensitivity check.

2.6.4 Application of Flood Damage Curves to the Study Area

It should be noted that the flood damages estimated for the study area need to be considered with care. The OEH residential stage-damage curves recommended for use in NSW have been developed based on flood damages from low-land mainstream/ flooding, where flood surface gradients are relatively flat and the depth of flooding within a dwelling is fairly uniform. Due to the steep terrain in parts of the study area and the generally shallow nature of overland flows (particularly in the more frequent flood events), flood levels may vary greatly on a property and damage may be concentrated on one side of a dwelling. Flood depths are also relatively shallow so the damage incurred may be less than those suggested by the curves. Nevertheless, the stage-damage curves provide the best guidance available for estimating flood damages given the scarcity of actual flood damage data to residential properties on overland flow paths and have been adopted for this study.

2.6.5 Summary

Flood damages in the study area is primarily attributed to residential dwellings that are impacted by overland flooding. The estimates based on Protection Level are adopted. The flood damages estimates were based on properties selected based on their impact from main areas of flooding, and excludes those affected by localised minor ponding. The residential AAD for the study area is $17.6 million. The non-residential AAD is $1.9 million.

There are 523 residential and non-residential properties that are estimated to experience above floor flooding (not protection level) for the 1% AEP event. In the PMF, 1,699 properties are estimated to experience above floor flooding.

While flood damage estimates for the study area are indicative only, they are useful in the evaluation of flood management options, aimed at reducing flood damage estimates while being economically viable to implement.

3. Floodplain Risk Management Measures

3.1 Overview

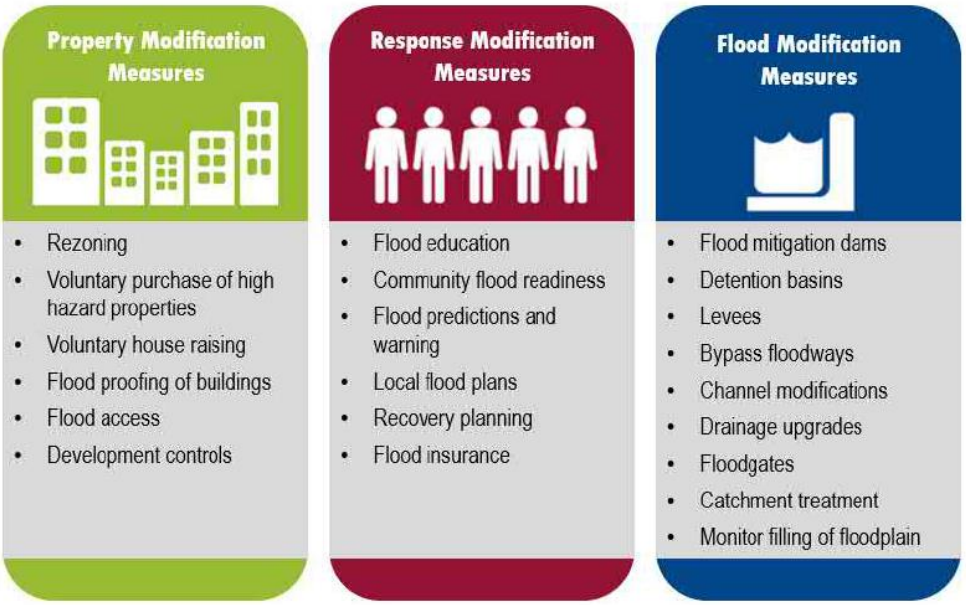
One of the objectives of this Floodplain Risk Management Study is to identify and compare various floodplain risk management options to deal with existing and future flood risk in the study area, considering and assessing their social, economic, ecological and cultural impacts and their ability to mitigate flood impacts.

The *Floodplain Development Manual* (NSW Government, 2005) describes floodplain risk management measures in three broad categories as described below:

- Property modification measures involve modifying existing properties (for example, house-raising) and/or imposing controls on new property and infrastructure development (for example, floor height restrictions);
- Response modification measures involve modifying the response of the population at risk to better cope with a flood event (for example improving community flood readiness); and
- Flood modification measures involve modifying the behaviour of the flood itself (for example, construction of a levee to exclude floodwaters from an area or flood retarding/detention basins to store floodwaters and reduce peak outflows).

Examples of measures falling under the three categories are outlined in Figure 3-1. Some of these measures may or may not be appropriate in a particular catchment, depending on factors such as the flooding behaviour and patterns of development.

Figure 3-1 Floodplain Risk Management Measures *(Source: Floodplain Development Manual, 2005)*



3.2 Considerations in Options Identification and Prioritisation

In determining the nature and priority of potential options for further detailed assessment, the following factors have been considered:

- The identified mitigation options are aimed at improving flooding conditions due to local catchment flooding. Riverine flood levels exceed the local catchment flood levels by a substantial amount particularly in the 1% AEP event and inundate low-lying areas of the study area. The local catchment flood mitigation options in these areas should be designed not to worsen the susceptibility of these areas to riverine flooding. For example, substantial lowering of raised berms may allow overtopping of river floodwaters in more frequent events.
- Design river tailwater conditions due to elevated ocean levels are up to 2.1m AHD in the 1% AEP event. Some low-lying areas on properties and roads have a ground level of approximately 2.6m AHD and would be difficult to drain via underground pipes.
- The effectiveness of mitigation options during future climate change scenario is to be considered. The design river tailwater conditions due to elevated ocean levels would increase to 3.0m AHD in the 1% AEP event in a climate change scenario, with 0.9m of sea level rise.
- The design riverine flood levels are 2.3 – 2.4m AHD in the 5% AEP event and 2.9 – 3.0m AHD in the 1% AEP event in the current climate. The flood levels in a climate change scenario are expected to increase by up to 0.8m in the 1% AEP event as a result of 0.9m sea level rise and 10% increase in rainfall (Patterson Britton and Partners, 2013).
- Given the low elevation of a number of identified sites for potential mitigation, it is expected that the effectiveness of the mitigation options would be reduced if local overland flooding coincided with a mainstream flood peak. Some contingency will be incorporated into the options modelling with adoption of elevated, but not peak, river tailwater levels.

3.3 Selection of Options for Detailed Assessment

A description and qualitative evaluation of identified works-based flood modification options at 16 locations was provided in the Working Draft Options Report, dated 9 December 2019. The identified options aim to mitigate flooding at the locations summarised in Table 2-2, in particular property flooding. A short-list of six combinations of options were selected by Council and the committee, and have been analysed in the TUFLOW model for hydraulic performance. The results of the modelling are described in this section.

Property and response modification measures will be addressed in the draft FRMS.

3.4 Assessed Flood Modification Measures

The short-listed options were tested in the TUFLOW model for the 0.2EY, 5%, 2% and 1% AEP events and the 1% AEP with climate change event to assess the improvements to flooding conditions. Existing underground utilities were considered in the configuration of the options based on Dial Before You Dig searches.

The assessed options are described, and their modelled performance is summarised for the 0.2EY, 5% and 1% AEP events in the following sections.

3.4.1 Black Swan Terrace, West Haven

Council commissioned, separately from this study, a design for an improved trunk drainage pipe inlet arrangement and high-flow diversion to the street. Additional works in the street including raising of the road verge and driveways are proposed. Details of the design were provided following the final flood study, hence it has not been incorporated into the design flood modelling and mapping. Since the design development of mitigation works at this location are already well-advanced, further mitigation options are not proposed in this study.

The pre-developed conditions at Black Swan Terrace have been retained in the mitigation case modelling. Post-development hydraulic modelling for this option is being undertaken by others on behalf of Council. Flow conditions in Koonwarra Street, downstream of the works, are not expected to be significantly changed as a result of the works, hence omission of the works from the mitigation case modelling should not affect the assessment of other mitigation options.

3.4.2 Kirmington Terrace to Pelican Court, West Haven

This area is identified as a critical flood problem area with significant flooding of properties in Koonwarra Street, Captain Cook Bicentennial Drive villas, Ocean Drive and Pelican Court. The flood hazard is high to very high (H4, some H5) on properties and on roads in the 1% AEP event. The area is highly affected in frequent events such as the 0.2EY event.

Flooding originates from three separate overland flow paths, including one from Black Swan Terrace, a second near Kirmington Terrace and a third from near Hoschke Road. Flow paths 1 and 2 converge in Koonwarra Street and then flow path 3 converges at Pelican Court. Overland flows are about 15m^3/s in flow paths 1 and 2 in total in the 1% AEP event downstream of Koonwarra Street, and 20m^3/s in combined flow paths 1, 2 and 3 in Pelican Court. Existing pipe flows in Pelican Court are 3m^3/s in the 1% AEP event in addition to the overland flows. The existing pipes in the network run full in the 0.2EY event. Flow paths 1 and 2 affect a number of properties throughout this area.

Flow path 3 directly affects two dwellings on Ocean Drive (numbers 384 and 386) near Hoschke Road in addition to contributing to flows in Pelican Court. It includes a 2m wide drainage channel through properties on the higher side of Ocean Drive, draining to a 2.4m x 0.9m box culvert under Ocean Drive, which is the main flow constraint. The culvert conveys 3.7m^3/s in the 1% AEP while another 3.7m^3/s overflows over Ocean Drive. it discharges to the formed swale on the low side of the road before the flows enter Pelican Court.

Floodwaters pond in Pelican Court and flow overland via an access road in addition to through properties to discharge to Queens Lake.

3.4.2.1 Option 4A+4B+4C

Description

The following options were assessed in combination (Options 4A+4B+4C):

- Option 4A – voluntary acquisition of one property in Koonwarra Street (number 53) which has floodway and H5 flood hazard conditions. Regrade the site to form a flow path to relieve flood conditions in the road and on adjacent properties.
- Option 4B – new additional trunk drainage line 2x 1200mm diameter pipes, intercepting flows at downstream end of channel on Captain Cook Bicentennial Drive villas, cross Ocean Drive and run under The Gateway and discharge to receiving waterway to the north of Pelican Court. This proposed pipe capacity would be approximately 5m^3/s which would reduce the total overland flow in Pelican Court by about 25% in the 1% AEP event. An inlet basin/rock debris trap similar to that proposed at Black Swan Terrace may be required.
- Option 4C – voluntary acquisition of one property, 7 Pelican Court, adjacent to the access road to form a larger flow path and provide additional capacity for flows out of Pelican Court sag.

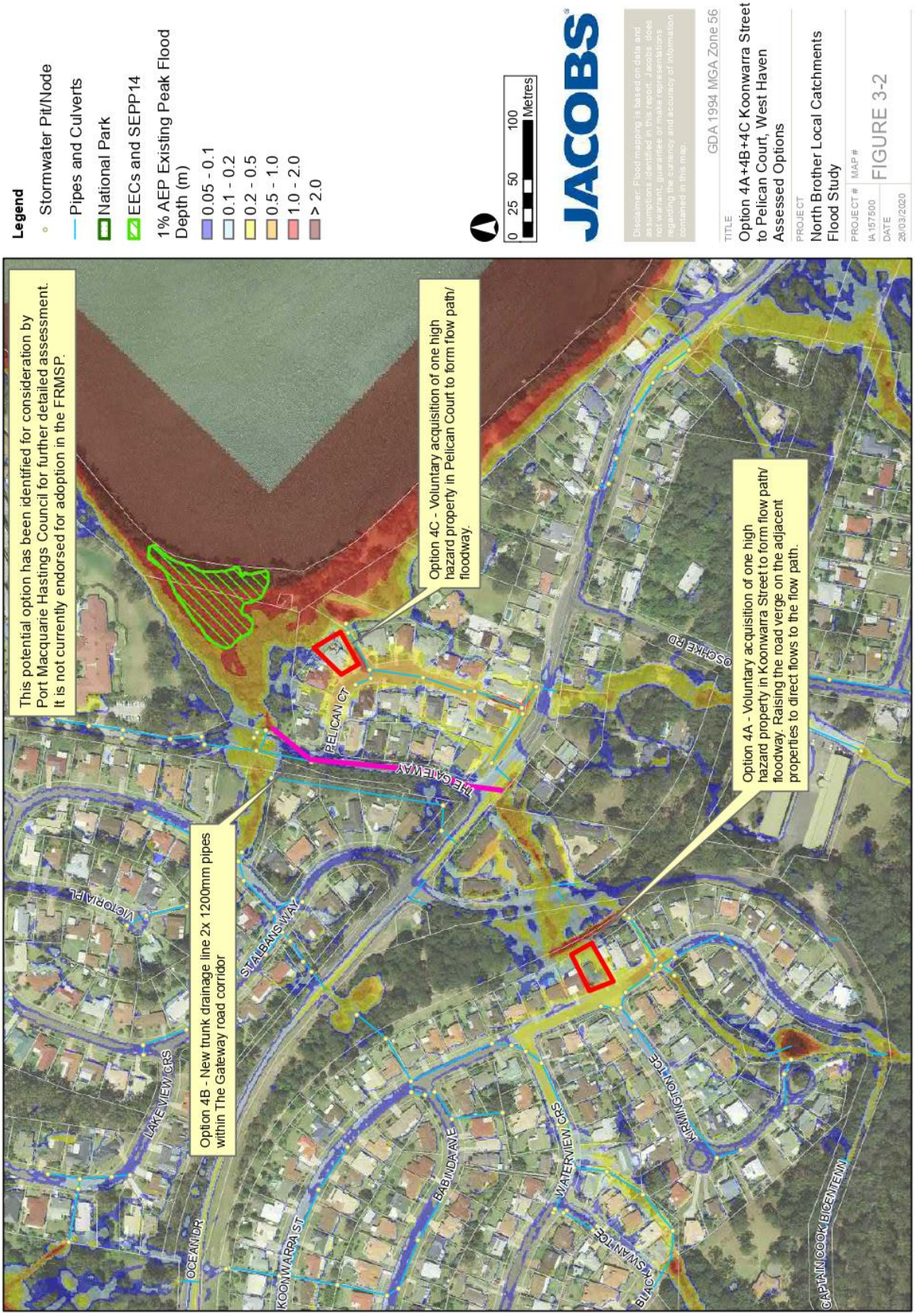
Refer to Figure 3-2 for illustration of options.

Constraints assessment

- High property prices (~$500K each) plus demolition and disposal costs.
- Existing underground utilities in Ocean Drive and The Gateway (Telstra, Optus, NBN, power, stormwater).
- Substantial number of trees in western verge of The Gateway, require removal if running new trunk drainage in the verge.

- Limited space to widen existing channel running through Captain Cook Bicentennial Drive villas and then turning at Ocean Drive. Presence of existing driveway crossing over channel into Ocean Drive property.
- Minimal space for rock debris trap at new trunk drainage inlet structure. Requires more detailed site assessment for potential rock debris loads. There are a number of informal traps upstream (e.g. road crossings) and a discontinuous flow path running off the mountain, so rock debris loads may be low.

Based on the site constraints it is assumed that the new trunk drainage line would run under the western side of The Gateway in order to minimise the number of underground services which need to be crossed and/or protected.


Legend
Stormwater Pit/Node
Pipes and Culverts
National Park
EECs and SEPP14
1% AEP Existing Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
0 25 50 100 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Option 4A+4B+4C Koonwarra Street to Pelican Court, West Haven Assessed Options
PROJECT
North Brother Local Catchments Flood Study
PROJECT # IA157500
MAP #
DATE 28/03/2020
FIGURE 3-2
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
Option 4C - Voluntary acquisition of one high hazard property in Pelican Court to form flow path/ floodway.
Option 4A - Voluntary acquisition of one high hazard property in Koonwarra Street to form flow path/ floodway. Raising the road verge on the adjacent properties to direct flows to the flow path.
Option 4B - New trunk drainage line 2x 1200mm pipes within The Gateway road corridor
PELICAN CT
THE GATEWAY
OSCHKE RD
VICTORIA PL
ST ALBANS WAY
LAKE VIEW CRS
OCEAN DR
KOONWARRA ST
BABINDA AVE
WATERVIEW CRS
BLACK SWAN TCE
NARRAWONG TCE
CAPTAIN COOK BICENTENN

Hydraulic performance

Flood impact maps, showing the change in flood levels, are presented in Figure 3-3 to Figure 3-5 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Options 4A+4B+4C is summarised in Table 3-1.

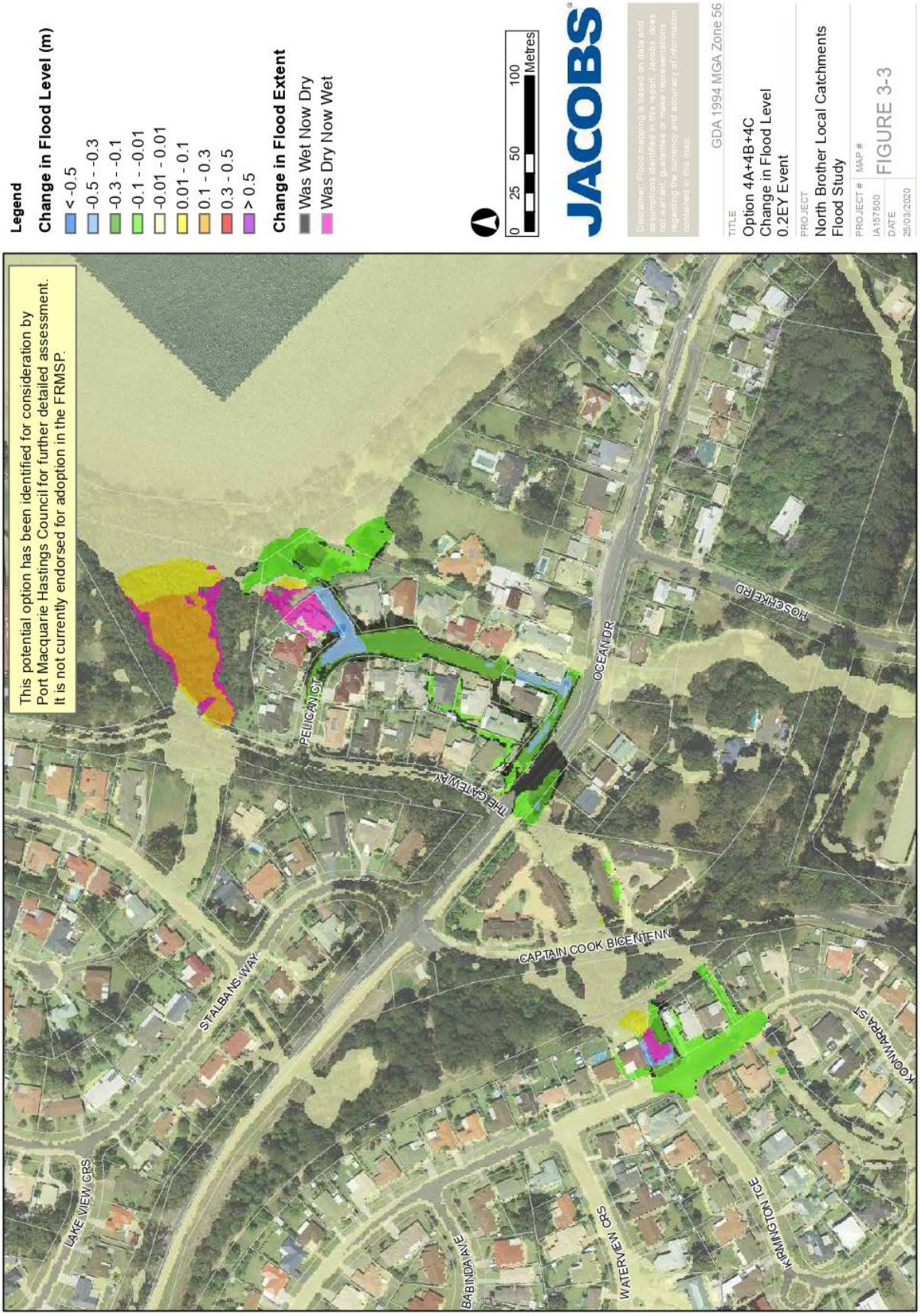
Table 3-1 Hydraulic performance of Options 4A+4B+4C

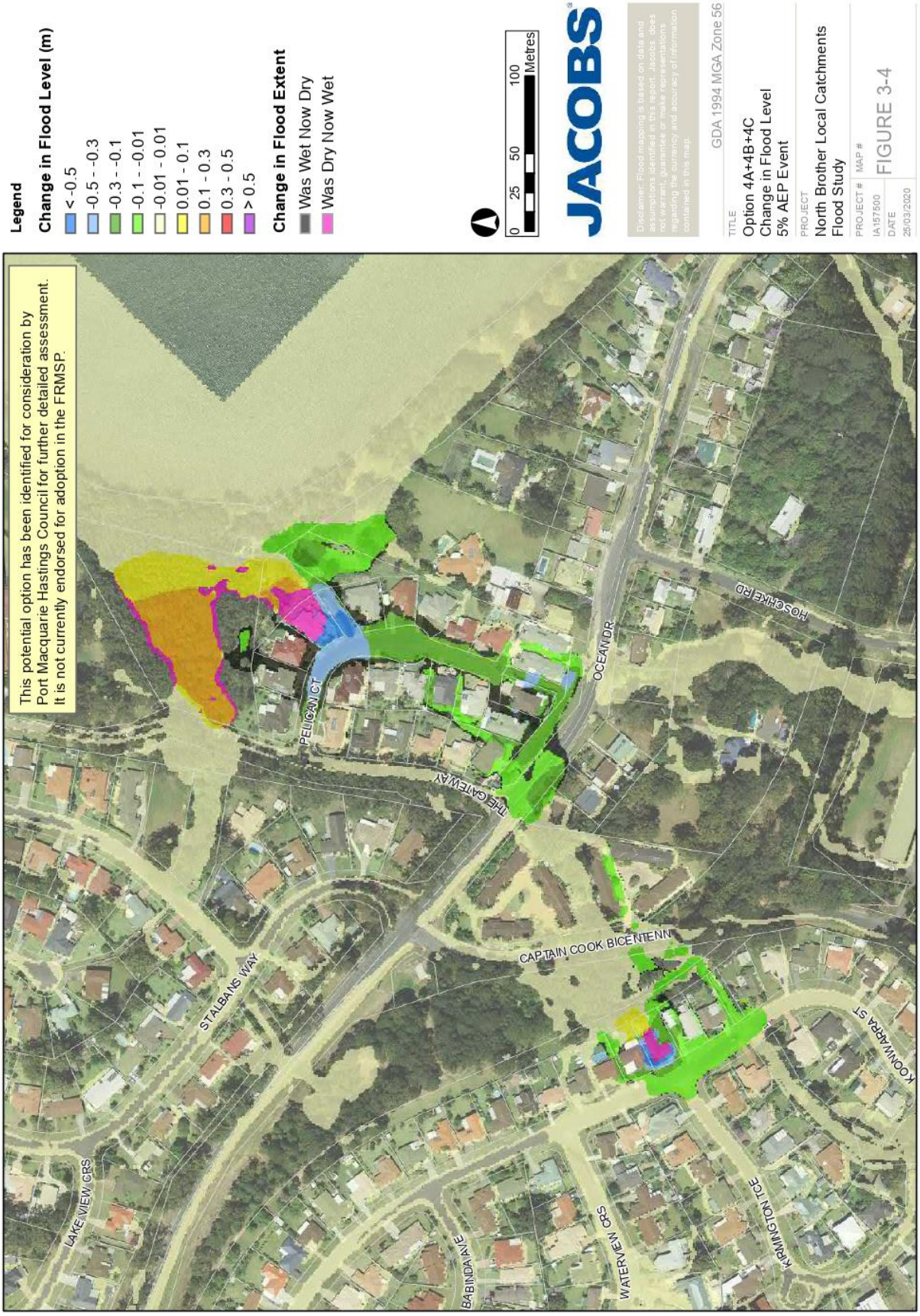
Event AEP	Changes in flood conditions
0.2EY	• Koonwarra Street – flood levels reduced by up to -0.04m at three properties adjacent to new floodway • Pelican Court – flood levels reduced by -0.2 to -0.4m in roadway and alleyway. Localised reductions only on properties up to -0.1m. • Reduced flood hazard from very high (H5) to mostly low (H1, H2) in Pelican Court, some moderate H3 in alleyway.
5% AEP	• Koonwarra Street – flood levels reduced by -0.04m to -0.2m at four properties adjacent to new floodway. • Pelican Court – flood levels reduced by -0.2 to -0.7m in roadway and alleyway. Reductions on properties typically to -0.1m, up to -0.4m on two properties. • Reduced extent of very high flood hazard (H5) in Pelican Court.
1% AEP	• Koonwarra Street – flood levels reduced by -0.04m to -0.4m at four properties adjacent to new floodway • Minor localised increase of +0.02m on Captain Cook Bicentennial Drive villas • Pelican Court – flood levels reduced by -0.2 to -0.7m in roadway and alleyway. Reductions on properties typically to -0.1m, up to -0.4m on two properties. • Eliminated occurrence of high - very high flood hazard (H4-H5) at two dwellings in Koonwarra Street (one through acquisition of property). • Reduced flood hazard on Ocean Drive from up to very high (H5) to low (H2). Note that road may be cut-off in other locations. • Reduced extent of H3-H5 hazard in Pelican Court.
1% AEP plus climate change	Similar performance to 1% AEP, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). No reduction in performance due to sea level rise.

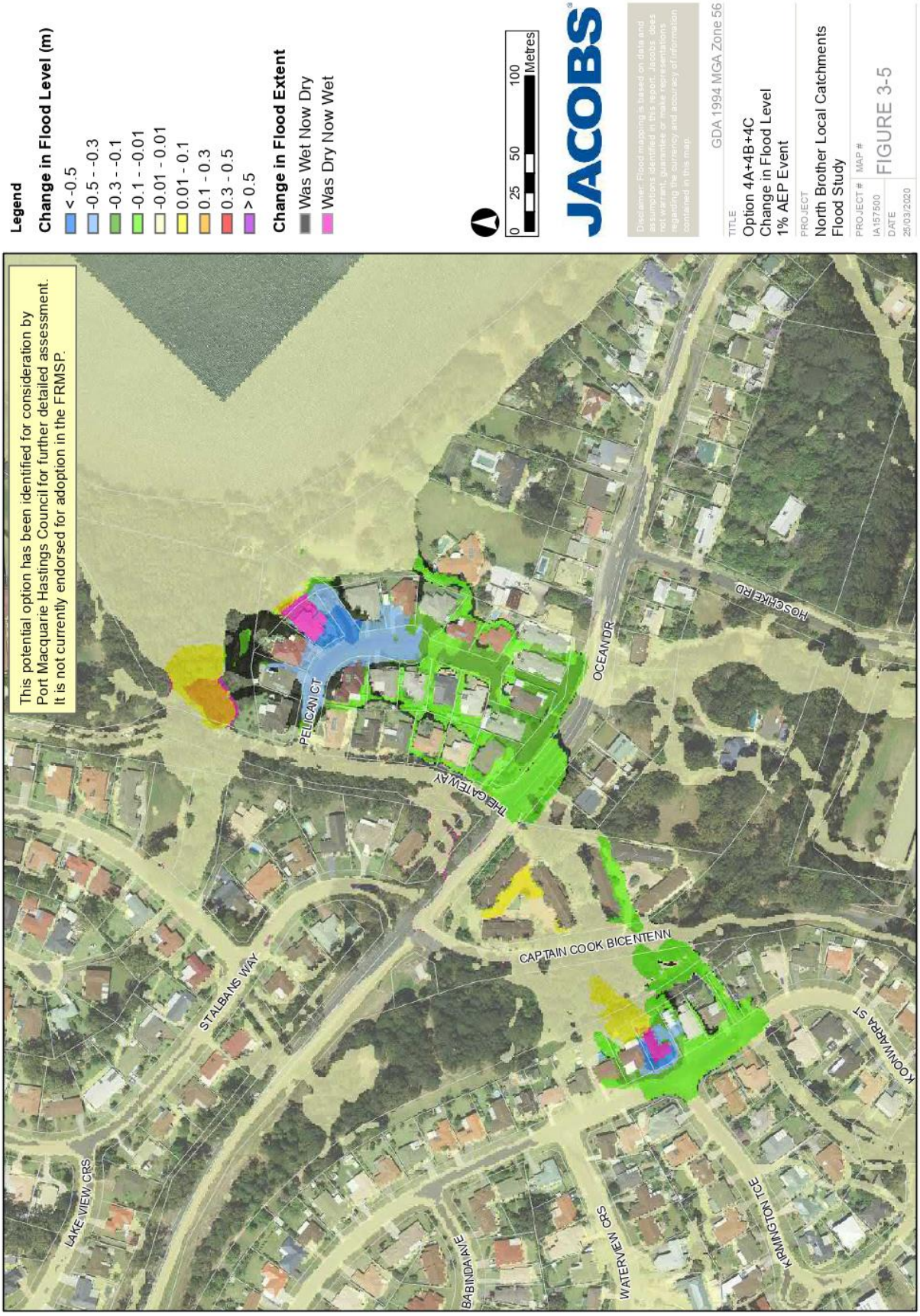
Summary

Options 4B and 4C appear to be effective at reducing flood levels and flood hazard (magnitude and extent) on Ocean Drive and Pelican Court including up to 20 dwellings.

Option 4A reduces the number of properties at risk to high hazard flooding and to flood damages due to the property purchase. However, the reductions in flood levels on adjacent properties is generally minor, with the more substantial reductions limited to one property. The likely high cost of this option (property purchase price plus demolition costs and earthworks) may make this option more challenging to justify purely from an economic standpoint. Notwithstanding, the removal of a household subject to high flood hazard should be considered in the subsequent multi-criteria evaluation of this option.


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 4A+4B+4C
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-3
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
PELICAN ST
THE GATEWAY
OCEAN DR
HOSKHE RD
CAPTAIN COOK BICENTENN
STALBANS WAY
LAKE VIEW CRS
BABINDA AVE
WATERVIEW CRS
KOOMWARRA ST
KIRMINGTON CCE


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 4A+4B+4C
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-4
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
PELICAN CT
THE GATEWAY
OCEAN DR
HOSKHE RD
CAPTAIN COOK BICENTENN
STALBANS WAY
LAKE VIEW CRS
BABINDA AVE
WATERVIEW CRS
KOOMWARRA ST
KIRRIMINGTON CCE


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 4A+4B+4C
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-5
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
PELICAN CT
THE GATEWAY
OCEAN DR
HOSKHE RD
CAPTAIN COOK BICENTENN
STALBANS WAY
LAKE VIEW CRS
BABINDA AVE
WATERVIEW CRS
KIRMINGTON TCE
KOOMWARRA ST

3.4.3 Tunis Street Overland Flow Path, Laurieton

This overland flow path originates above Blackbutt Crescent and Peach Grove, where a natural gully overflows into a constructed diversion channel which skirts around properties on Blackbutt Crescent and conveys flows through an easement to Peach Grove at Tunis Street. There is an existing low capacity pipe (375mm diameter) draining the flows in the easement to the existing drainage system. Flows in excess of the overland flow path spill out onto properties on Peach Grove and contribute to flooding at the main complex at Laurieton retirement village, although flooding at this complex is exacerbated by partially-trapped drainage low points.

The main flow path splits around Gow Place and Norman Street/Tunis Street intersection, with the northern branch flowing through the Laurieton retirement village villas and exiting around Kew Road at Castle Street, and the southern branch draining to the sag point on Bold Street at Tunis Street, and then joining a separate flow path through commercial and residential properties on Bold Street to McLennan Street.

The main stormwater drainage line consists of up to 900mm diameter pipe in Tunis Street, draining to the river.

Peak overland flows in these flow paths are summarised in Table 3-2.

Table 3-2 Peak flood flows at Tunis Street overland flow path

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
Upstream of Peach Grove	5.2	9.4	14.1
Tunis Street at Peach Grove	3.5	6.2	9.2
Gow Street branch	1.8	3.2	5.0
Tunis Street and natural gully at Lord Street	2.1	4.1	7.1

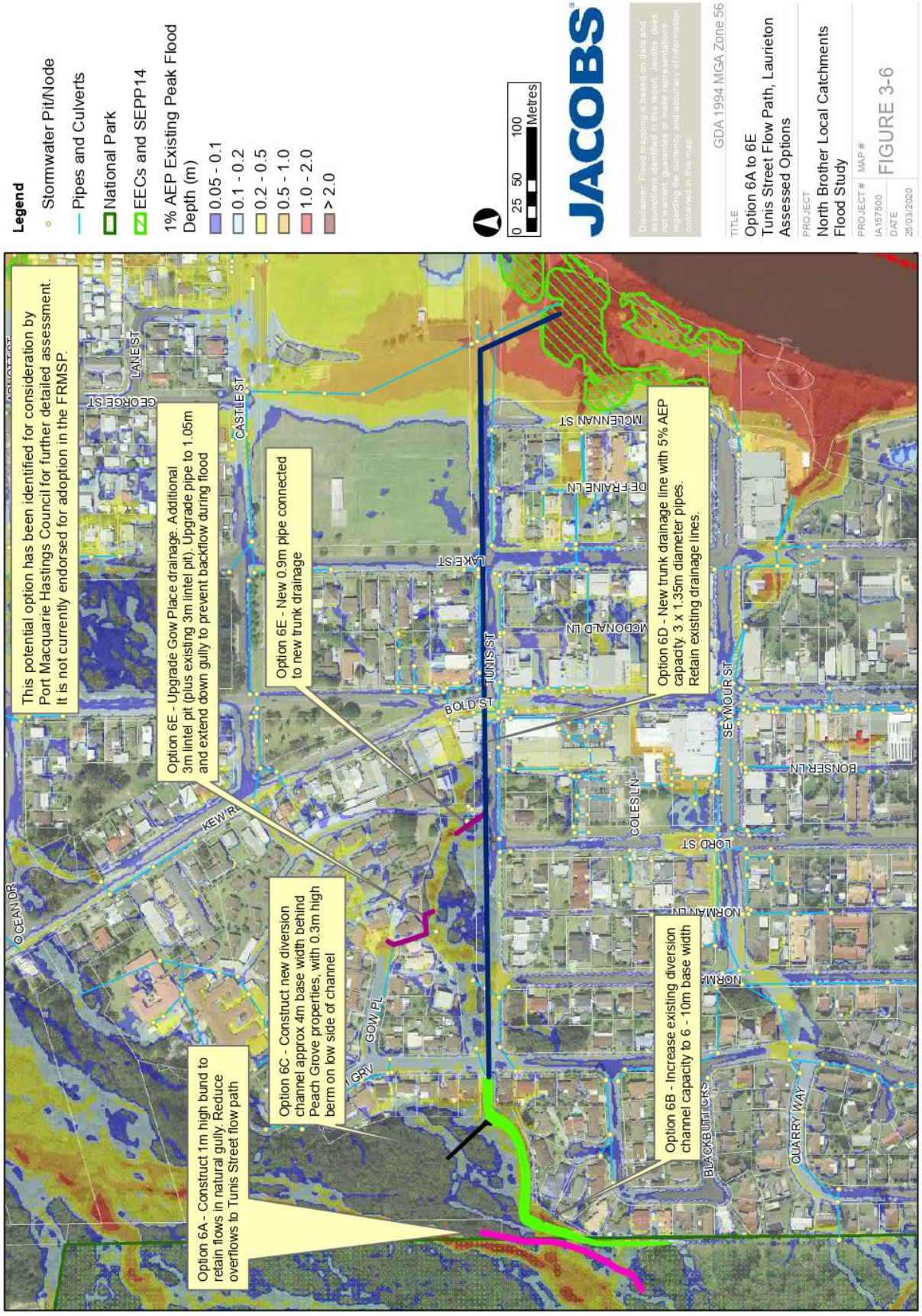
3.4.3.1 Option 6A

Description of Options

Option 6A was assessed individually:

- Option 6A – construct/raise a 160m long berm, up to 1m high above existing ground levels, between the natural flow path and the diversion channel above Blackbutt Crescent to reduce overflows into the diversion channel and hence reduce flows through the properties downstream. However, this option is expected to increase the flows being directed toward St Josephs School.

Refer to Figure 3-6 for illustration of Option 6A. The figure also describes Options 6B to 6E, refer to Section 3.4.3.2 for details.


Legend
Stormwater Pit/Node
Pipes and Culverts
National Park
EECs and SEPP14
1% AEP Existing Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
0 25 50 100 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Option 6A to 6E
Tunis Street Flow Path, Laurieton
Assessed Options
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-6
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
Option 6E - Upgrade Gow Place drainage. Additional 3m lintel pit (plus existing 3m lintel pit). Upgrade pipe to 1.05m and extend down gully to prevent backflow during flood
Option 6E - New 0.9m pipe connected to new trunk drainage
Option 6D - New trunk drainage line with 5% AEP capacity. 3 x 1.35m diameter pipes. Retain existing drainage lines.
Option 6C - Construct new diversion channel approx 4m base width behind Peach Grove properties, with 0.3m high berm on low side of channel
Option 6A - Construct 1m high bund to retain flows in natural gully. Reduce overflows to Tunis Street flow path
Option 6B - Increase existing diversion channel capacity to 6 - 10m base width
OCEAN DR
KEW RD
GOW PL
GEORGE ST
LANE ST
CASTLE ST
LAKE ST
TUNIS ST
BOLD ST
MCLENNAN ST
DE FRAINE LN
MCDONALD LN
COLES LN
SEYMOUR ST
LORD ST
BONSER LN
NORMAN LN
BLACKBUTTERS
QUARRY WAY

Constraints assessment

- Option 6A would need to be constructed within the national park area, likely requiring removal of a large number of trees for the proposed bund in addition to site access for construction plants.
- The option would be constructed on a natural berm which appears to be formed from flood-flow deposits of rock rubble and other material. Geotechnical conditions may be challenging.
- Periodic maintenance of the proposed bund would be required.

Hydraulic performance

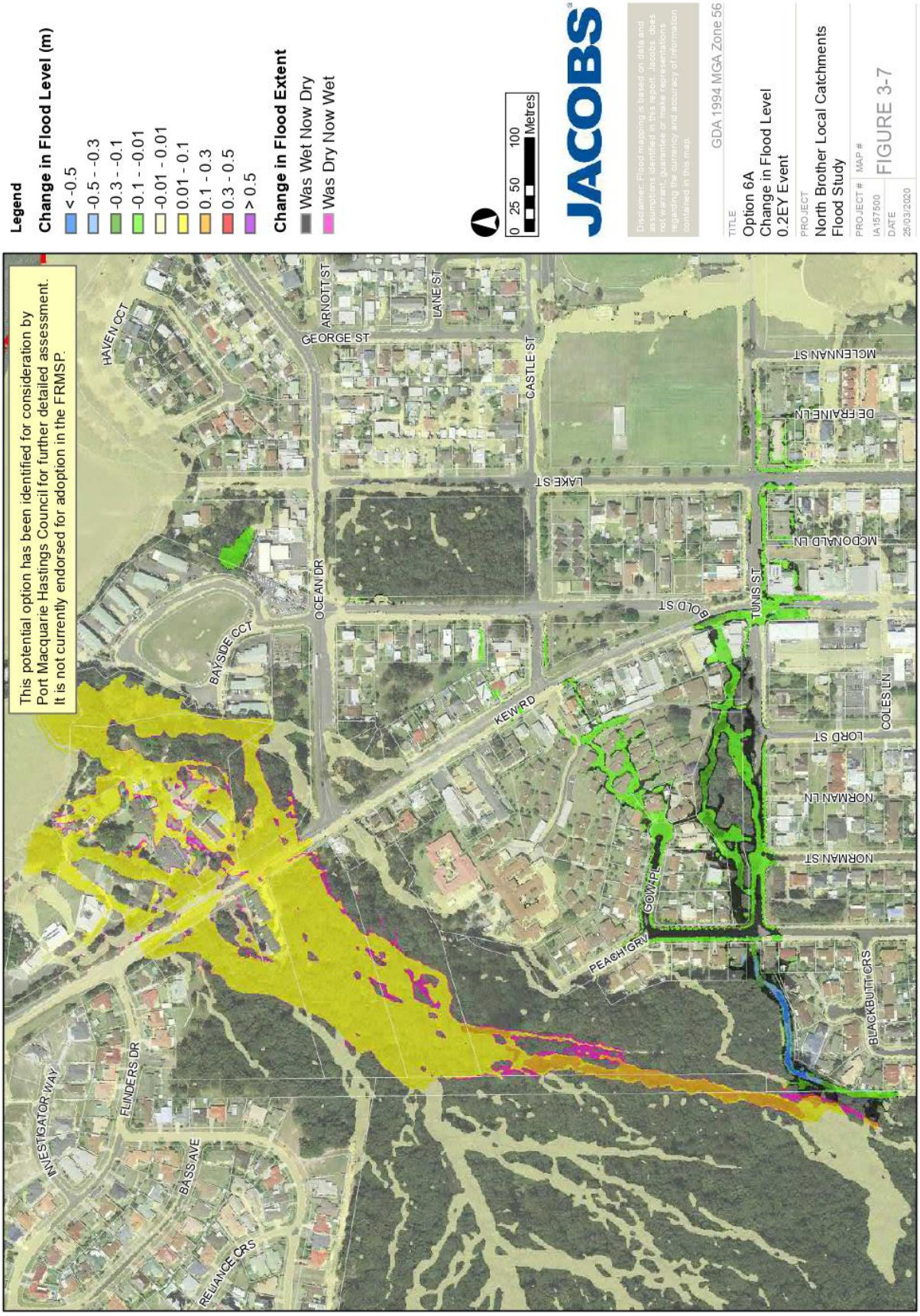
Flood impact maps, showing the change in flood levels, are presented in Figure 3-7 to Figure 3-9 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Option 6A is summarised in Table 3-3.

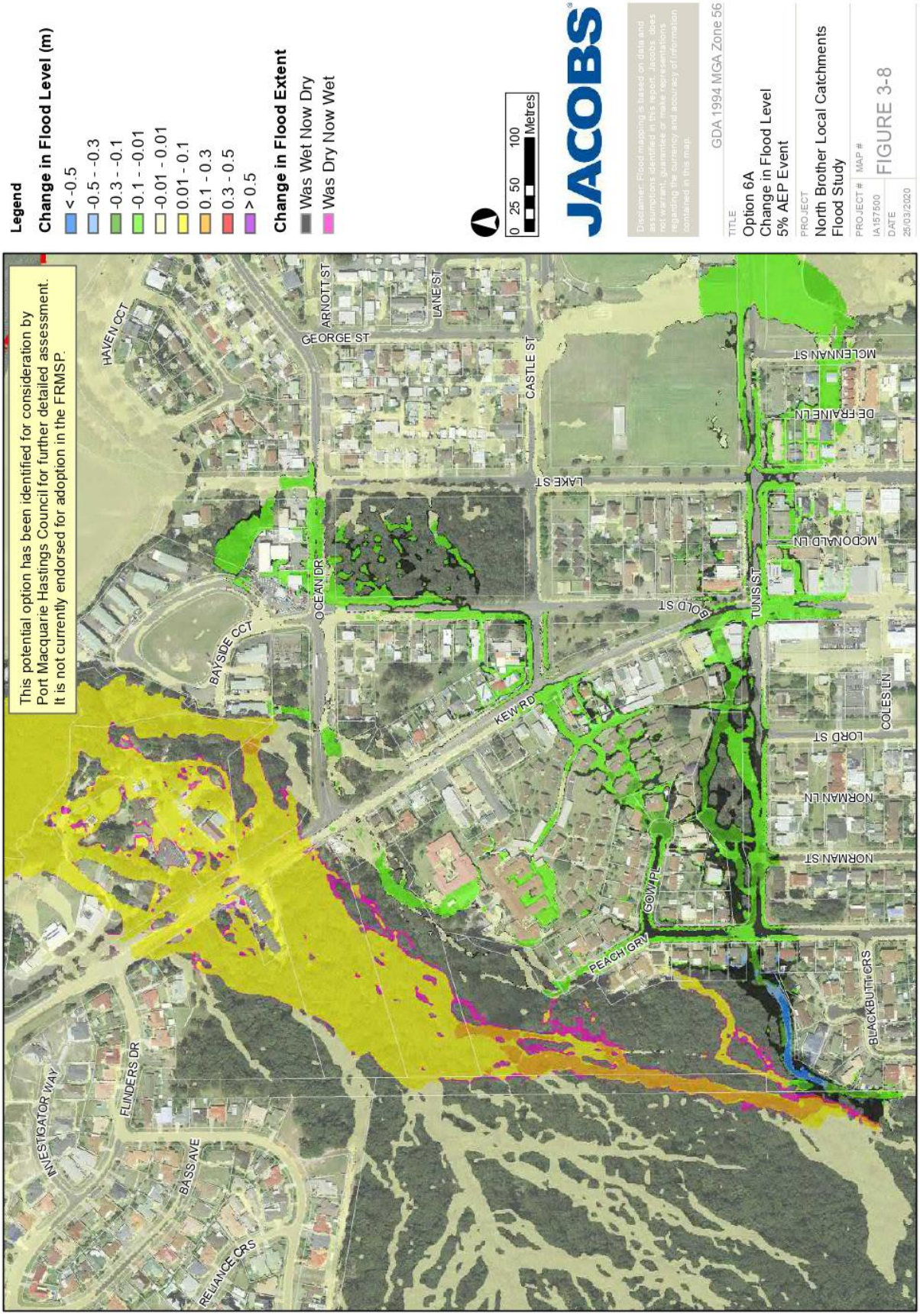
Table 3-3 Hydraulic performance of Options 6A

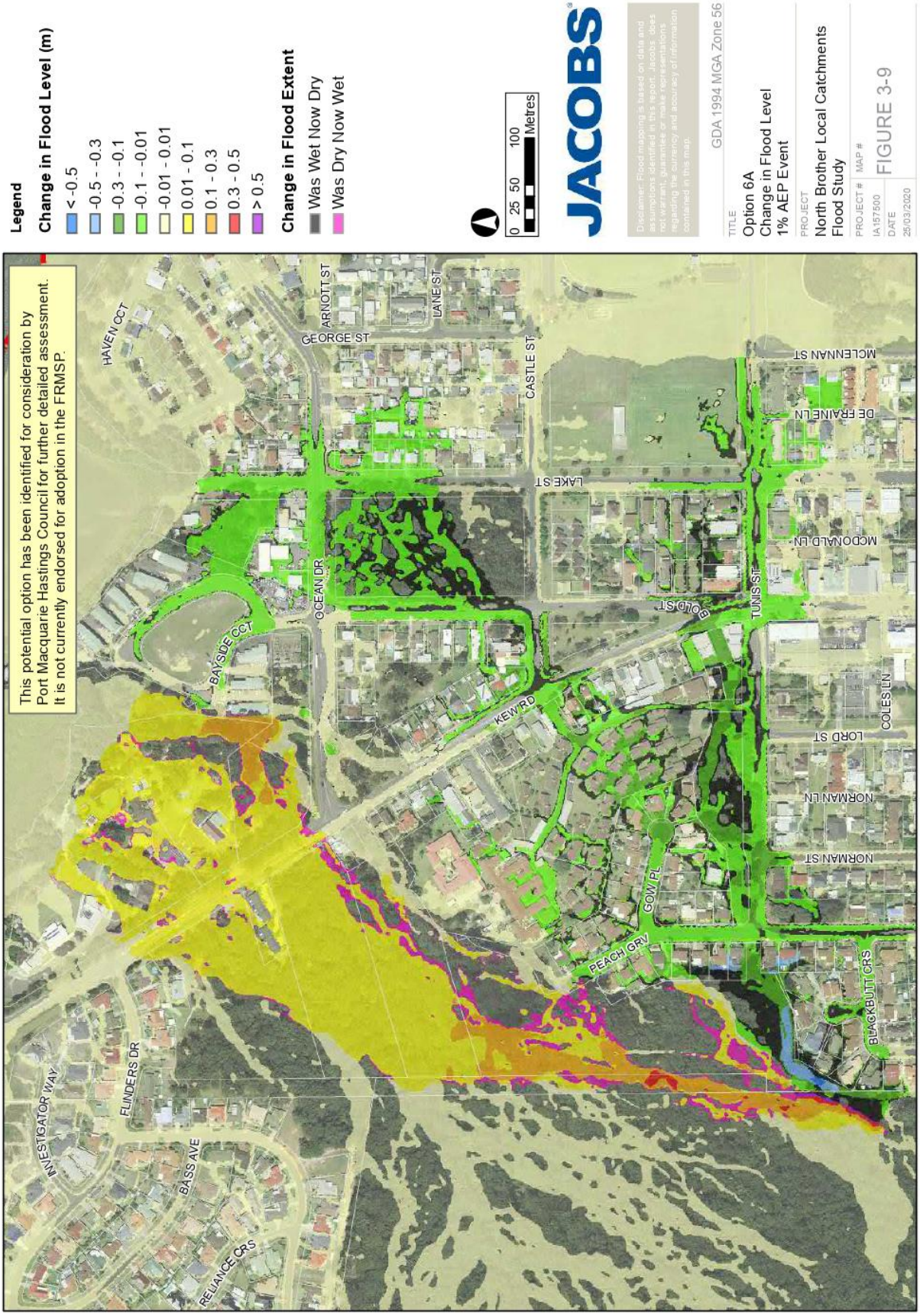
Event AEP	Changes in flood conditions
0.2EY	• Reductions in flood levels of -0.05 to -0.1m on Gow Place properties and Laurieton retirement village villas. • Localised reductions of up to -0.4m on Peach Grove properties. • Minor reductions of up to -0.05m on residential and commercial properties on and to the east of Ocean Drive. • Widespread minor increases of +0.02m on St Josephs School grounds.
5% AEP	• Reductions in flood levels of -0.05 to -0.2m on Gow Place properties and Laurieton retirement village villas, some localised areas greater than -0.02m. Reductions of -0.03m at Laurieton retirement village main facility. • Localised reductions of up to -0.4m on Peach Grove properties. One property experiences minor increases of less than +0.02m. • Minor reductions of up to -0.06m on residential and commercial properties on and to the east of Ocean Drive. • Widespread increases of +0.03 to +0.07m on St Josephs School grounds.
1% AEP	• Reductions in flood levels of -0.05 to -0.2m on Gow Place properties and Laurieton retirement village villas, some localised areas greater than -0.02m. Reductions of -0.1m at Laurieton retirement village main facility. • Localised reductions of up to -0.4m on Peach Grove properties. One property experiences minor increases of less than +0.02m. • Minor reductions of up to -0.06m on residential and commercial properties on and to the east of Ocean Drive. • Widespread increases of +0.03 to +0.07m on St Josephs School grounds.
1% AEP plus climate change	Similar performance to 1% AEP, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). No reduction in performance due to sea level rise.

Summary

While there are minor to modest (up to -0.2m) reductions in flood levels on a large number of residential properties, these are offset by minor increases (+0.03 to +0.07m) on St Josephs School. An engineered berm in the national park is likely to result in vegetation impacts and hence requires consultation with NPWS.


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 6A
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-7
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
HAVEN CCT
GEORGE ST
ARNOTT ST
LANE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
MCDONALD LN
OCEAN DR
BAYSIDE CCT
BOLD ST
TUNIS ST
KEW RD
COLES LN
LORD ST
NORMAN LN
NORMAN ST
GOWRIE PL
PEACHGROVE
BLACKBUTT CRS
INVESTIGATOR WAY
FLINDERS DR
BASS AVE
RELIANCE CRS


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Option 6A
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-8
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
HAVEN CCT
ARNOTT ST
LANE ST
GEORGE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
OCEAN DR
BAYSIDE CCT
BOLD ST
TUNIS ST
MCDONALD LN
KEW RD
COLES LN
LORD ST
NORMAN LN
NORMAN ST
COWPL
PEACH GRV
BLACKBUTT CRS
INVESTIGATOR WAY
FLINDERS DR
BASS AVE
RELIANCE CRS


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 6A
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-9
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
HAVEN CCT
ARNOTT ST
LANE ST
GEORGE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
MCDONALD LN
OCEAN DR
BAYSIDE CCT
BOLD ST
TUNIS ST
KEW RD
COLES LN
LORD ST
NORMAN LN
NORMAN ST
GOW PL
PEACH GRV
BLACKBUTT CRS
INVESTIGATOR WAY
FLINDERS DR
BASS AVE
RELIANCE CRS

3.4.3.2 Option 6B+6C+6D+6E

Description of Options

The following options were assessed in combination (Options 6B+6C+6D+6E):

- Option 6B – increase the existing diversion channel capacity behind Blackbutt Crescent properties to reduce overflows onto properties, achieved by a combination of widening the existing channel to a base width of 6 – 10m (current base width 3 – 5m, top width 5 – 8m), raising the banks (e.g. block retaining wall along the property boundaries) and clearing of vegetation in the channel.
- Option 6C – construct new diversion channel 3m base width and 1m deep behind Peach Grove properties north of Tunis Street to direct flows south to the easement at the end of Tunis Street. This is outside of the national park. Form a bund on the lower side of the channel to increase capacity.
- Option 6D – install new trunk drainage line from the easement down Tunis Street to discharge to the river (approximately 740m). A new line consisting of 3 x 1.35m diameter pipes has been assessed, having a system capacity of approximately 5% AEP (about 9.5m^3/s) and would reduce the 1% AEP overland flows through downstream properties by about 67%. A rock debris trap/basin would need to be constructed at the trunk drainage inlet to reduce the inlet blockage risk.
- Option 6E – upgrade drainage in Gow Place cul-de-sac to reduce overflows through properties and the retirement village villas. The existing drainage consists of a 450mm pipe which drains through an easement and discharges to open space between Gow Place and Tunis Street. There is an existing 3m lintel pit inlet plus smaller approximately 1m lintel inlets. Replacing one of these smaller inlets with a second 3m lintel is proposed. The existing 450mm pipe is proposed to be upgraded to 1.05m pipe and extended to discharge further down the gully to prevent backflow into the cul-de-sac. A 900mm pipe connection from the gully to the new trunk drainage line is proposed.

Constraints assessment

- Option 6B - Works would need to be undertaken on the edge of the national park land for a 100m section of the upgraded channel. The channel is assumed to be grassed and would need to be maintained to ensure limited vegetation growth.
- Option 6C - The channel is assumed to be grassed and would need to be maintained to ensure limited vegetation growth.
- Option 6D – There are numerous existing underground utilities (Telstra, Optus, NBN, power, stormwater) under Tunis Street and adjoining streets. Approximately 10 crossings of the utilities are identified and would need to be protected. It is assumed that the existing utilities are at sufficiently shallow depth to enable the new trunk drainage to be laid beneath. Trench construction methods are expected to be appropriate for most sections of the alignment. Deep trenching (up to 3m) with temporary shoring is likely to be required for sections of the alignment. Pipe jacking installation is expected to be required in the section between Lord Street and Lake Street (about 200m) to allow the road access to remain open (e.g. Coles loading dock). Design and construction will need to minimise traffic impacts including delivery truck access to Coles Supermarket loading dock. A rock debris trap/basin would need to be constructed at the trunk drainage inlet to reduce the inlet blockage risk.
- A structural assessment was undertaken for Option 6D due to the space constraints related to this option. Relevant findings are summarised below

The existing buildings are single storey and are likely to have shallow foundations. The construction zone of construction access & excavation for the proposed 3x 1.35m diameter pipes would need to extend approx. 3m to 5m from the edge of the new pipes to limit effect to the existing buildings. For open cut sections this construction zone would take up most of the two lanes of Tunis Street and footpaths i.e. 11m to 15m wide. Appropriate traffic diversions would be required.

Vibration due to construction activities can be a concern and a detailed structural inspection of the existing buildings should be conducted to assess if some areas of the existing buildings are more susceptible to such vibration. The construction techniques can then be chosen to limit effects in these vibration sensitive zones.

The soils in this location are likely to be high acid-sulphate. Trial pitting and geotechnical investigation and interpretation should be carried out by to confirm risks and mitigation measures.

Overall, it is considered feasible to construct 3x 1.35m diameter stormwater flood control pipes underground along Tunis Street. The width and depth of excavation for the pipes would be considerable taking up most of Tunis Street and footpaths. Numerous controls would need to be put in place for environmental considerations and for the structural integrity of existing buildings during construction. Consideration could be given to the option for 2x larger pipes to limit the width of excavation and zone of construction activities. The other alternative would be for rectangular box culverts where open cut & cover excavation might be considered – this may offer some advantages in terms of width of excavation but would require a substantial structural cover slab to withstand the vehicular loadings.

Hydraulic performance

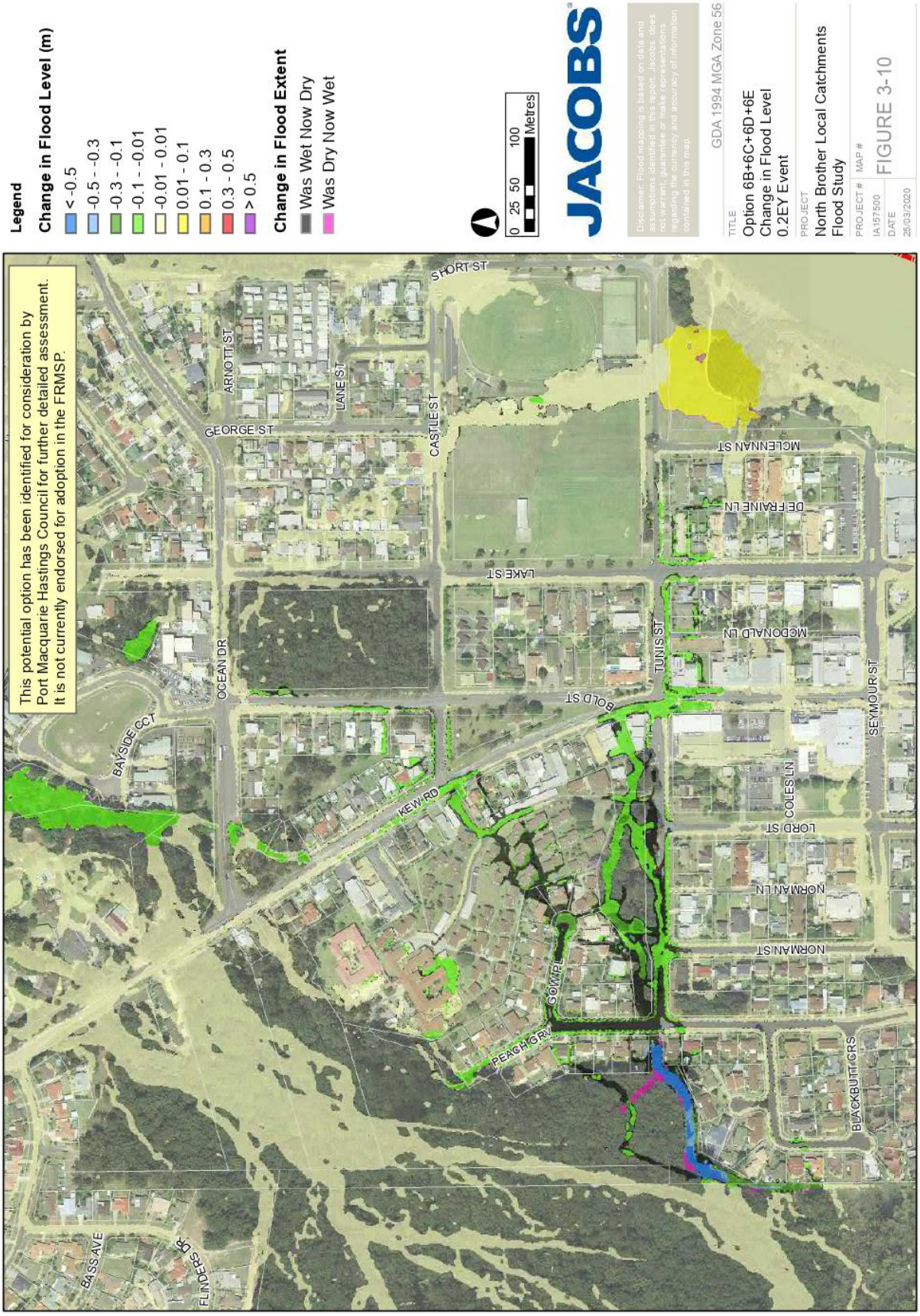
Flood impact maps, showing the change in flood levels, are presented on Figure 3-10 to Figure 3-12 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Option 6B+6C+6D+6E is summarised in Table 3-4.

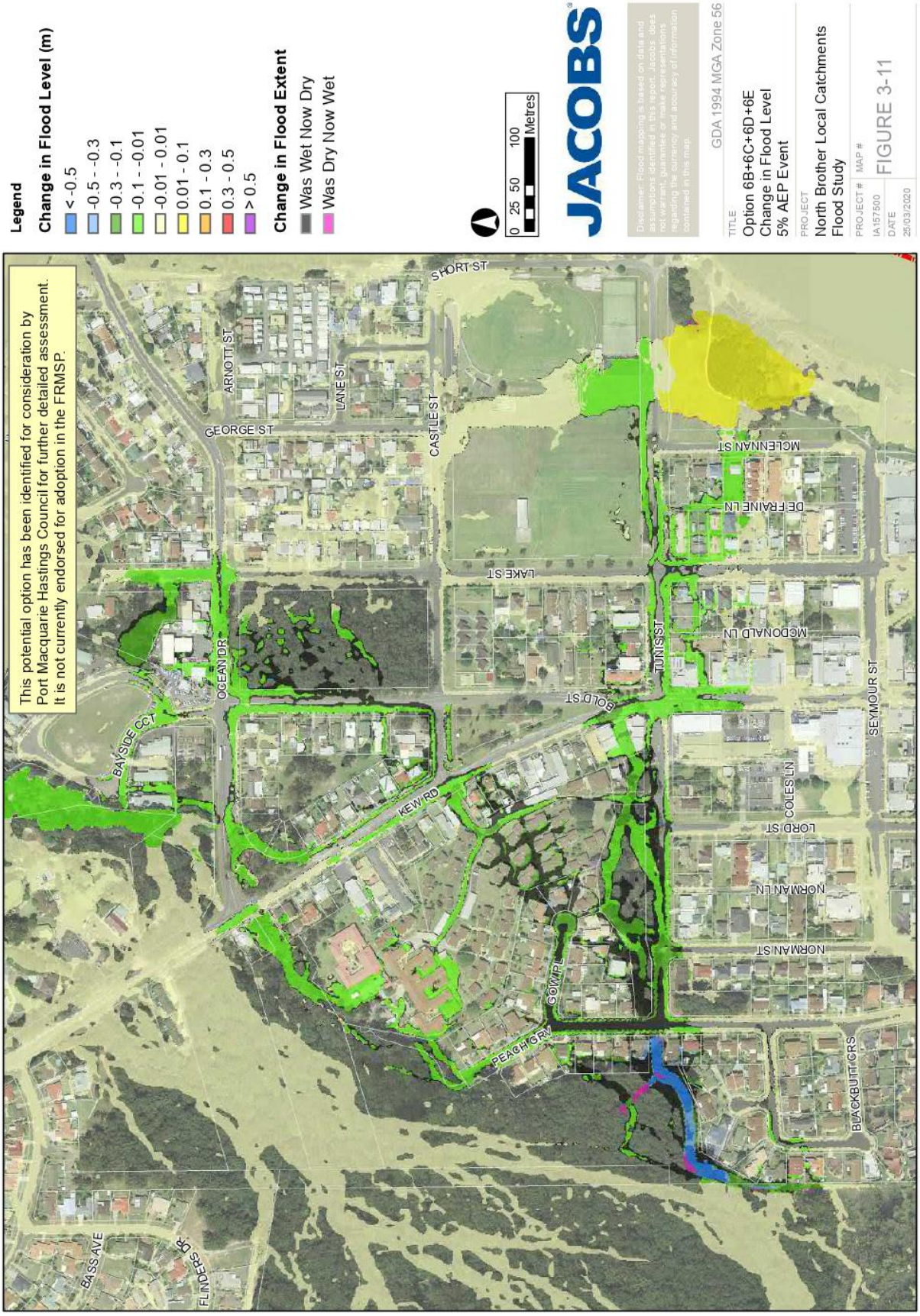
Table 3-4 Hydraulic performance of Options 6B+6C+6D+6E

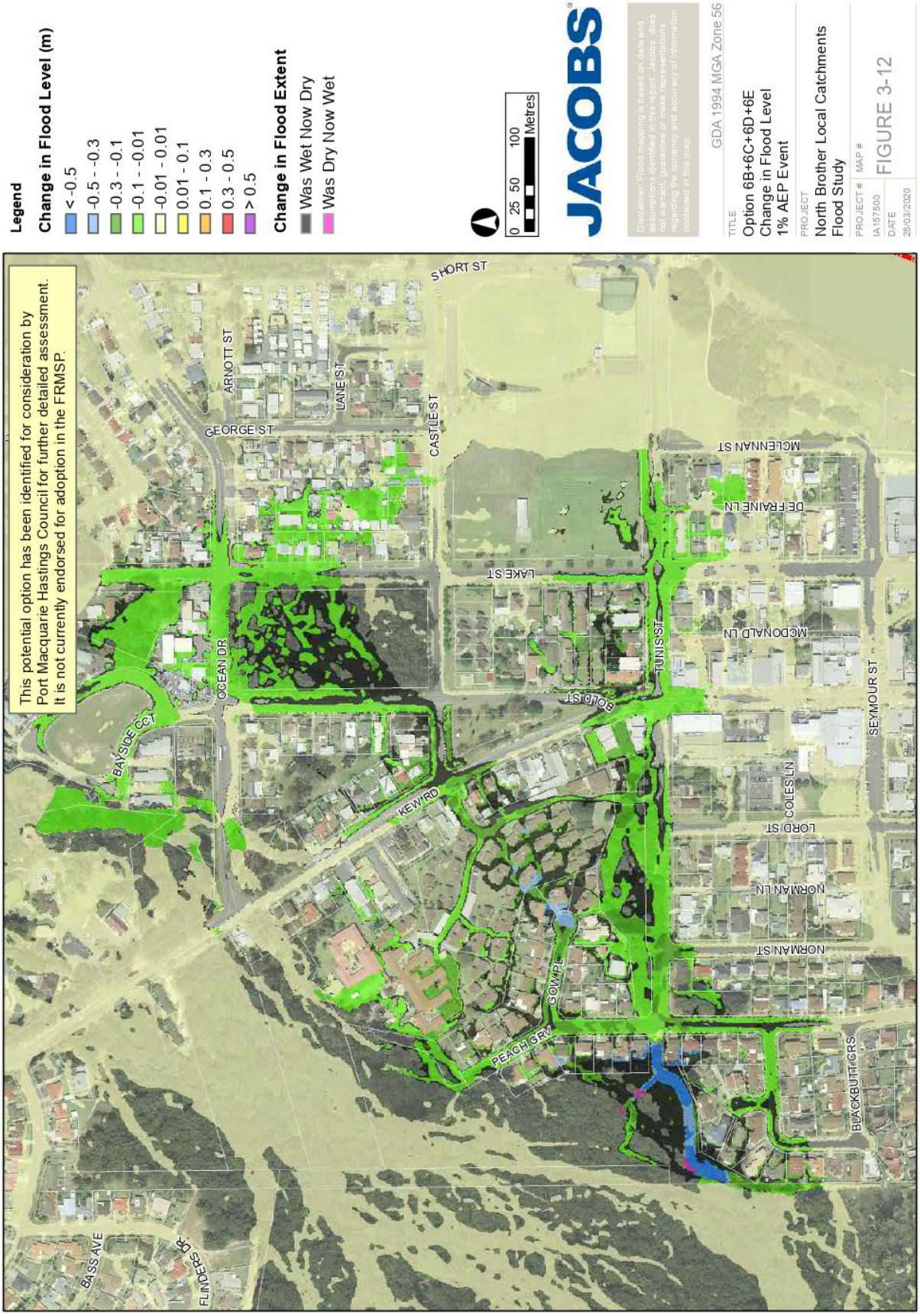
Event AEP	Changes in flood conditions
0.2EY	• Reductions in flood levels of up to -0.3m on Gow Place properties and Laurieton retirement village villas, including substantial reductions in flood extent. • Reductions in flood levels of up to -0.4m on Peach Grove properties including reductions in flood extent. • Minor reductions of up to -0.05m on residential and commercial properties on and to the east of Kew Road/Bold Street.
5% AEP	• Reductions in flood levels of up to -0.3m on Gow Place properties and Laurieton retirement village villas, including substantial reductions in flood extent. • Reductions in flood levels of up to -0.5m on Peach Grove properties including reductions in flood extent. • Reductions of -0.05 to -0.1m on residential and commercial properties on and to the east of Ocean Drive, with some localised reductions of -0.2m. • Removal of areas of very high hazard (up to H5) in road and on properties between Peach Grove and to the east of Kew Road/Bold Street.
1% AEP	• Reductions in flood levels of up to -0.4m on Gow Place properties and Laurieton retirement village villas, including some reductions in flood extent. • Reductions in flood levels of up to -0.5m on Peach Grove and Blackbutt Crescent properties including reductions in flood extent. Some localised reductions of up to -0.7m. • Reductions of -0.1 to -0.2m on residential and commercial properties on and to the east of Ocean Drive. • Removal of areas of very high hazard (up to H5) in road and on properties between Blackbutt Crescent/Peach Grove and to the east of Kew Road/Bold Street.
1% AEP plus climate change	Generally similar performance to 1% AEP, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). Slight reduction in performance due to sea level rise in low elevation areas below 3m AHD, where the reductions fall from -0.07m in the current climate case to -0.01m in the climate change scenario.

Summary on performance

The combined options 6B+6C+6D+6E provide substantial reductions in flood levels, extents and hazard as a result of significant drainage capacity upgrades. There are minor reductions in flood levels in low-lying areas as a result of sea level rise in the climate change scenario.


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 6B+6C+6D+6E
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-10
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
SHORT ST
ARNOTT ST
LANE ST
GEORGE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
OCEAN DR
BOLD ST
TUNIS ST
MCDONALD LN
BAYSIDE CCT
KEW RD
SEYMOUR ST
COLES LN
LORD ST
NORMAN LN
NORMAN ST
GOWRIE
PEAGHGRV
BLACKBUTT GRS
BASS AVE
FLINDERS


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 6B+6C+6D+6E
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-11
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
SHORT ST
ARNOTT ST
LANE ST
GEORGE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
MCDONALD LN
TUNIS ST
BOLD ST
OCEAN DR
BAYSIDE CCT
KEW RD
COLES LN
LORD ST
SEYMOUR ST
NORMAN LN
NORMAN ST
GOWRIE PL
PEAGHS RW
BLACKBUTT CRS
BASS AVE
FLINDERS RD


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 25 50 100 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 6B+6C+6D+6E
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-12
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
SHORT ST
ARNOTT ST
LANE ST
GEORGE ST
CASTLE ST
MCLENNAN ST
DE FRAINE LN
LAKE ST
OCEAN DR
BAYSIDE CCT
BOLD ST
TUNIS ST
MCDONALD LN
SEYMOUR ST
KEW RD
COLES LN
LORD ST
NORMAN LN
NORMAN ST
GOWRIE PL
PEACH GRV
BLACKBUTT CRS
BASS AVE
FLINDERS DR

3.4.4 Lake Street at Seymour Street, Laurieton

The corner property at this location receives overland flows and trunk drainage flows from the Quarry Way flow path. There is an open channel and flow path through this property, where the dwelling is surrounded by high hazard flooding to depths of over 1m in the 1% AEP event. The floodwaters pond behind the raised road crest in Lake Street before overflowing over the road and around the southern side of the Laurieton United Services Club. It is identified as being affected by above-floor flooding.

The drainage at this location includes 2x 1.5m x 0.75m box culverts at the inlet at the downstream end of the channel through this property, turning into 2x 1200mm pipes crossing Lake Street, which then increase to 2x 1500mm pipes on the low side of the road and discharging to a channel on the southern side of the Services Club.

Flood mitigation works proposed for the Quarry Way flow path as described in Section **Error! Reference source not found.** would mitigate flooding at this location. Further works could be provided for additional mitigation.

3.4.4.1 Option 8B

Description of Options

Option 8B was selected for assessment. The culvert inlet is currently unscreened and has been modelled as 50% blocked due to likely debris blockage. A large-faced debris screen or other debris controls are proposed to retrofit the existing culvert inlet to reduce the risk of blockage. The debris screen is assumed to be effective and has been represented with a reduced blockage factor of 10%.

Refer to **Error! Reference source not found.** for illustration.

Constraints assessment

No major constraints identified for this option. Inspection and maintenance after significant storm events are required to increase reliability.

Hydraulic performance

Flood impact maps, showing the change in flood levels, are presented on Figure 3-14 to Figure 3-16 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Option 8B is summarised in Table 3-5.

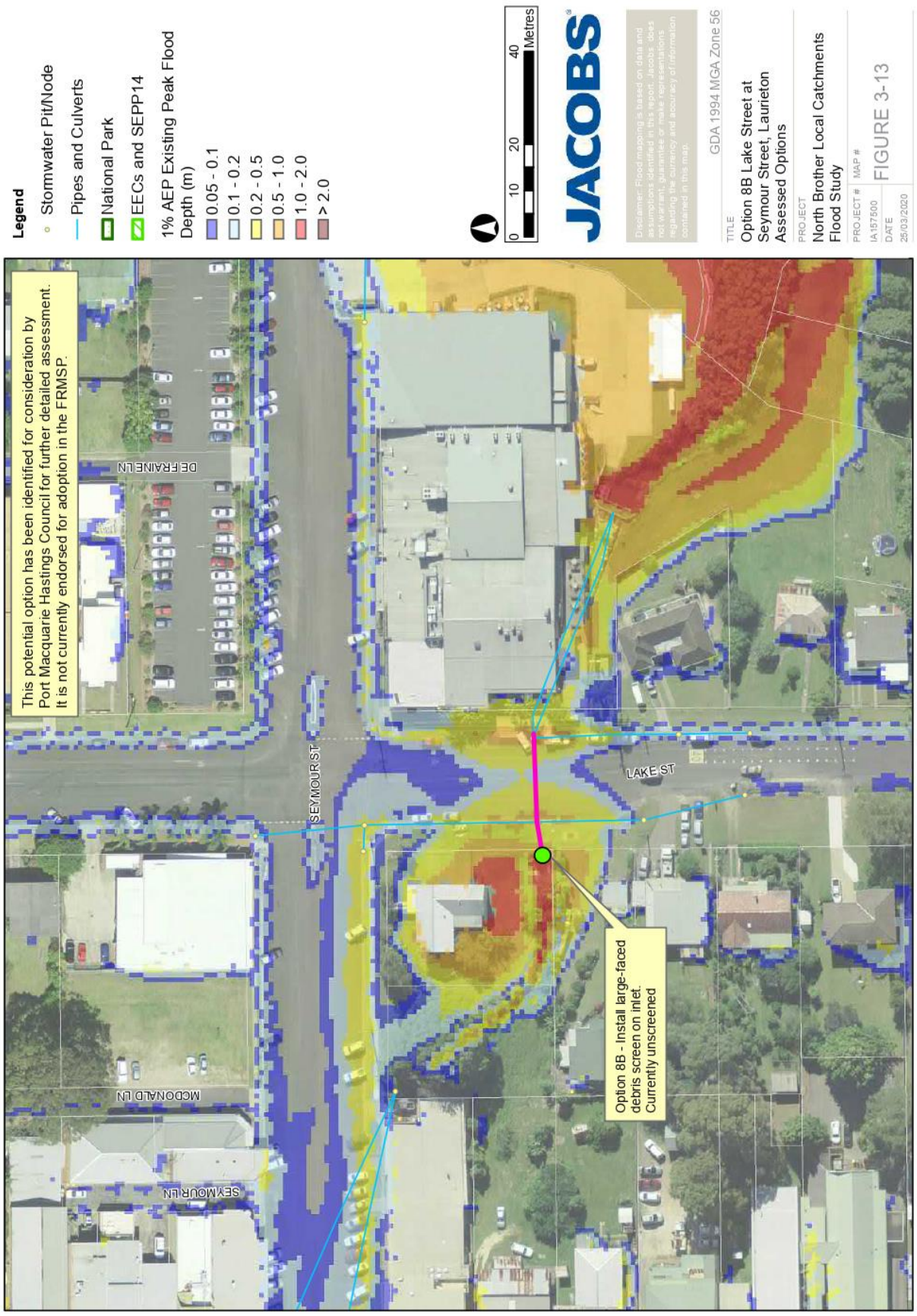
Table 3-5 Hydraulic performance of Options 8B

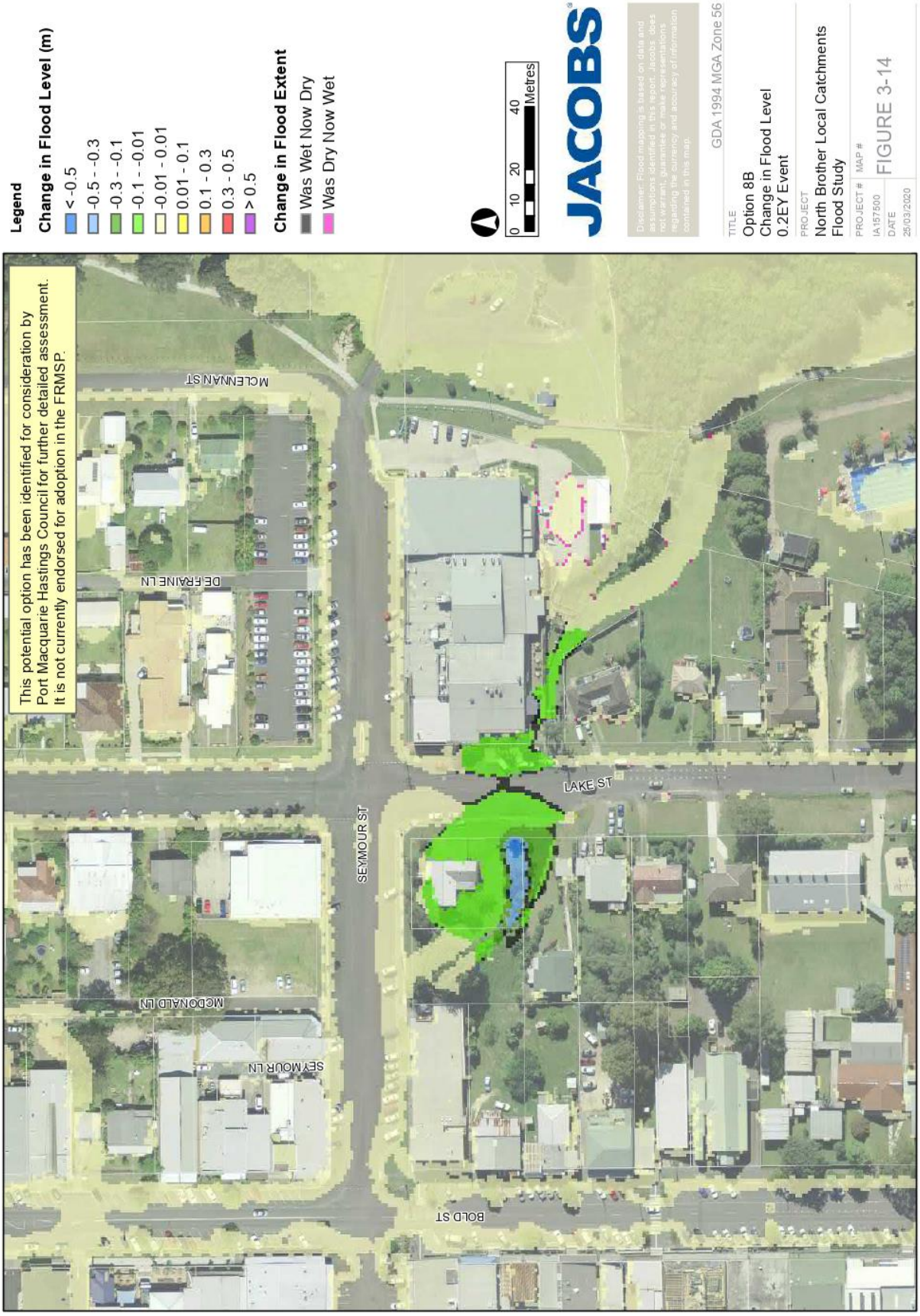
Event AEP	Changes in flood conditions
0.2EY	• Minor reductions of -0.03m on private property dwelling and Laurieton United Services Club side entrance. • Reductions of up to -0.1m on Lake Street
5% AEP	• Reductions of -0.08m on private property dwelling and -0.13m at Laurieton United Services Club side entrance. • Reductions of up to -0.1m on Lake Street • Minor increases of less than -0.02m on some private properties and parts of club property due to reduced drainage capacity of local stormwater drainage branches.
1% AEP	• Reductions of -0.1m on private property dwelling and Laurieton United Services Club side entrance. • Reductions of up to -0.1m on Lake Street. • Minor localised increases of less than -0.02m on some private properties due to reduced drainage capacity of local stormwater drainage branches.
1% AEP plus climate change	Similar performance to 1% AEP, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). No reduction in performance due to sea level rise.

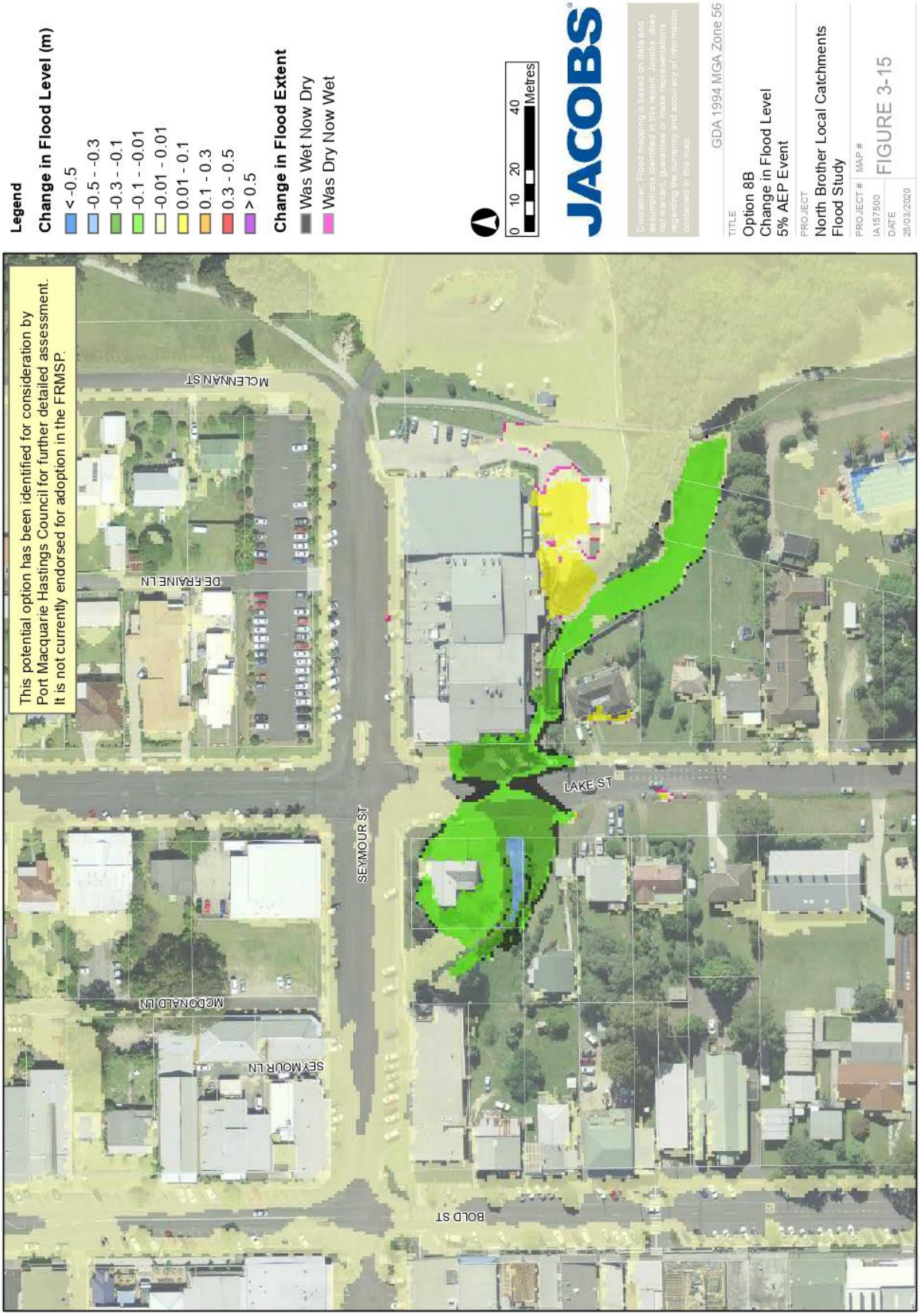
Summary on performance

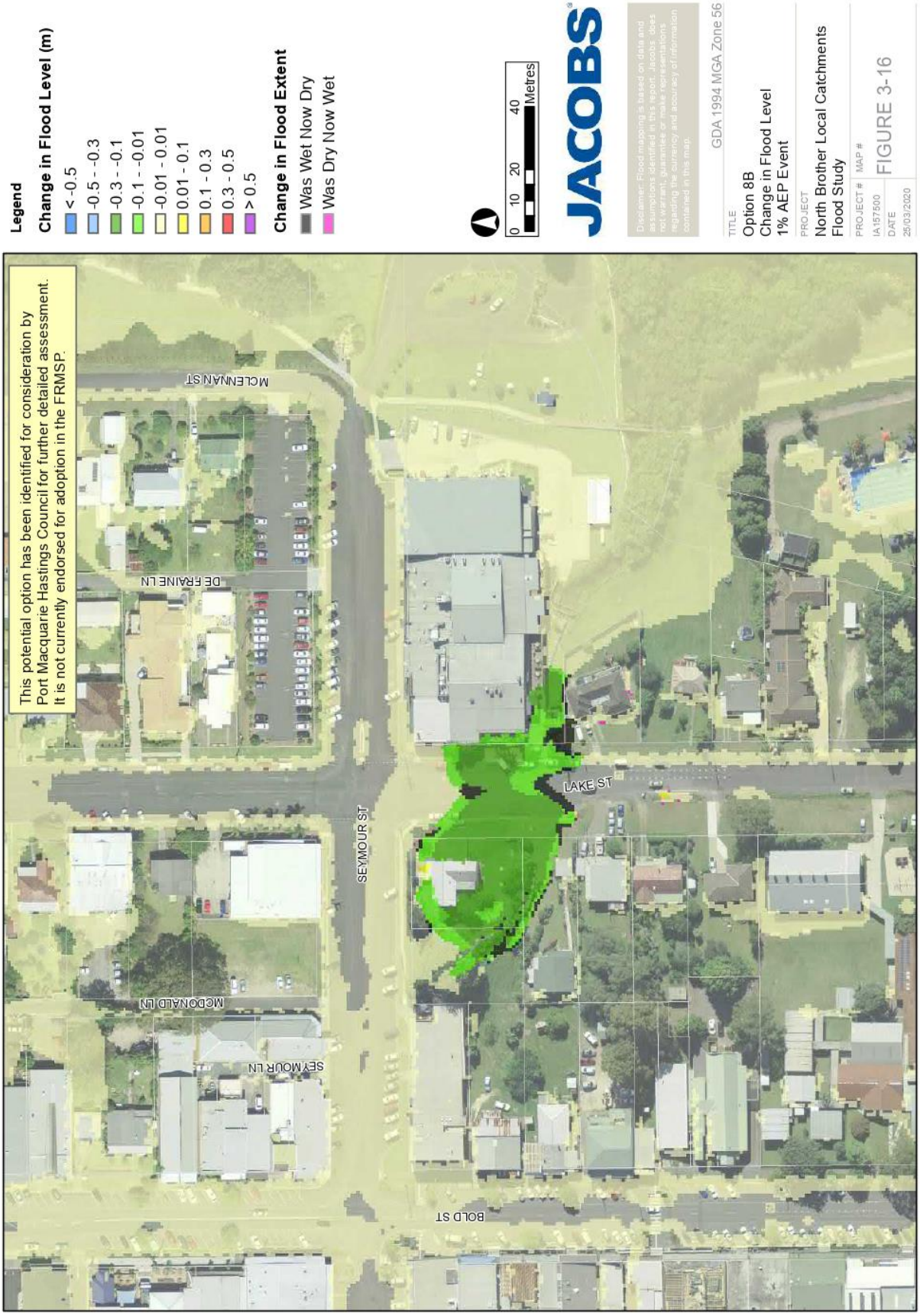
Option 8B provides minor to modest improvements (up to -0.1m) in flooding conditions with benefits confined to one residential property. The spatial extent of the reductions in flood levels at the Services Club are limited to the western side entrance on Lake Street, while there are no changes in flood levels along the main northern side of the club building. The effect of the proposed inlet debris screen is constrained by the limited capacity of the existing culverts crossing the road.

While the debris screen proposed as Option 8B provides at best modest improvements to flooding conditions to property and the road, it could be considered by Council as a low-cost measure to reduce the risk of severe blockage of the culvert inlet at this and other locations in the study area.


Legend
Stormwater Pit/Node
Pipes and Culverts
National Park
EECs and SEPP14
1% AEP Existing Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 8B Lake Street at Seymour Street, Laurieton Assessed Options
PROJECT
North Brother Local Catchments Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-13
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
DE FRAINE LN
SEYMOUR ST
LAKE ST
MCDONALD LN
SEYMOUR LN
Option 8B - Install large-faced debris screen on inlet. Currently unscreened


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Option 8B
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # MAP #
IA157500 FIGURE 3-14
DATE
25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
MCLENNAN ST
DE FRAINE LN
SEYMOUR ST
LAKE ST
MCDONALD LN
SEYMOUR LN
BOLD ST


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 8B
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-15
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
MCLENNAN ST
DE FRAINE LN
SEYMOUR ST
LAKE ST
MCDONALD LN
SEYMOUR LN
BOLD ST


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Option 8B
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-16
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
MCLENNAN ST
DE FRAINE LN
SEYMOUR ST
LAKE ST
MCDONALD LN
SEYMOUR LN
BOLD ST

3.4.5 St Joseph's School, Laurieton

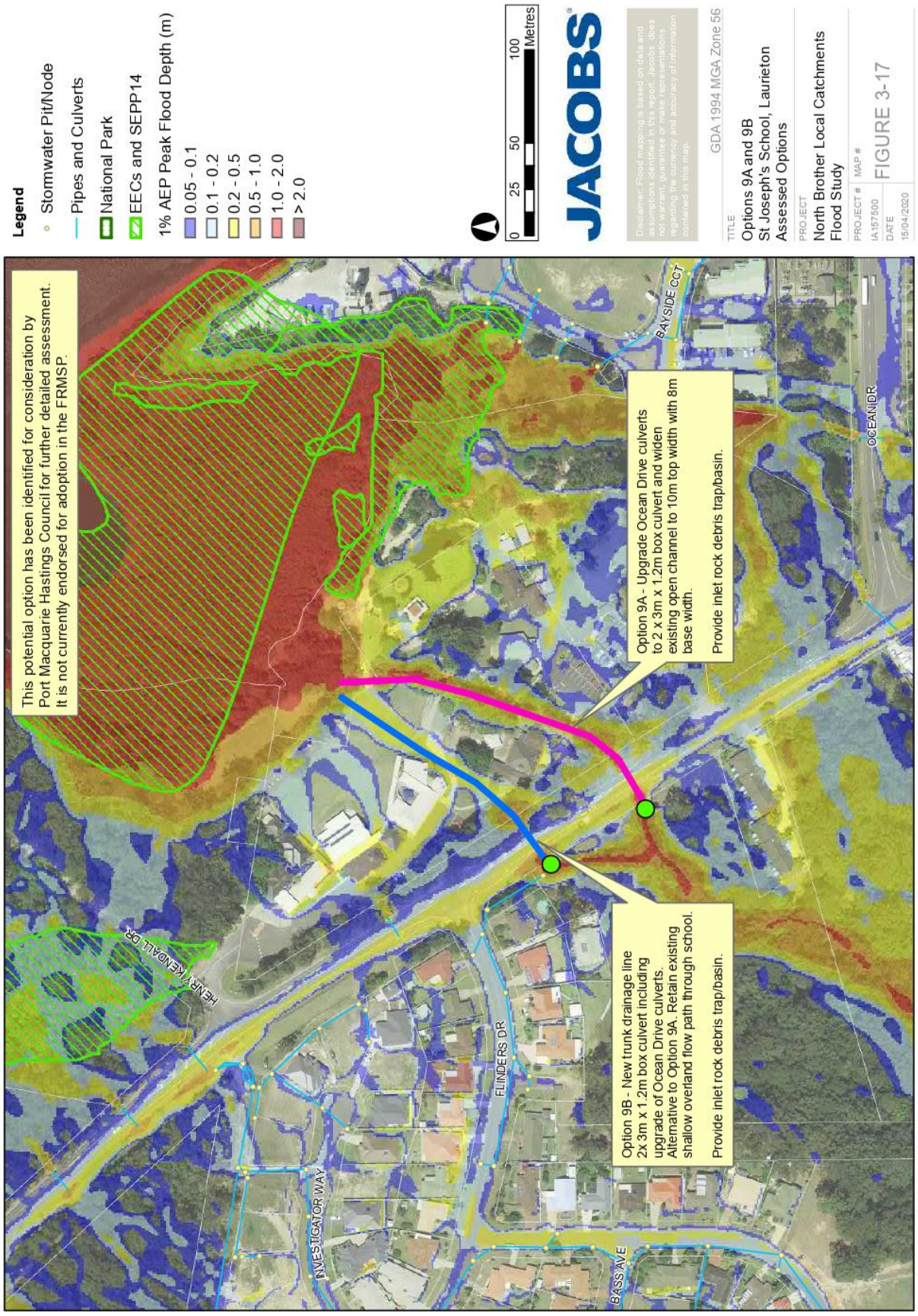
Flooding at the school results from natural flow paths being directed down to Ocean Drive to three culvert crossings. The culverts discharge on the low side of the road and along with road overflows, overland flooding passes through the school in three main flow paths, including one through the main cluster of school administration and classroom buildings. Council's stormwater drainage spatial layer does not show an existing underground trunk drainage conveying flows though the school grounds, although from review of aerial photography there appears to be drainage pits connected to a privately-owned system. Flows exceed 0.5m deep in the 1% AEP event with areas of very high (H5) flood hazard.

Peak overland flows in these flow paths are summarised in Table 3-6.

Table 3-6 Peak flood flows in overland flow paths at St Joseph's School

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
Northern flow path (admin bldg.)	4	5.5	8
Middle flow path	5.5	6.5	8.5
Southern flow path	8.5	10	12.5
Total	17.5	22	29

Refer to Figure 3-17 for illustration of options.


Legend
Stormwater Pit/Node
Pipes and Culverts
National Park
EECs and SEPP14
1% AEP Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
0 25 50 100 Metres
JACOBS
GDA 1994 MGA Zone 56
TITLE
Options 9A and 9B
St Joseph's School, Laurieton
Assessed Options
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 15/04/2020
FIGURE 3-17
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
Option 9A - Upgrade Ocean Drive culverts to 2 x 3m x 1.2m box culvert and widen existing open channel to 10m top width with 8m base width.
Provide inlet rock debris trap/basin.
Option 9B - New trunk drainage line 2x 3m x 1.2m box culvert including upgrade of Ocean Drive culverts. Alternative to Option 9A. Retain existing shallow overland flow path through school.
Provide inlet rock debris trap/basin.
BAYSIDE CCT
OCEAN DR
HENRY KENDALL DR
FLINDERS DR
INVESTIGATOR WAY
BASS AVE

3.4.5.1 Option 9A

Description of Option

Option 9A was assessed, involving widening and reconstruction of a landscaped open channel in the southern flow path. The southern flow path and road cross culvert is the main flow path and there is a formalised open channel provided for this flow path. The proposed channel would have an 8m base width (about 10m top width) and a depth of 1 – 1.5m. The existing channel has an approximately 6 – 8m top width with variable base width.

Box culverts were originally proposed for this site to fit under the existing channel, however, elevations are too low to fit such a culvert option while maintaining a surface flow path.

A rock debris trap/basin would need to be constructed at the Ocean Drive culvert inlet to reduce the inlet blockage risk.

Constraints assessment

There are a number of existing structures and features including buildings, footbridges, car parks and paths which would be potentially affected or considered in the design of Option 9A. The minimum clearance between buildings or other existing structures is about 19m.

The existing buildings are single storey and are likely to have shallow foundations. Additionally, one of the building is an existing old church building believed to be around 120 years old. The construction access & excavation zone for the proposed channel widening would need to extend approximately 3 – 5m from the edge of the channel to limit effect to the existing buildings.

Vibration due to construction activities can be a concern and a detailed structural inspection of the existing buildings should be conducted to assess if some areas of the existing buildings are more susceptible to such vibration. The final alignment of the proposed culvert can then be chosen to avoid these vibration sensitive zones.

The sediments adjacent to the school may be mildly contaminated. The soils in this location are likely to be high acid-sulphate. Trial pitting and geotechnical investigation and interpretation should be undertaken to confirm risks and mitigation measures.

There will be numerous building stormwater drains discharging into the existing open channels in the school grounds and these will need to be surveyed and coordinated with the design of the modified open channel.

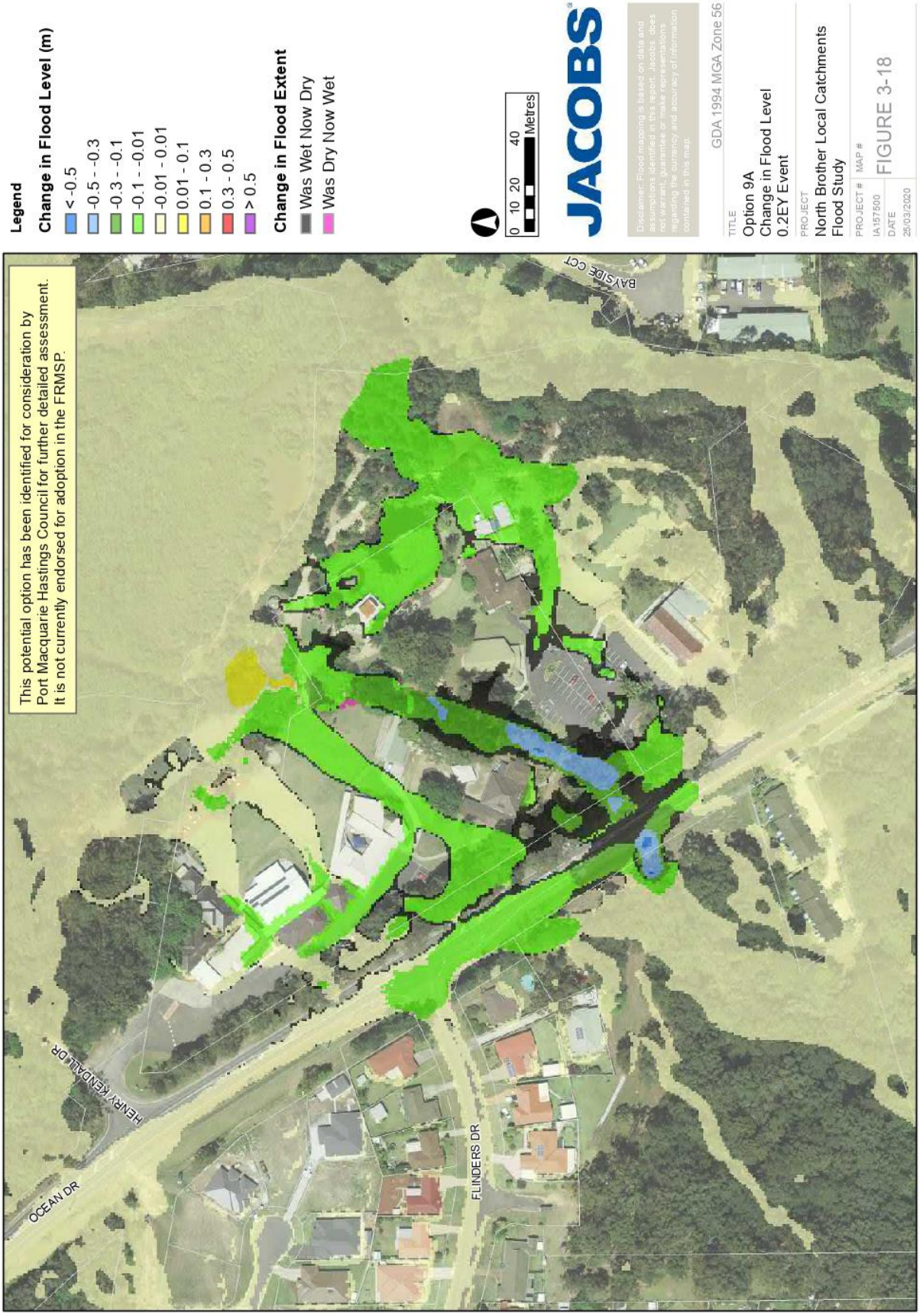
The existing channel and its banks appear to be landscaped with well-established gardens, which are likely to be of high value to the school and adjacent church. The option needs to include landscaping to re-establish the gardens.

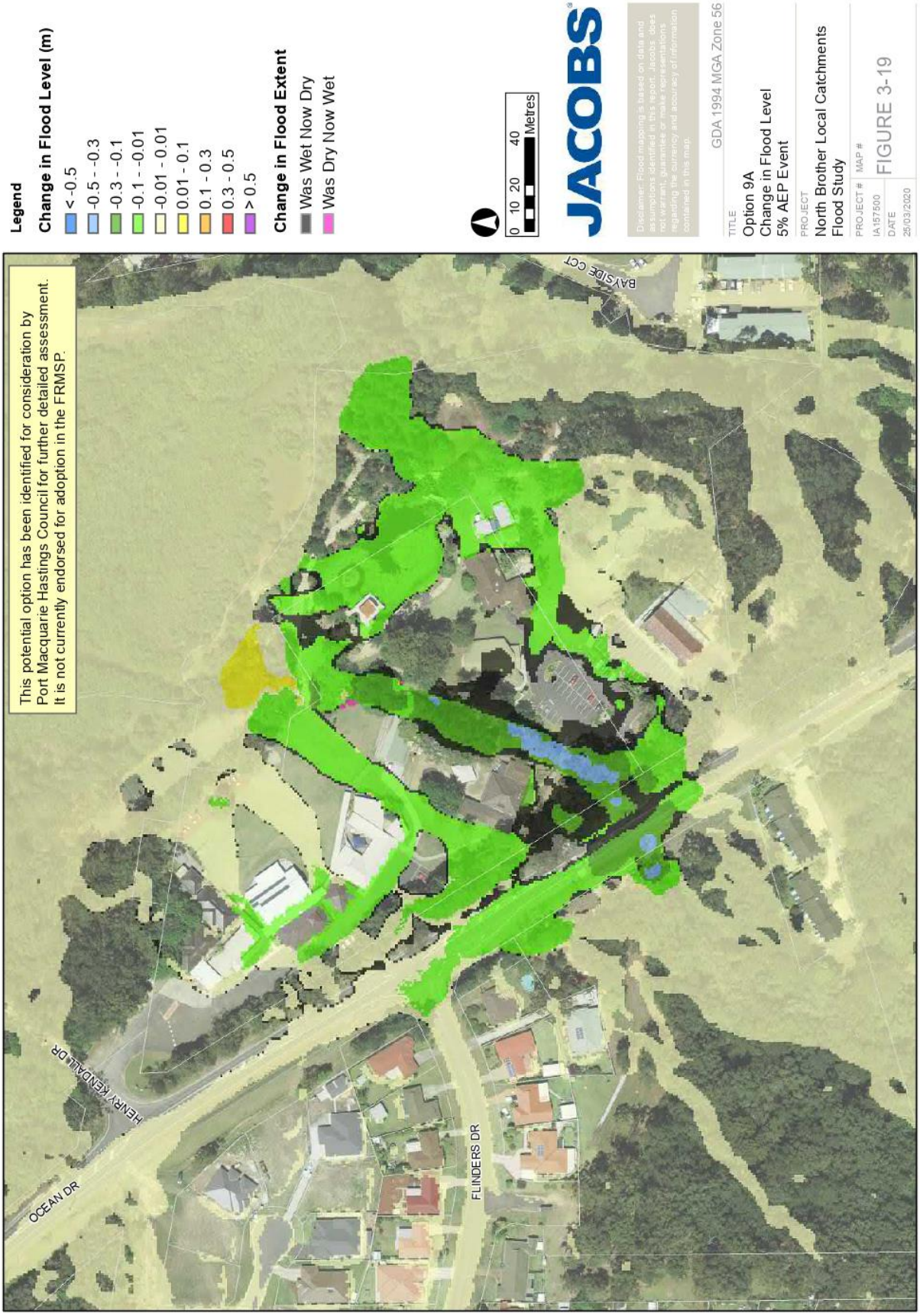
There are existing utilities along Ocean Drive (Optus, Telstra, NBN, power) which cross the existing culverts under the road. It is assumed that sufficient clearance from the utilities can be maintained if the upgraded culverts are installed at a similar elevation.

The channel through the mangrove/wetland areas would need to be widened downstream to Stingray Creek to accommodate increased flood flows and this would have localised impacts on sensitive habitats (EECs/SEPP 14 wetlands). Additionally, the school grounds have dense tree coverage which will inhibit construction access. Existing trees will need to be protected during the construction works. It is anticipated that that a REF will be required and would need a flora and fauna study.

Hydraulic performance

Flood impact maps, showing the change in flood levels, are presented on Figure 3-18 to Figure 3-20 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Option 9A is summarised in Table 3-7.


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9A
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-18
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
BAYSIDE CCT
HENRY KENDALL DR
OCEAN DR
FLINDERS DR


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9A
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-19
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
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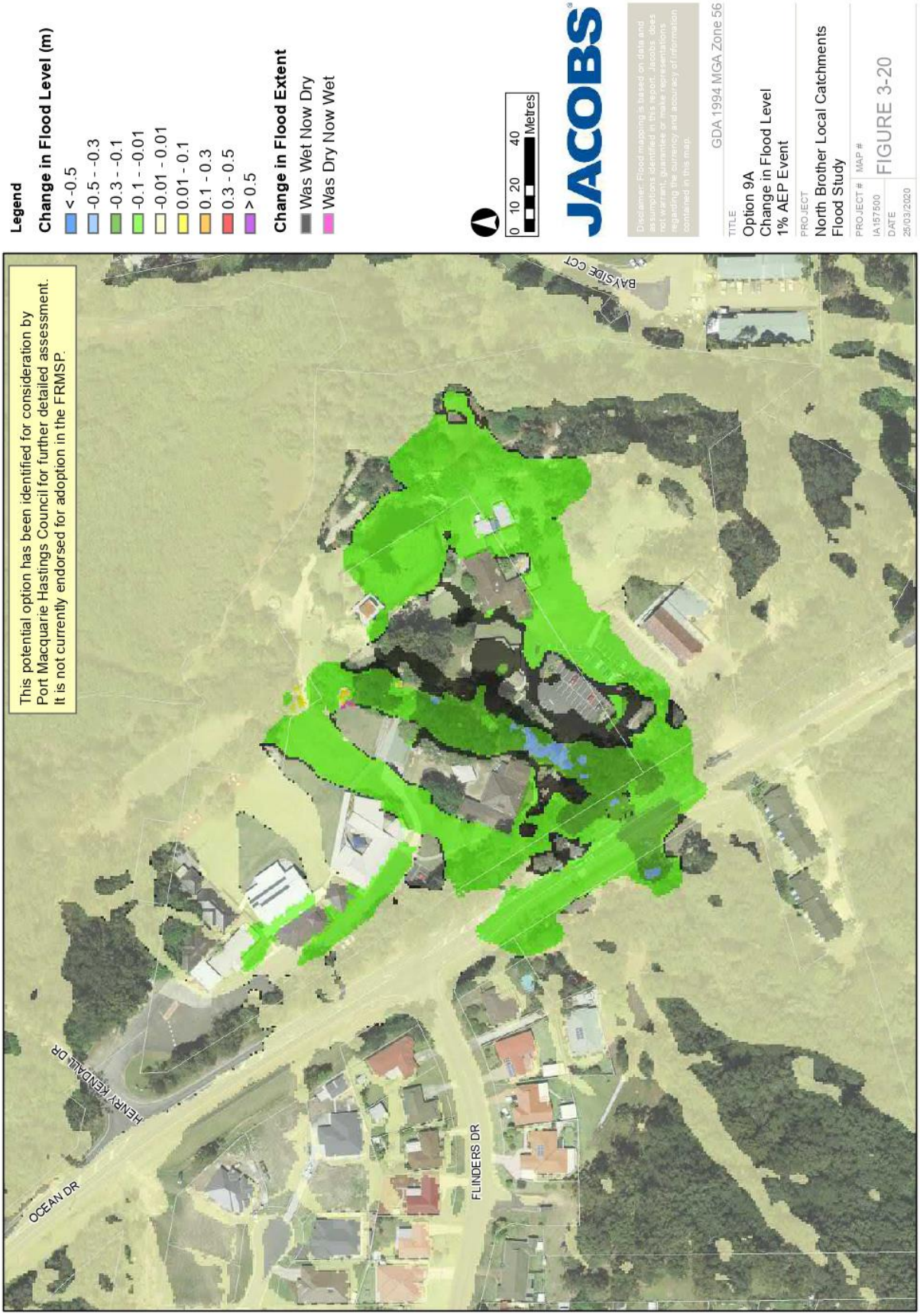
Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9A
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-20
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
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OCEAN DR
FLINDERS DR

Table 3-7 Hydraulic performance of Options 9A

Event AEP	Changes in flood conditions
0.2EY	• Maximum decreases of -0.4 to -0.5m in the channel (southern flow path) upstream and downstream of Ocean Drive culvert crossing, with reductions in flood extent • Decrease of -0.02 to -0.06m at and between school buildings, minimal reduction in flood extent • Some reduction in high-very high hazard extent in southern and middle flow paths including on walkways, minimal reduction in flood hazard around school office (only localised high hazard in existing case and mostly low hazard)
5% AEP	• Maximum decreases of -0.3 to -0.4m in the channel (southern flow path) upstream and downstream of Ocean Drive culvert crossing, with reductions in flood extent • Decrease of -0.02 to -0.08m at and between school buildings, minimal reduction in flood extent • Some reduction in high-very high hazard extent in southern and middle flow paths including on walkways, minimal reduction in flood hazard around school office (only localised high hazard in existing case and mostly low hazard)
1% AEP	• Maximum decreases of -0.3 to -0.4m in the channel (southern flow path) upstream and downstream of Ocean Drive culvert crossing, with reductions in flood extent • Decrease of -0.02 to -0.08m at and between school buildings, minimal reduction in flood extent • Some reduction in high-very high hazard extent in southern and middle flow paths including on walkways, minimal reduction in flood hazard around school office (only localised high hazard in existing case and mostly low hazard)
1% AEP plus climate change	Similar performance to 1% AEP, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). No reduction in performance due to sea level rise.

3.4.5.2 Option 9B

Description of Option

An alternative option to 9A is option 9B, consisting of installation of box culverts beneath the middle flow path. There is an existing shallow overland flow path through this alignment and it was assumed that this could be retained. The culverts would need to fit between existing school buildings. A rock debris trap/basin would need to be constructed at the Ocean Drive culvert inlet to reduce the inlet blockage risk.

Constraints assessment

The culverts would need to fit between two existing buildings and require reconstruction of a vehicle access driveway to one of the buildings. There is 16m clearance between the buildings. The existing buildings are single storey and are likely to have shallow foundations. The construction access and excavation zone for the proposed culverts would need to extend approximately 3 – 5m from the edge of the proposed culverts to limit effect to the existing buildings.

Vibration due to construction activities can be a concern and a detailed structural inspection of the existing buildings should be conducted to assess if some areas of the existing buildings are more susceptible to such vibration. The final alignment of the proposed culvert can then be chosen to avoid these vibration sensitive zones. Overall, the excavation for the proposed 1.2m deep box culverts can be located at least 5m from the existing structures which should, subject to investigations, not interfere with the existing building foundations.

The sediments adjacent to the school may be mildly contaminated. The soils in this location are likely to be high acid-sulphate. Trial pitting and geotechnical investigation and interpretation should be carried out by to confirm risks and mitigation measures.

There will be numerous building stormwater drains discharging into the existing open channels in the school grounds and these will need to be surveyed and coordinated with the design of the modified open channel.

There appears to be an existing pit and pipe drainage line beneath the middle flow path, which may need to be relocated for installation of the box culverts. This line should be maintained for local drainage.

There are existing utilities along Ocean Drive (Optus, Telstra, NBN, power) which cross the existing culverts under the road. It is assumed that sufficient clearance from the utilities can be maintained if the upgraded culverts are installed at a similar elevation.

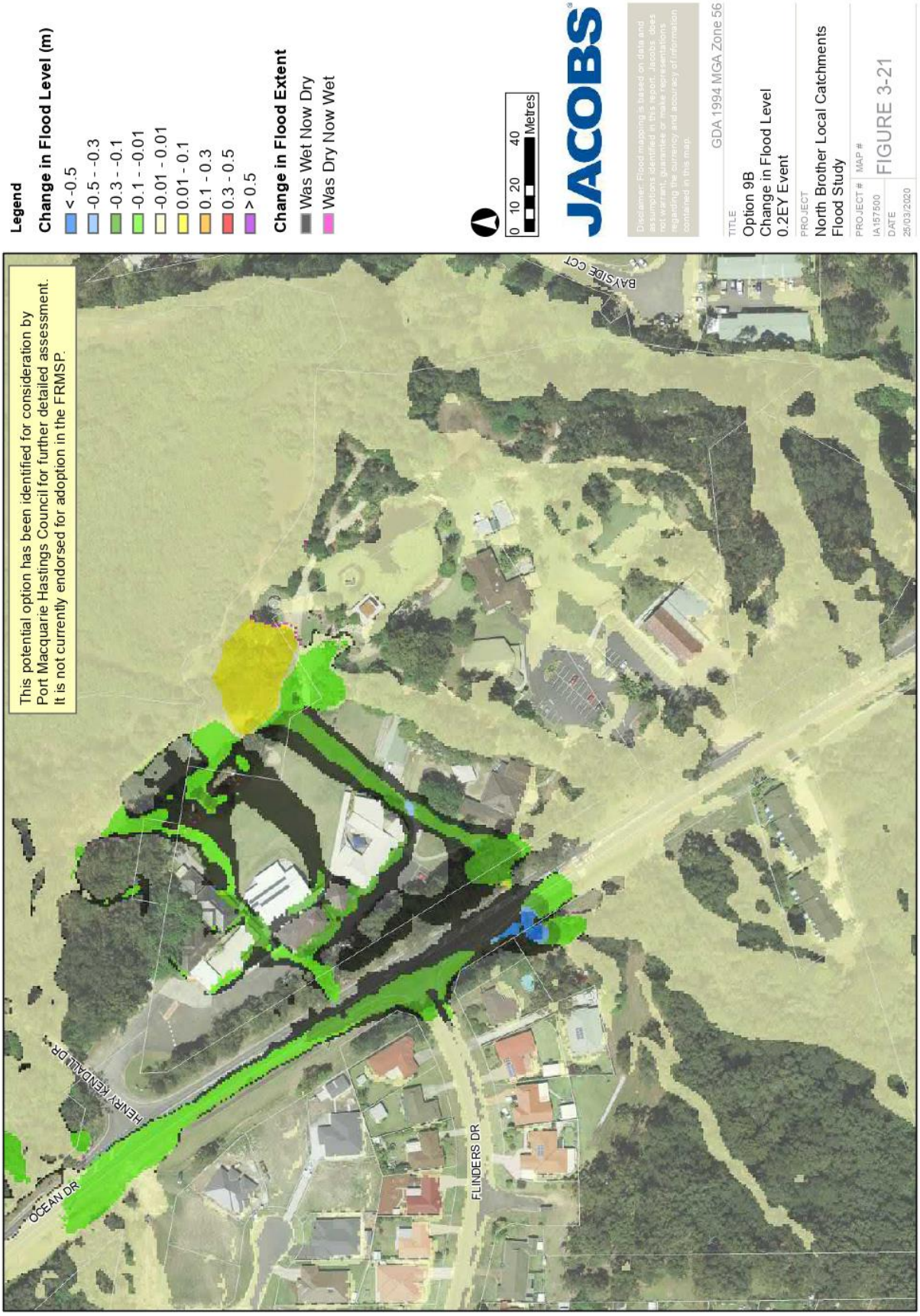
The channel through the mangrove/wetland areas would need to be widened downstream to Stingray Creek to accommodate increased flood flows and this would have localised impacts on sensitive habitats (EECs/SEPP 14 wetlands). Appropriate rock scour protection would be required at the culvert outlet. It is anticipated that that an REF will be required and would need a flora and fauna study.

Hydraulic performance

Flood impact maps, showing the change in flood levels, are presented on Figure 3-21 to Figure 3-23 for the 0.2EY, 5% and 1% AEP events, respectively. The hydraulic performance of Option 9B is summarised in Table 3-8.

Table 3-8 Hydraulic performance of Options 9B

Event AEP	Changes in flood conditions
0.2EY	• Maximum decreases of -0.2 to -0.3m in the middle flow path and adjacent buildings through the school, with substantial reductions in flood extent • Decrease of up -0.2m around school office and adjacent buildings, with substantial reduction in flood extents • Reductions in flood depths on Ocean Drive around Flinders Drive of up to -0.2m. reductions in flood levels/depths around Ocean Drive culvert crossing (middle flow path) of up to -0.3m with substantial reduction in flood extents • Reductions from high-very high hazard (up to H5) in the middle flow path in the existing case including on walkways, down to all low hazard (H1) in mitigation case • Reductions from localised high hazard (up to H4) around the school office in the existing case including on walkways, down to low hazard (H1, some localised H2) in mitigation case.
5% AEP	• Maximum decreases of -0.2 to -0.3m in the middle flow path and adjacent buildings through the school, with substantial reductions in flood extent • Decrease of up -0.2m around school office and adjacent buildings, with substantial reduction in flood extents • Reductions in flood depths of -0.1 to -0.2m. on Ocean Drive around Flinders Drive and reductions of up to -0.3m at culvert crossing • Reductions from high-very high hazard (up to H5) in the middle flow path in the existing case including on walkways, down to all low hazard (H1) in mitigation case • Reductions from localised high hazard (up to H4) around the school office in the existing case including on walkways, down to low hazard (H1, some localised H2) in mitigation case.
1% AEP	• Maximum decreases of -0.2 to -0.3m in the middle flow path and adjacent buildings through the school, with substantial reductions in flood extent • Decrease of up -0.2m around school office and adjacent buildings, with some reduction in flood extents • Reductions in flood depths on Ocean Drive around Flinders Drive of -0.1 to -0.2m. reductions in flood levels/depths around Ocean Drive culvert crossing (middle flow path) of up to -0.3m with substantial reduction in flood extents • Reductions from very high hazard (H5) in the middle flow path in the existing case including on walkways, down to mostly low hazard (H1-H2) in mitigation case • Reductions from high-very high hazard (H4-H5) around the school office in the existing case including on walkways, down to mostly low hazard (H1-H2, some localised H3-H4) in mitigation case.
1% AEP plus climate change	Similar performance to the 1% AEP event, in terms of reductions in flood levels in mitigated versus existing development case (with climate change). No reduction in performance due to sea level rise.


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9B
Change in Flood Level
0.2EY Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-21
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
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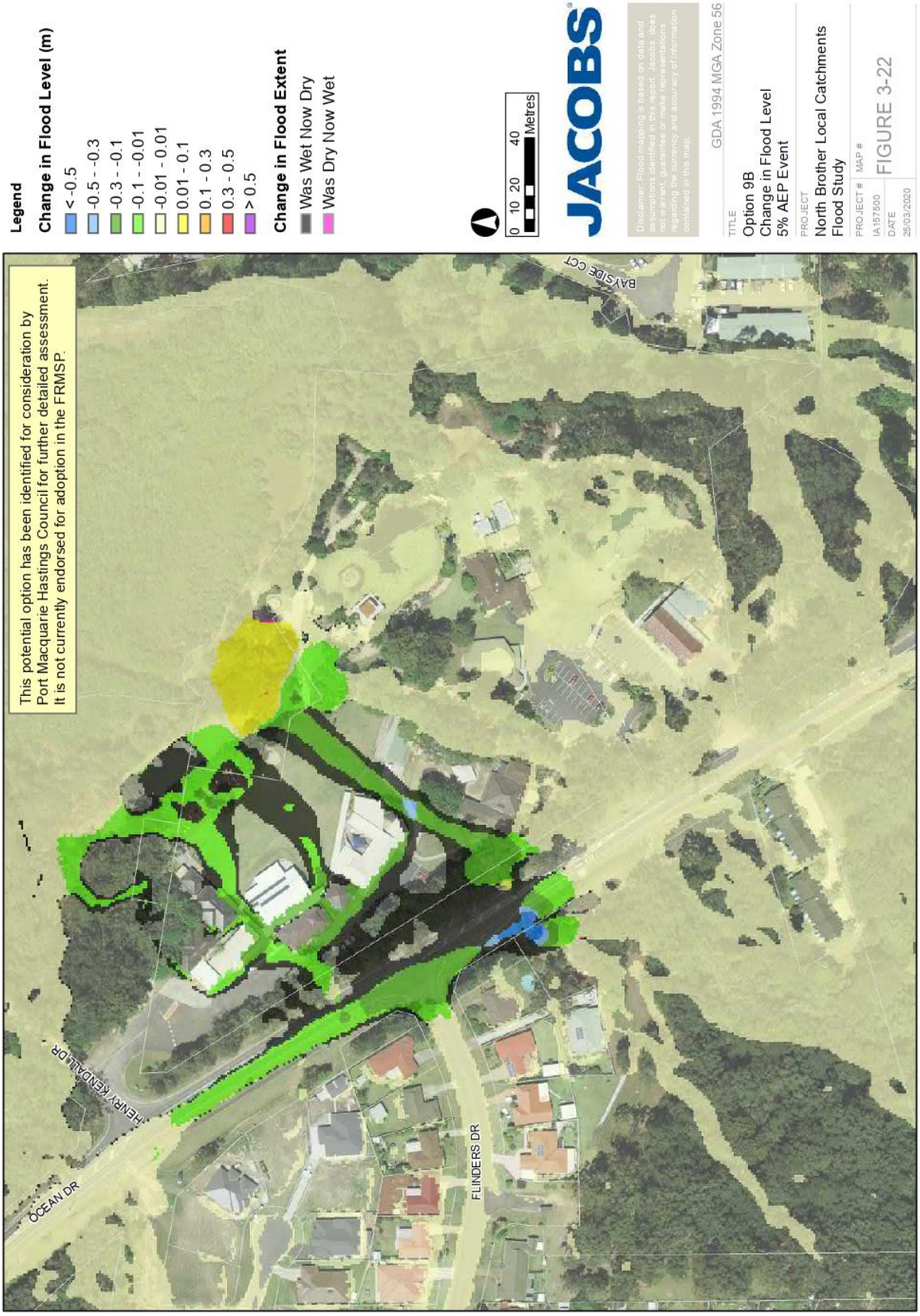
Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9B
Change in Flood Level
5% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP # FIGURE 3-22
DATE 25/03/2020
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
BAYSIDE CCT
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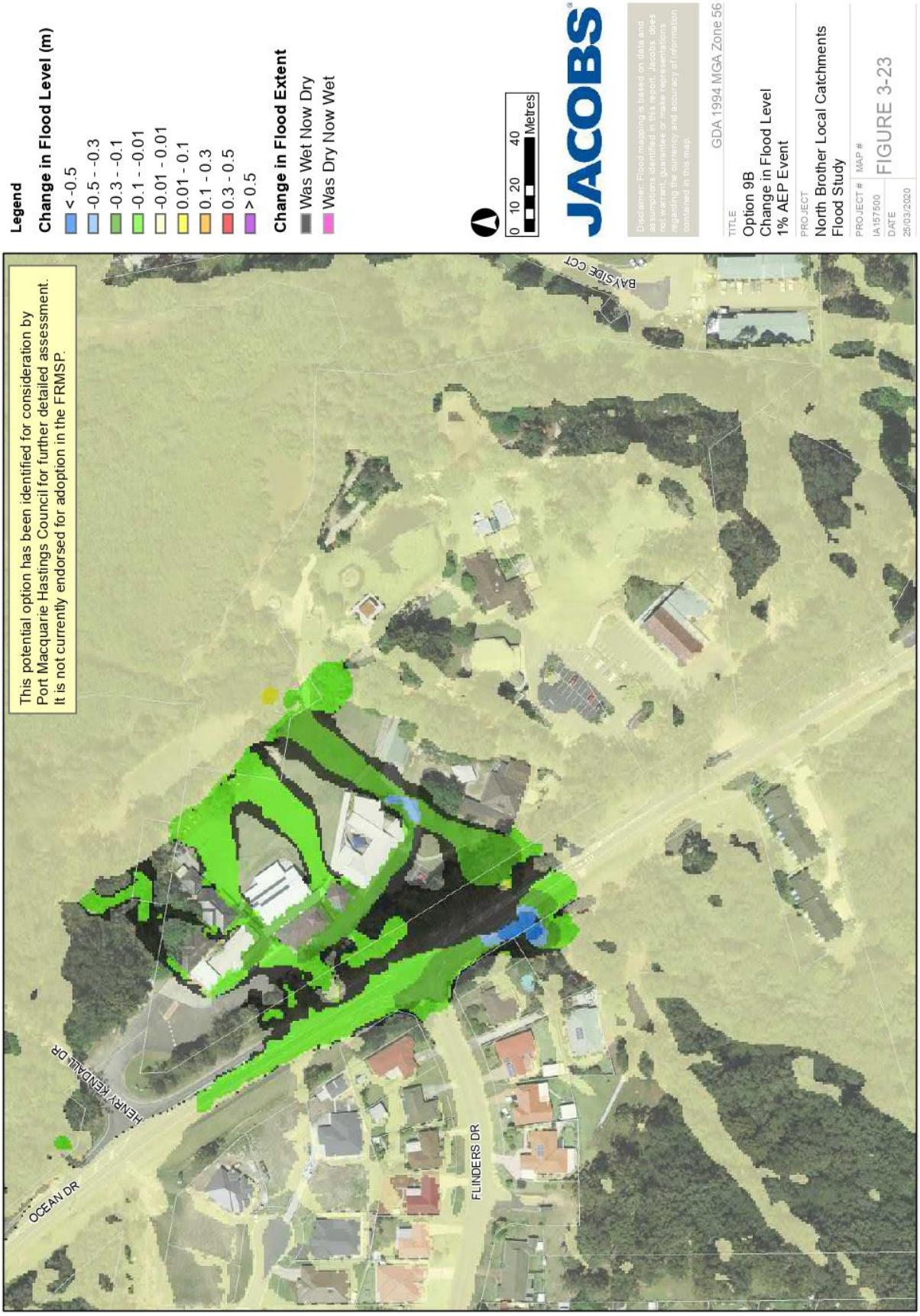
OCEAN DR
FLINDERS DR


Legend
Change in Flood Level (m)
< -0.5
-0.5 - -0.3
-0.3 - -0.1
-0.1 - -0.01
-0.01 - 0.01
0.01 - 0.1
0.1 - 0.3
0.3 - 0.5
> 0.5
Change in Flood Extent
Was Wet Now Dry
Was Dry Now Wet
0 10 20 40 Metres
JACOBS
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
GDA 1994 MGA Zone 56
TITLE
Option 9B
Change in Flood Level
1% AEP Event
PROJECT
North Brother Local Catchments
Flood Study
PROJECT # IA157500
MAP #
DATE 25/03/2020
FIGURE 3-23
This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.
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OCEAN DR
FLINDERS DR

3.5 Summary of Options

The assessed options are summarised in Table 3-9. A description, constraints/impacts, hydraulic performance, improvements to property flooding and estimated savings in flood damages are provided. The savings in flood damages are a comparison of the net present value of average annual flood damages between the mitigated and existing cases, based on a 0.5m protection level, over an assumed 50 year life of the option and assuming a 7% discount rate.

For the flood damage assessment, the PMF was assumed not be changed by the mitigation options given the magnitude of the flood event. The AAD is not sensitive to this assessment given the rarity of the PMF event.

The flood damages also only consider overland flooding and do not account for damages due to peak mainstream flooding.

Further detailed assessment will include cost estimation and benefit-cost assessment and multi-criteria assessment, incorporating refinements to the options where appropriate.

Table 3-9 Summary of assessed flood modification options performance

Option	Location	Description	Constraints and Impacts Plus other comments	Hydraulic Benefits (1% AEP event unless otherwise noted) *And Negative Impacts if Any*	Savings in Flood Damages (50 years life, 7% Discount Factor)	Cost of Works	Benefit Cost Ratio
4A+4B +4C	Koonwarra Street to Pelican Court, West Haven	• Voluntary acquisition of 53 Koonwarra Street. Regrade the site to form a flow path • New additional trunk drainage line 2x 1200mm diameter pipes, intercepting flows at downstream end of channel on Captain Cook Bicentennial Drive villas, cross Ocean Drive and run under The Gateway. Inlet debris trap basin required. • Voluntary acquisition of 7 Pelican Court. Regrade the site to form a flow path	• High property prices (~$500K each) plus demolition and disposal costs • Existing underground utilities in Ocean Drive and The Gateway (Telstra, Optus, NBN, power, stormwater). • Substantial number of trees in western verge of The Gateway, require removal if running new trunk drainage in the verge. • Limited space to widen existing channel running through Captain Cook Bicentennial Drive villas and then turning at Ocean Drive. Presence of existing driveway crossing over channel into Ocean Drive property. • Minimal space for rock debris trap at new trunk drainage inlet structure. Requires more detailed site assessment for potential rock debris loads.	• Koonwarra Street – flood levels reduced by -0.04m to -0.4m at four properties • *Minor localised increase of +0.02m on Captain Cook Bicentennial Drive villas* • Pelican Court – flood levels reduced by -0.2 to -0.7m in roadway and alleyway. Reductions on properties typically to -0.1m, up to -0.4m on two properties. • Eliminated occurrence of H4-H5 flood hazard at two dwellings in Koonwarra Street (one through acquisition of property). • Reduced flood hazard on Ocean Drive from up to H5 to H2. Note that road may be cut-off in other locations. • Reduced extent of H3-H5 hazard in Pelican Court. • 0.2EY event: Reduced flood hazard from H5 to H1-H2 in Pelican Court, some H3 in alleyway • Number of above-floor flooded properties reduced by 6 in the 1% AEP event. Options 4B and 4C reduce flood levels and hazard on Ocean Drive and Pelican Court including up to 20 dwellings. Option 4A reduces the number of properties at risk due to the property purchase. However, the reductions in flood levels on adjacent properties is generally minor. The substantial reductions are limited to one property. The likely high cost of this option may make this option more challenging to justify purely from an economic standpoint. Notwithstanding, the removal of a household subject to high flood hazard should be considered in the subsequent multi-criteria evaluation of this option	$3,876,000	TBC	TBC

Option	Location	Description	Constraints and Impacts Plus other comments	Hydraulic Benefits (1% AEP event unless otherwise noted) *And Negative Impacts if Any*	Savings in Flood Damages (50 years life, 7% Discount Factor, with 0.5m protection level)	Cost of Works	Benefit Cost Ratio
6A	Tunis Street Overland Flow Path, Laurieton	Construct/raise berm between the natural flow path and the diversion channel above Blackbutt Crescent to reduce overflows into the diversion channel	• Works fully within national park area, likely requiring removal of a large number of trees for the proposed bund in addition to site access for construction plants. • The option will be constructed on a natural berm which appears to be formed from flood-flow deposits of rock rubble and other material. Geotechnical conditions may be challenging. • Periodic maintenance of the proposed bund would be required.	• Reductions in flood levels of -0.05 to -0.2m on Gow Place properties and Laurieton retirement village villas, some localised areas greater than -0.02m. Reductions of -0.1m at Laurieton retirement village main facility. • Localised reductions of up to -0.4m on Peach Grove properties. One property experiences minor increases of less than +0.02m. • Minor reductions of up to -0.06m on residential and commercial properties on and to the east of Ocean Drive. • *Widespread increases of +0.03 to +0.07m on St Josephs School grounds* • Number of above-floor flooded properties reduced by 19 (residential) in the 1% AEP event.	$2,265,000 net	TBC	TBC
6B+6C +6D+ 6E	Tunis Street Overland Flow Path, Laurieton	• Increase existing diversion channel capacity behind Blackbutt Crescent properties. Widen and remove/maintain vegetation • Construct new diversion channel behind Peach Grove properties north of Tunis Street • Install new 3 x 1.35m trunk drainage line from the easement down Tunis Street to discharge to the river (approximately 740m). Inlet debris trap basin required. • Upgrade and extend drainage in Gow Place to 1.05m dia pipe. Upgrade pit inlets. Install new 900mm pipe connection from the gully to the new trunk drainage line.	• Works would need to be undertaken in part in the national park. • Upgraded diversion channels are to be grassed and require maintenance to limit vegetation growth. • Close proximity to existing buildings likely to have shallow foundations. Wide construction footprint for trenching likely to take up most of road corridor. Appropriate traffic diversions would be required. • Vibration due to construction activities may be a concern. • Acid sulphate soils in this location. • Numerous existing underground utilities (Telstra, Optus, NBN, power, stormwater) under Tunis Street and adjoining streets. Approximately 10 crossings of the utilities are identified and would need to be protected. It is assumed that the existing utilities are at sufficiently shallow depth to enable the new trunk drainage to be laid beneath. • Design and construction will need to minimise traffic impacts including delivery truck access to Coles Supermarket loading dock. Pipe jacking likely required for this section • A rock debris trap/basin would need to be constructed at the trunk drainage inlet to reduce the inlet blockage risk.	• Reductions in flood levels of up to -0.4m on Gow Place properties and Laurieton retirement village villas, including some reductions in flood extent. • Reductions in flood levels of up to -0.5m on Peach Grove and Blackbutt Crescent properties including reductions in flood extent. Some localised reductions of up to -0.7m. • Reductions of -0.1 to -0.2m on residential and commercial properties on and to the east of Ocean Drive. • Removal of areas of very high hazard (up to H5) in road and on properties between Blackbutt Crescent/Peach Grove and to the east of Kew Road/Bold Street. • Climate change scenario: the option generally has similar performance to 1% AEP, in terms of reductions in flood levels. Slight reduction in performance due to sea level rise in low elevation areas below 3m AHD, where the reductions fall from -0.07m in the current climate case to -0.01m in the climate change scenario. • Number of above-floor flooded properties reduced by 36 in the 1% AEP event (34 residential, 2 commercial).	$15,680,000	TBC	TBC

Option	Location	Description	Constraints and Impacts Plus other comments	Hydraulic Benefits (1% AEP event unless otherwise noted) *And Negative Impacts if Any*	Savings in Flood Damages (50 years life, 7% Discount Factor, with 0.5m protection level)	Cost of Works	Benefit Cost Ratio
8B	Lake Street at Seymour Street, Laurieton	Install debris control structure at existing or proposed upgraded culvert inlet	• No significant constraints • Inspection and maintenance after storm events required to increase reliability	• Reductions of -0.1m on private property dwelling and Laurieton United Services Club side entrance. • Reductions of up to -0.1m on Lake Street. • *Minor localised increases of less than -0.02m on some private properties due to reduced drainage capacity of local stormwater drainage branches.*	$8,000	TBC	TBC
9A	St Joseph's School, Laurieton	Upgrade Ocean Drive culvert crossing. Inlet rock debris trap basin required. Widen existing open channel in southern flow path to 10m top width (8m base width)	• Minimum clearance between buildings and other features is 19m. Existing buildings are single storey and are likely to have shallow foundations. One building believed to be around 120 years old. Vibration due to construction activities can be a concern and a detailed structural inspection of the existing buildings should be conducted to assess if some areas of the existing buildings are more susceptible to such vibration. The final alignment of the proposed culvert can then be chosen to avoid these vibration sensitive zones. • Sediments may be mildly contaminated and high acid-sulphate. • Existing drainage needs to be surveyed and coordinated with the design of the modified open channel. • The existing channel and its banks appear to be landscaped with well-established gardens, which are likely to be of high value to the school and adjacent church. The option needs to include landscaping to re-establish the gardens. • Existing utilities along Ocean Drive (Optus, Telstra, NBN, power). • Sensitive habitats downstream. Possible localised impacts from expanded channel draining to Stingray Creek. Review of Environmental Factors likely required.	• Maximum decreases of -0.3 to -0.4m (up to -0.5m in 0.2EY event) in the channel (southern flow path) upstream and downstream of Ocean Drive culvert crossing, with reductions in flood extent • Decrease of -0.02 to -0.08m at and between school buildings, minimal reduction in flood extent • Some reduction in high-very high hazard extent in southern and middle flow paths including on walkways, minimal reduction in flood hazard around school office (only localised high hazard in existing case and mostly low hazard)	$145,000	TBC	TBC

Option	Location	Description	Constraints and Impacts Plus other comments	Hydraulic Benefits (1% AEP event unless otherwise noted) *And Negative Impacts if Any*	Savings in Flood Damages (50 years life, 7% Discount Factor, with 0.5m protection level)	Cost of Works	Benefit Cost Ratio
9B	St Joseph's School, Laurieton	Install 2x 3m x 1.2m box culvert in the middle flow path, including upgrade of Ocean Street culvert crossing. Inlet rock debris trap basin required	• Minimum clearance between buildings and other features is 16m • Existing buildings are single storey and are likely to have shallow foundations. One building believed to be around 120 years old. Vibration due to construction activities can be a concern and a detailed structural inspection of the existing buildings should be conducted to assess if some areas of the existing buildings are more susceptible to such vibration. The final alignment of the proposed culvert can then be chosen to avoid these vibration sensitive zones. • Sediments may be mildly contaminated and high acid-sulphate. • Existing drainage need to be surveyed and coordinated with the design of the modified open channel. Reconstruction of existing driveway required. • Existing utilities along Ocean Drive (Optus, Telstra, NBN, power). • Sensitive habitats downstream. Possible localised impacts from expanded channel draining to Stingray Creek. Review of Environmental Factors likely required.	• Maximum decreases of -0.2 to -0.3m in the middle flow path and adjacent buildings through the school, with substantial reductions in flood extent • Decrease of up -0.2m around school office and adjacent buildings, with some reduction in flood extents • Reductions in flood depths on Ocean Drive around Flinders Drive of -0.1 to -0.2m. Reductions in flood levels/depths around Ocean Drive culvert crossing (middle flow path) of up to -0.3m with substantial reduction in flood extents • Reductions from H5 hazard in the middle flow path in the existing case including on walkways, down to mostly H1-H2 • Reductions from H4-H5 hazard around the school office in the existing case including on walkways, down to mostly H1-H2 hazard, some localised H3-H4 in mitigation case. Reductions from H4 down to H1-H2 in up to 5% AEP event.	$500,000	TBC	TBC

4. Non-Structural Measures

4.1 Property Modification Measures

4.1.1 Voluntary Purchase of High Hazard Properties

Voluntary purchase of high flood hazard properties may be considered in order to eliminate the potentially high risk of loss of life and damage to property from these areas by physically removing the dwellings at risk to hazardous flood conditions.

OEH has prepared Guidelines for Voluntary Purchase Schemes (OEH, 2013b). This describes the eligibility criteria for NSW Government funding for VP schemes, which include:

- no other feasible flood risk management options are available to address the risk to life at the property;
- residential properties and not commercial and industrial properties;
- buildings were approved and constructed prior to 1986;
- properties are located either 1) within high hazard areas where there is a significant risk to life for occupants and those who may have to evacuate or rescue them, 2) within a floodway where the removal of the house may be part of a floodway clearance program aimed to reduce the significant impacts caused by the existing development on flood behaviour elsewhere in the floodplain, or 3) within the footprint of a proposed flood mitigation measure or where a flood mitigation measure may result in a significant increase in flood risk to a house that cannot be protected.

Two high flood hazard properties have been nominated for voluntary purchase in order to form a floodway to relieve flooding semi-trapped points in Koonwarra Street and Pelican Court, refer to Options 4A and 4C in the flood modification measures (Section 3.4.2.1).

In total, there are 19 residential properties affected by high hazard flooding, considered as being H5 or higher, in the 1% AEP event which may be eligible for voluntary purchase. This excludes any villas, units or strata buildings. There are limits to the funding available for a voluntary purchase program and additional eligibility criteria may apply. Feasibility of a voluntary purchase program is likely to be limited by the relatively high property prices in the study area. Further assessment needs to be undertaken with the finalised structural mitigation options and whether these eliminate the high flood hazard conditions to particular properties.

4.1.2 Voluntary House Raising

Voluntary house raising has long been a traditional response to flooding in New South Wales, as demonstrated by the number of raised houses in frequently flooded urban areas such as Lismore and Fairfield (Floodplain Development Manual, 2005). There are advantages associated with house raising which are noted as follows (Frost and Rice, 2003).

- A reduction of flood damages due to personal items being stored above the nominated flood level
- A reduction in danger to personal safety and a reduction in the cost of potentially needing to evacuate residents
- Potentially cost-effective alternative to voluntary purchase, with positive social outcomes (i.e. home owners who have strong sentimental value on their properties can remain in the same location).

Some of the disadvantages include:

- Residents' concern over security and privacy due to an open, exposed ground floor
- Accessibility issues for the elderly or people with a disability
- Following raising, residents may develop a false sense of security from impacts. This can result in a belief that they will not be impacted by flooding or reluctance to evacuate when required.

- Over time and when flooding has not occurred, residents may be inclined to utilise the ground floor and converting it to a habitable area.

OEH has prepared *Guidelines for Voluntary House Raising Schemes* (OEH, 2013a). This describes the eligibility criteria for NSW Government funding of VHR schemes including:

- not located in floodways;
- limited to areas of low flood hazard;
- the suitability of individual houses for raising;
- residential properties and not commercial and industrial properties;
- buildings were approved and constructed prior to 1986;
- properties cannot be benefiting substantially from other floodplain mitigation measures;
- VHR should generally return a positive net benefit in damage reduction relative to its cost (benefit–cost ratio greater than 1).

Inclusion of a property in a voluntary house raising scheme places no obligation on the owner to sell the property or on the council or NSW Government to fund the purchase of the property. Owner participation in the scheme is voluntary and there are limitations on the availability of funding.

Whilst house raising can be considered for a range of building types, it is easiest and cheapest for timber-framed houses clad with non-masonry materials. A large proportion of houses in the study area which area flood-affected are of single or double brick construction which are considered costly and impractical for raising.

Due to the factors outline above, house raising is not considered feasible as a mitigation measure for dwellings within the study area.

4.1.3 Planning and development controls

4.1.3.1 General

Land use planning and development controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Planning controls including flood planning levels, flood related development control plans and restrictions on permissible types of development in different parts of the floodplain are recommended to ensure that development in the study area occurs in an appropriate manner in relation to flooding.

4.1.3.2 Amendments to LEP

The *Port Macquarie Hastings Local Environmental Plan 2011* (LEP 2011) provides land use controls for the LGA and has been developed to be consistent with the FDM. Part 7.3 of the LEP 2011 contains clauses on flood planning. Excepts of this clause are provided below:

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

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

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

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to:

(a) land that is identified as "Flood planning area" on the Flood Planning Map*, and*

(b) other land at or below the flood planning level.

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

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005, unless it is otherwise defined in this clause.

The LEP includes mapping of known flood liable lands, where there are flood studies completed for those areas. It currently does not include the overland flood areas of the North Brother local catchments.

While the LEP does require consideration of the compatibility of development to the "flood hazard of the land", it only makes reference to the flood liable lands and flood planning area. It does not make reference to the actual flood hazard rating, that being governed by flood depth, velocity and/or velocity-depth product, or to the hydraulic category of the floodplain (floodway, flood storage etc.).

Recommendation

The following updates to LEP 2011 and the Section 10.7 certificates are recommended:

- Amendment of LEP 2011 to include the North Brother local catchments flood mapping on the LEP Flood Planning Map. The current flood prone land mapping and flood planning area mapping does not include this study area.
- The Section 10.7 certificates should provide flood information for properties such as flood levels and flood planning levels across the lot, in addition to the flood hazard and hydraulic categories present on each lot.

4.1.3.3 Amendments to Flood Policy

Overview

Council's Flood Policy (2015) outlines the development controls to be applied to proposed developments to manage flood risk to occupants and minimise flood damages to the development and flood impacts to adjacent properties. Development controls include flood planning level categories and provisions for different types of development (permissible development types, minimum floor levels), considerations for filling, fencing, boundary adjustments, rezoning and subdivision in the different hydraulic zones in the floodplain. The flood policy draws on the design flood information borne from Council's existing flood studies

Prescriptive Controls

Prescriptive controls that apply to a particular Flood Risk include:

- Floor Level
- Flood Proofing
- Flood Impact on Other Properties
- Site Access and Flood Evacuation Requirements.

The Flood Policy provides requirements for different types of development in relation to these prescriptive controls. These requirements vary depending on the hydraulic classification and flood hazard conditions on the property.

Hydraulic Classifications

The flood policy provides definitions for the different hydraulic classifications of the floodplain, including floodway, flood storage and flood fringe areas. It outlines the type and nature of development which is allowed according to the hydraulic classifications on the property. Generally, new development is not allowed in floodway areas. There may be circumstances in which certain types of limited or Minor Development (including infill development, redevelopment, replacement development or minor extensions) could proceed, subject to a range of considerations.

Flood Hazard

The flood policy provides guidance on how proposed developments are to comply with the prescribed development controls and provisions. One of these is consideration of the flood hazard on the property. The flood hazard categorisation system adopted in the flood policy differs from the hazard categorisation system recommended in Australian Rainfall and Runoff 2019, which is based on recent research and which is presented in *Australian Disaster Resilience Handbook 7. Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017a) and *Guideline 7-3 Flood Hazard* (AIDR, 2017b). The flood hazard mapping prepared in this study for the North Brother Local Catchments follows the ARR 2019 system.

Flood Planning Levels

The Flood Policy defines the adopted flood planning levels for various types of proposed development. Council has adopted a 0.5m freeboard across the whole LGA, including both mainstream and overland flood areas. The different flood planning level categories define the minimum levels for floor levels, flood proofing, flood impacts to other properties and site access (e.g. roads) and evacuation routes for different types of development.

Table 4-1 Flood Planning Level (FPL) Categories

Category Proposed	FPL Category Description
FPL1	20 year ARI Flood level (No allowance for Climate Change, No Freeboard)
FPL2	100 year ARI Flood level + Climate Change Allowance (No Freeboard)
FPL3	100 year ARI Flood level + Climate Change Allowance + 500mm Freeboard
FPL4	Probable Maximum Flood (PMF)

Comments and Recommendations

- The Flood Policy should be updated to refer to this North Brother Local Catchments Flood Study and the flood mapping and other design flood data following adoption of this study by Council.
- Design flood events are referred to in the Flood Policy in terms of Average Recurrence Interval (ARI) which is not in line with current floodplain management best practice of referring to events by Annual Exceedance Probability (AEP). Update to the Flood Policy should include reference to AEP terminology and/or definitions on conversion in its glossary (i.e. 5% AEP = 20 year ARI, and 1% AEP = 100 year ARI).
- The Flood Policy has been developed mainly in the context of mainstream flooding. For example, in relation to reliable site access for new residential developments, the Flood Policy states that Council will only support development where "Effective Warning Time and reliable access is available for evacuation. Developments will be required to demonstrate that evacuation through low hazard conditions during the early warning period of a Flood is achievable. A minimum 8 hours Effective Warning Time must be available to a particular site". For overland flooding such warning time is not available (usually the warning time is less than 1 hour). Therefore, it is recommended to update the Flood Policy to provide exemptions or modified conditions for development of properties subject to overland flooding.
- Continuing from the item above, mapping should be provided and included/cited in the Flood Policy which indicates the areas subject to mainstream flooding (as defined by the riverine flood studies) and those subject to overland flooding (as defined in this and subsequent overland flood studies and which are above the extent of mainstream flooding). This mapping will be prepared as a part of this study, for the North Brother study area.
- The Flood Policy needs to state that both the mainstream and overland flooding conditions need to be considered for development and re-development of properties.
- Consider incorporation of the ARR 2019 flood hazard categorisation system into the Flood Policy to reflect the current best practice in defining flood hazard conditions.
- "High flood hazard" could be considered as H3 or higher hazard (ARR 2019 hazard categories). The lower threshold for H3 hazard is similar or slightly lower than the high and transitional hazard categories in the *Floodplain Development Manual* method.

4.1.3.4 Rezoning

Rezoning could be considered where there is an incompatibility of the flood hazard or hydraulic category on the property compared to the type of land use. Section 2.4 identifies sensitive properties and critical facilities which are affected by high hazard flooding and floodway (as well as flood storage and flood fringe) areas. Unlike mainstream flooding, the high hazard and floodway areas are generally localised in the 1% AEP event. Rezoning of entire properties, especially larger premises occupied by schools, nursing homes etc. to preclude those land uses is likely to result in the suitable parts of the properties being underutilised.

Properties with larger areas of high hazard up to H5/H6 in PMF include:

- St Josephs school
- Laurieton Retirement Village
- Stockland Camden View Retirement Village.

Rezoning of these properties in response to flood hazard in the PMF could be considered, although many of these sensitive properties are large facilities and there is an absence of large vacant lots to which these facilities could be relocated, and relocation would be an expensive and complex exercise. Other measures and development controls may be appropriate to manage redevelopment of these properties. Therefore, rezoning of the identified affected sensitive properties and critical facilities is generally not recommended, based on the overland flood conditions presented in this study. Rezoning in response to mainstream flood conditions has not been assessed.

4.1.4 Council Redevelopment

This measure is an alternative to voluntary purchase (refer Section 4.1.1) whereby Council would still purchase high-impacted flooded properties on a voluntary basis but instead of rezoning the land, the property is redeveloped with new dwellings designed to withstand the high hazard flooding conditions on the property and resist flood damages. The intention is for the redeveloped property to be resold with a break-even financial outcome, which offsets the high property purchase costs which tend to make voluntary purchase unfeasible.

However, initial assessment identifies a number of issues with this approach:

- It would be in conflict with Council's Flood Policy in addition to other planning policies which preclude (re)development in floodway and high flood hazard areas.
- This approach may need to be fully funded by Council.
- Specialised building design and engineering would be required to withstand high to extreme hazard flood forces (H5 and H6 hazard rating) in the 1% AEP event and rarer, which adds to the cost of this option.
- This approach would not reduce the risk of flooding on the population in the PMF.
- There is a high upfront cost to be borne by Council for each redevelopment.
- There may also be probity issues in the case of Council acquiring the property, redeveloping and reselling the property.
- The generally older characteristics of the local population may mean that there is a reduced capacity for the residents of properties to move elsewhere. There may be reluctance to sell-off the properties in this regard. Conversely, however, there may be increased uptake in this option for residents who are frequently affected by flooding.

Recommendation

Further consideration by Council is required to determine if these issues can be addressed to make this a viable approach. Development controls such as floor levels above the PMF for flood refuge would need to be assessed for suitability in a town planning context.

4.1.5 Flood Proofing and Flood Compatible Design of Individual Buildings

Flood compatible design refers to the design and construction of buildings with appropriate water-resistant materials such that flood damage to the building itself (structural damage) and possibly its contents, is minimised should the building be inundated. *Reducing Vulnerability of Buildings to Flood Damage* (Hawkesbury-Nepean Floodplain Management Steering Committee, 2007) provides a comprehensive discussion of the various options for building design to minimise the impact of flooding. These include structural and architectural design and building materials, in addition to design considerations such as setting of electrical equipment above flood levels to reduce risk of their damage.

Flood compatible and flood proofing design measures are prescribed for different types of development in Council's Flood Policy (2015), including the minimum elevations in the development which the flood compatible materials must reach in all parts of proposed buildings.

Promotion of types of flood proofing measures should also be undertaken as a part of flood awareness and readiness improvement programs (refer Section 4.2.3).

Flood proofing of residential properties can also refer to implementing external measures such as walls or landscaping to redirect flows away from and around vulnerable parts of the house, such as doorways and other entry points. It is generally a measure that can be pursued by individual property owners in low hazard areas to prevent above floor inundation but may result in diversion of flows to neighbouring properties and resultant impacts. A flood impact assessment may be required by Council as per the Flood Policy to ensure adverse flood impacts to adjacent properties are prevented.

Recommendation

Promotion of flood proofing measures should also be included in flood education and awareness programs.

4.2 Response Modification Measures

4.2.1 Flood Warning Systems

The study area includes local catchments and overland flow paths where flash flooding may occur. Flash flood catchments are those defined as catchments in which less than six hours may elapse between heavy rainfall and flooding. Flash flooding usually results from relatively short intense bursts of rainfall, commonly from thunderstorms. This is problematic in urban areas where drainage systems may not cope. Flash floods tend to be quite local and it is difficult to provide effective warning because of their rapid onset. The reasons for this have been identified for flash flood catchments as follows (McKay, 2004, 2008):

- Flash floods are less predictable than larger scale flooding. Rainfall over small catchments is usually not well predicted by numerical weather prediction models
- For flash floods, there is insufficient time to develop reliable flood warnings and for effective the dissemination and response to the flood warnings. More rapid user response is required, which necessitates specialised communication systems and a high level of public flood awareness
- A reliance on rainfall triggers increases the frequency of false alarms
- The use of water level triggers does not allow sufficient time for response.

It is not possible for BOM to issue specific predictions for flash flood catchments based on their regional rainfall gauging network. More importance is placed on the role of the SES and other agencies to interpret the regional warnings which are provided by BOM to warn the community of the potential road closures and damage as a result of predicted storms and flash floods.

Flash flood warning systems have been proposed for some catchments, such as the Avalon overland flood areas on the Northern Beaches of Sydney. However, the time to peak for critical storm events in the Avalon area is about 1 hour from the start of the storm, and about 30 minutes after peak rainfall rates in the design storm event (MHL, 2016), which offers a short warning time. The critical duration in that area for the 1% AEP event is the 2 hour event.

In contrast, although some of the lower areas in North Brother study area have a critical storm duration of up to 2 hours, the critical duration for most of the study area is generally the 30 minute duration event. Time to peak in many flow paths, especially on known problem areas further up the mountain, is in the range of 15 minutes. Due to the steepness of the local catchments the overland flooding is expected to peak almost instantaneously (5 to 10 minutes) in response to high intensity rainfall. Therefore, there would be minimal to no warning provided for many locations in the study area. Potential delays in analysis of rainfall data and subsequent dissemination of warnings via phone or text systems would further erode the warning time.

Given the issues and challenges discussed above, the development of a flash flood warning system for the study area is not recommended. Greater emphasis should be placed on the importance of flood education and awareness in the community. Local residents have a role in being able to understand how the issued weather warnings and actual occurrences of intense rainfall during a storm may translate to flooding impacts to their properties, and in addition, be aware of ways to prepare their properties to reduce flood damages and risk to life.

4.2.2 Flood Depth Signage on Roads

A number of road crossings are affected by significant flooding. Flood depth signage is recommended for key locations primarily to warn drivers of the flood hazard during a flood event and reduce occurrences of people driving into floodwaters. Flood depth signage may also act as a passive reminder to residents of the potential for flooding in their neighbourhood streets. Nominated locations are where H3 or higher flood hazard occurs in the 1% AEP event, including:

- Ocean Drive 70m east of Sirius Drive
- Ocean Drive 380m east of Fairwinds Avenue
- Ocean Drive 30m east of The Gateway
- Bold Street sag between Laurie Street and Mill Street
- Bold Street sag between Mill Street and Hanley Street.

While there are other roads affected by high hazard flooding conditions, Ocean Drive and Bold Street are higher-trafficked roads and crossed by major flow paths with a higher risk of vehicles being washed off the road.

Recommendation

It is recommended that flood depth signage be installed at key road crossings as a warning of the flood hazard during a flood event and reduce occurrences of people driving into floodwaters, in addition as a passive reminder of flooding risk.

4.2.3 Flood Education, Awareness and Readiness

Flood education and awareness should be promoted throughout the study area. Measures may include information brochures in English and multi-lingual including promotion of NSW SES FloodSafe brochures and website (http://www.floodsafe.com.au/). Additionally, Council or SES may run educational workshops or distribute information sheets to help people plan and prepare for a flood.

Section 10.7 certificates issued by Council could be used to inform property owners about flood risk to their properties, where there are flood studies completed within Port Macquarie Hastings LGA.

Additionally, Council's floodplain management web page and social media could be further developed to enhance the messaging on flood risk and flood preparation, particularly in relation to overland flooding. This may include flood mapping on an interactive mapping portal on the website itself rather than links to the flood study reports and mapping, where it can be difficult for community members to navigate through often lengthy technical reports. Information on, or links to external websites (SES, floodsafe, etc), should be included for advice for residents on how to prepare for flooding.

During flood events, Council should a list of road closed to flooding (and roads recently opened as the flooding recedes) on their website and social media. This will encourage road users to find alternative routes and reduce the number of drivers encountering flooded roads and potentially driving into floodwaters.

A flood education and awareness program should be developed by Council which outlines and schedules various flood education methods to be implemented (e.g. brochures, news articles highlighting previous flooding, SES events, Council web pages etc.). The program should be reviewed after each significant flood event to assess the effectiveness of the program, reinvigorate flood awareness in the community and plan the roll-out of new flood information as it becomes available.

As a part of an overall flood education and awareness program for the study area, Council should consult with operators of sensitive properties and facilities to provide information on the flood risk on the property and

promote the development of a flood management plan for the properties (refer to Section 4.2.5 for further details).

Recommendation

It is recommended that Council develops a flood education program to promote flood awareness and readiness in the community. Measures may include:

- Promotion of FloodSafe brochures to help residents understand the flood risk and prepare their property and personal plans for a flooding event.
- Flood depth signage on key roads affected by flooding.
- List of road closures and roads recently opened on website/social media page during flood events
- Section 10.7 certificates to inform property owners about flood risk to their properties
- Provide flood mapping on an interactive mapping portal on Council's website for easier viewing
- Promotion and support for SES information events
- Enhanced messaging on flood risk and flood preparedness on Council's floodplain management webpage particularly for overland flooding.
- Consult with operators of sensitive properties and occupants of dwellings affected by high flood hazard to provide information on the flood risk and promote the development of a flood management plan for the properties.

The program should be reviewed after each significant flood event.

4.2.4 Improved flood evacuation response and procedures

Flood evacuation is under the control of the SES and the SES needs to update the current evacuation planning based on information presented in this report, including flood depth and hazard mapping.

Recommendation

It is recommended that the SES updates the current emergency planning, such as development of a Local Flood Plan or update of the EMPLAN, based on information presented in this study.

4.2.5 Development of Flood Management Plans

A flood management plan is a document which outlines and discusses the measures to help manage the flood risk on a particular property, and its occupants and visitors to the site. The purposes of the plan are:

- To address existing, future and continuing flood risks on the site;
- To promote a satisfactory awareness of expected flood behaviour and risks;
- To identify measures to become flood prepared, and
- To recommend a course of action during and after flood events.

Flood management plans can be likened to a fire evacuation plan or a bushfire emergency plan and should be tailored specifically for a particular property. It outlines procedures for prior, during and after a flood event and the roles and responsibilities, generally of facility staff, in enacting the flood management plan. It may also describe evacuation routes and refuge places.

Several facilities are affected by very high to extreme (H5, up to H6) flood hazard in the PMF. Development of a flood management plan for the facilities should be considered to manage the flood risk to occupants. Council and SES should also consider encouraging and helping occupants of private dwellings to prepare their own flood management plans. Council should consult with the facility operators and occupants of dwellings subject to high flood hazard as a part of an overall flood education and awareness program for the study area and promote the development of a flood management plan for the properties.

As a part of the development of a flood management plan, evacuation from the site may be identified as a suitable option. This would require safe evacuation routes to be identified or otherwise new safe evacuation access installed (see Section 1.1.1). If sheltering-in-place in facility buildings is identified as a more suitable approach, an assessment of the structural stability of the buildings in the flood conditions should be undertaken.

Recommendation

Council should consult with high flood risk facilities and occupants of dwellings subject to high flood hazard regarding management of flood risk on the site. Development of a flood management plan for the site should be considered by the facility operators with the assistance of Council/SES.

5. Conclusions and Recommendations

5.1 Conclusions

Six selected structural options and combinations of options have been assessed in the TUFLOW hydraulic model for the North Brother local catchments. The options were selected by Council and the floodplain risk management committee from a long-list of options for 16 locations in the study area. The hydraulic performance, site constraints and improvements in flood damages have been confirmed for the selected options. The following options have high merit in terms of reductions in flood damages and improvements in flood hazard:

- Option 4A+4B+4C
- Option 6B+6C+6D+6E
- Option 9B.

Subsequent costing of these options in addition to cost benefit an multi-criteria analyses will confirm the economic feasibility and viability of these options.

In addition, a range of non-structural options have been evaluated for the study area. These include measures related to planning and policy, property modification and flood emergency management and response modification. Recommendations have been made in relation to these measures with consideration of the flood behaviour in the study area.

5.2 Recommendations

- Council and the committee are to review and consider the findings on the hydraulic and damages assessment for the selected options. Feedback is sought on the assessment, including any refinements to the options.
- Consultation with stakeholders, landowners and community is to be undertaken on the short-listed options.
- The hydraulic modelling will be subsequently updated based on proposed refinements to the options following Council/committee and stakeholder consultation. The flood damages will be updated, and costing of options undertaken for input into a cost-benefit analysis. A multi-criteria analysis will also be undertaken to consider other aspects of the options.
- A floodplain risk management study and plan will be formed based on the subsequent outcomes, for community consultation and approval by Council.

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7. Glossary

Annual Exceedance Probability (AEP)

The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. It is to be noted that design rainfalls used in the estimation of design floods up to and including 100 year ARI (ie. 1% AEP) events was derived from 1987 Australian Rainfall and Runoff. The following relationships between AEP and ARI applies to this study (AR&R, 2016).

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very frequent	**12**			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.50
	1	**63.2**	1.58	1.00
Frequent	0.69	**50.00**	2	1.44
	0.5	39.35	2.54	2.00
	0.22	**20.00**	5	4.48
	0.2	18.13	5.52	5.00
	0.11	**10.00**	10.00	9.49
Infrequent	0.05	**5.00**	20	20.0
	0.02	**2.00**	50	50.0
	0.01	**1.00**	**100**	100
Rare	0.005	0.50	**200**	200
	0.002	0.20	**500**	500
	0.001	0.10	**1000**	1000
	0.0005	0.05	**2000**	2000
Extremely Rare	0.0002	0.02	5000	5000
			↓	
Extreme			PMP	

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Average Annual Damage (AAD)

Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would

	occur in a nominated development situation from flooding over a very long period of time.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrences of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
DRAINS	DRAINS is a computer program which is used to simulate local catchment rainfall-runoff and stormwater system hydraulics and is widely used across Australia.
Development	Is defined in Part 4 of the EP&A Act In fill development: refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. New development: refers to development of a completely different nature to that associated with the former land use. Eg. The urban subdivision of an area previously used for rural purposes. New developments involve re-zoning and typically require major extensions of exiting urban services, such as roads, water supply, sewerage and electric power. Redevelopment: refers to rebuilding in an area. Eg. As urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either re-zoning or major extensions to urban services.
Effective Warning Time	The time available after receiving advise of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
Exceedances per Year (EY)	The number of times an event is likely to occur or be exceeded within any given year.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.

Flood liable land	Is synonymous with flood prone land (i.e.) land susceptibility to flooding by the PMF event. Note that the term flooding liable land covers the whole floodplain, not just that part below the FPL (see flood planning area)
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
Floodplain risk management options	The measures that might be feasible for the management of particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
Floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually include both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defines objectives.
Flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, division and local levels. Local flood plans are prepared under the leadership of the SES.
Flood planning levels (FPLs)	Are the combination of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "designated flood" or the “flood standard” used in earlier studies.
Flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings and structures subject to flooding, to reduce or eliminate flood damages.
Flood readiness	Readiness is an ability to react within the effective warning time.
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the

	severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
m AHD	Metres Australian Height Datum (AHD)
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m^3/s	Cubic metres per second or "cumecs". A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Modification measures	Measures that modify either the flood, the property or the response to flooding.
Overland flow path	The path that floodwaters can follow as they are conveyed towards the main flow channel or if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation couplet with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of

	consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Stage	Equivalent to water level (both measured with reference to a specified datum)
TUFLOW	TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation. It provides coupled 1D and 2D hydraulic solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia.

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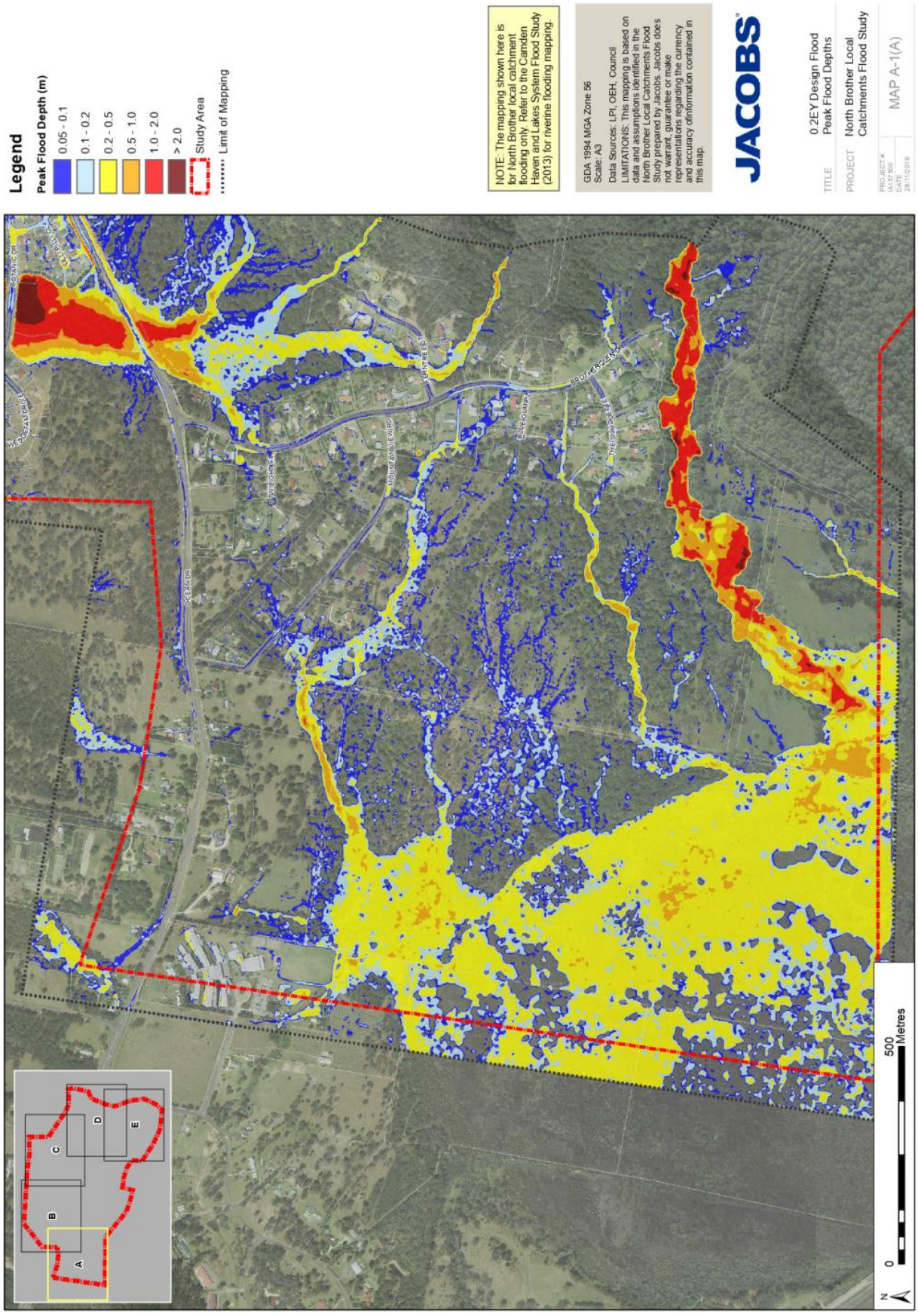
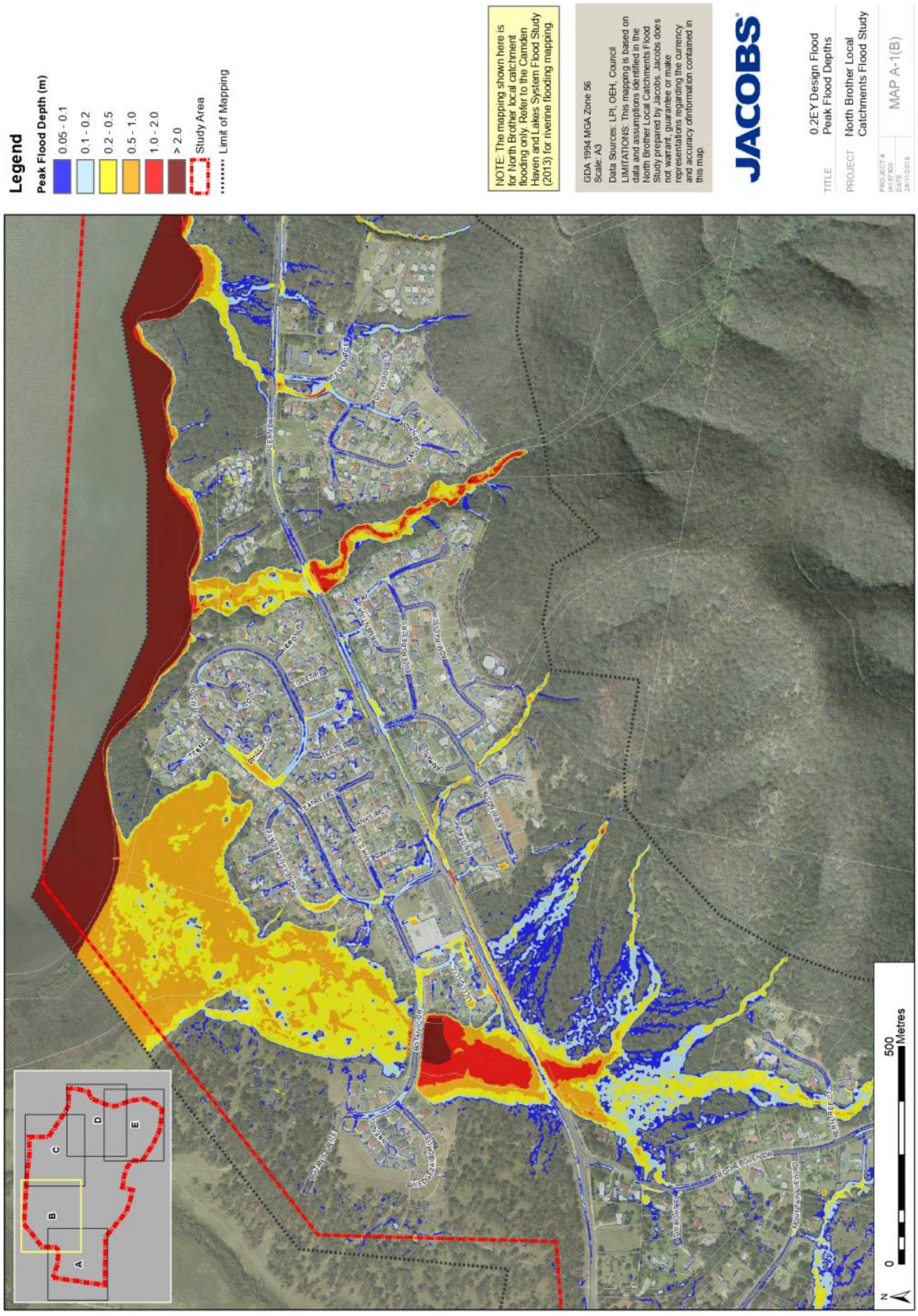
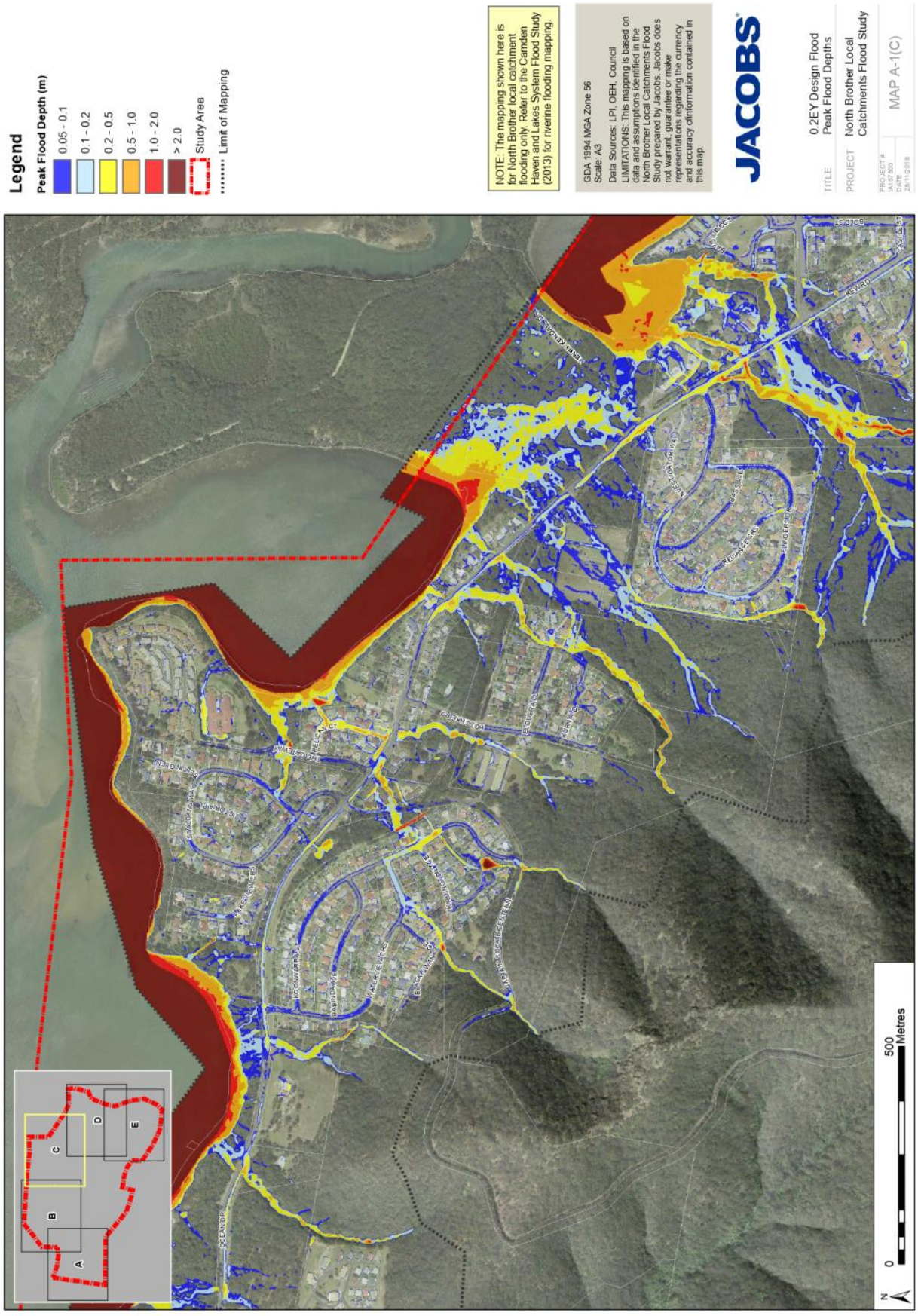
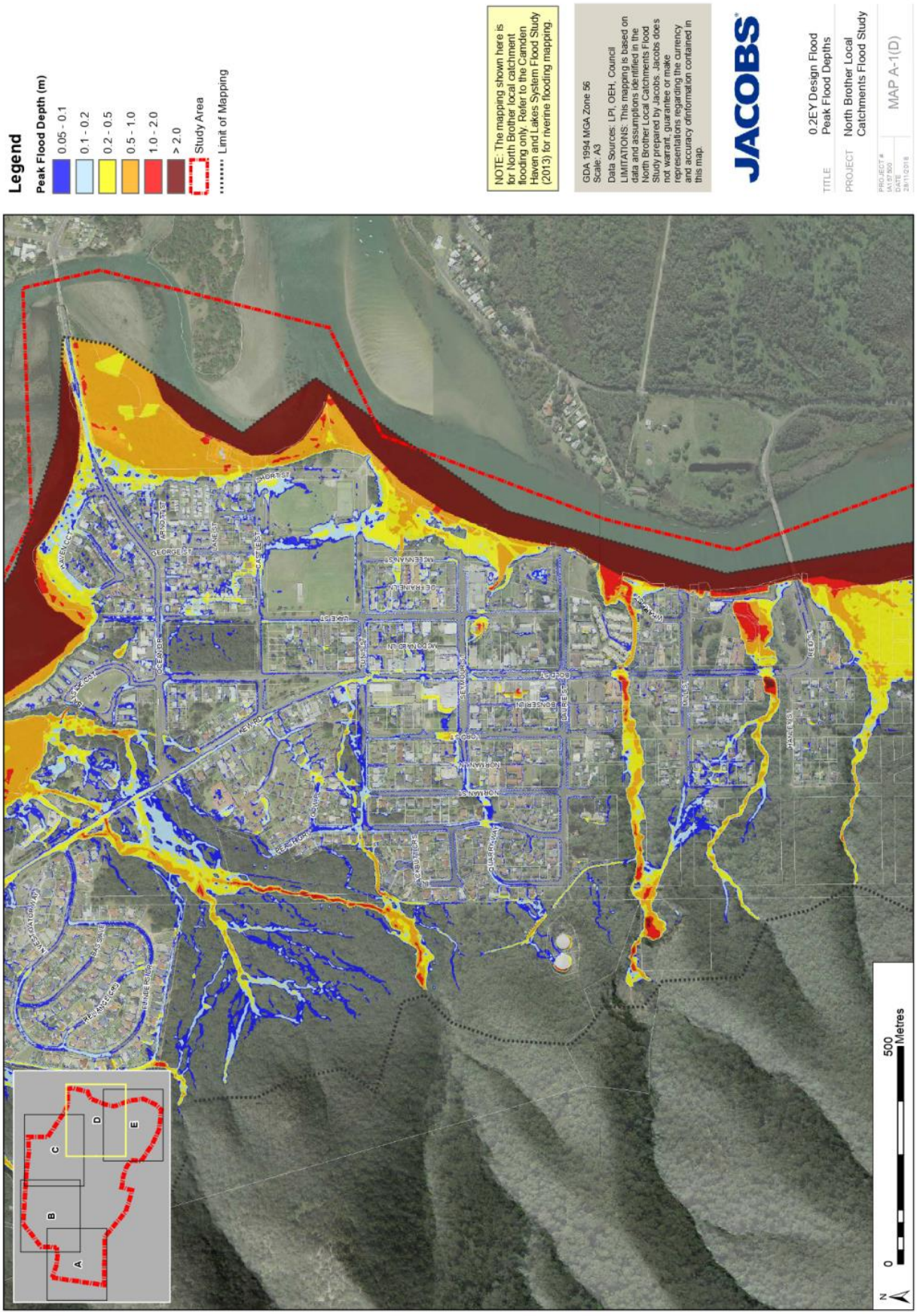
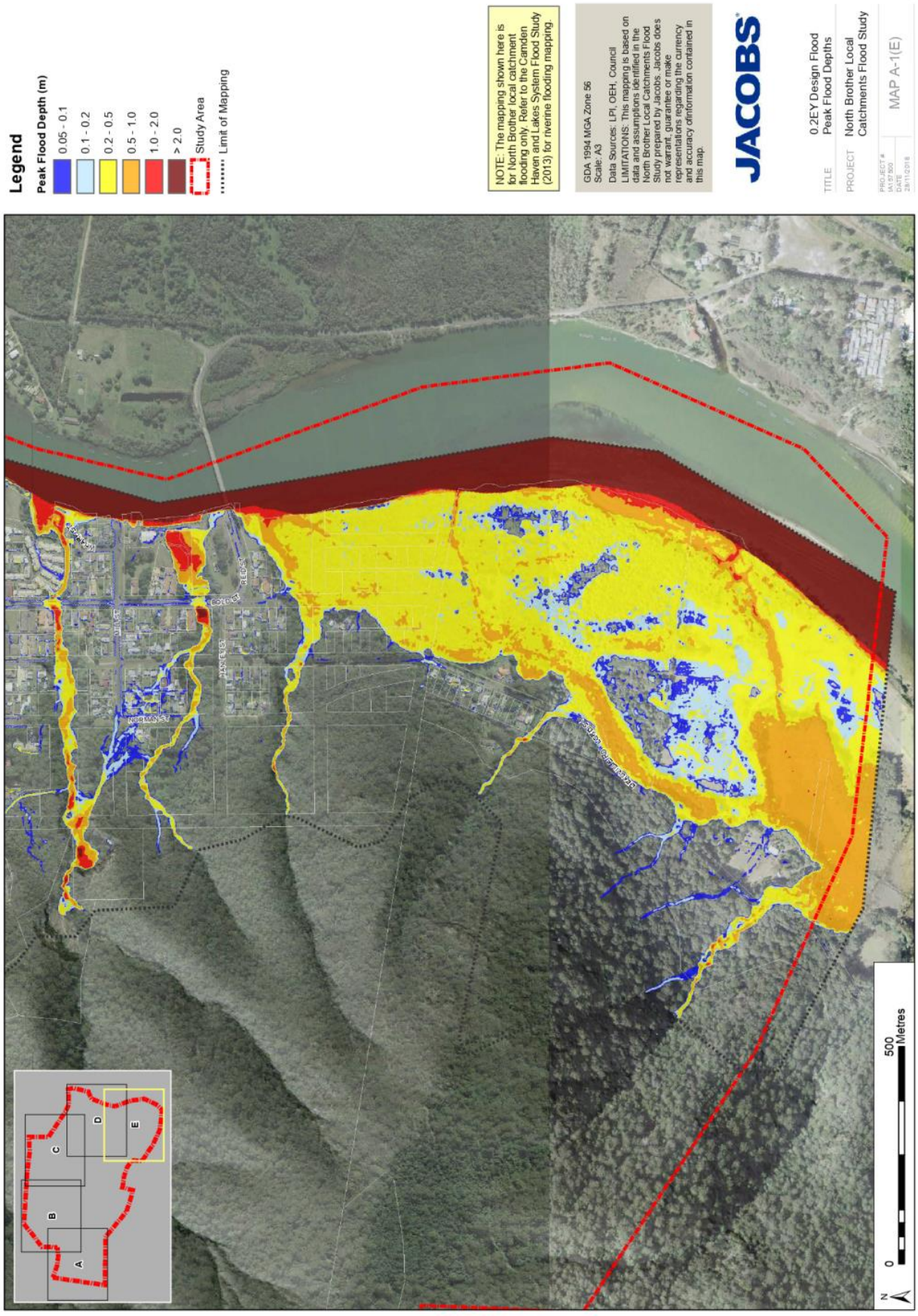
Appendix A. Flood Mapping

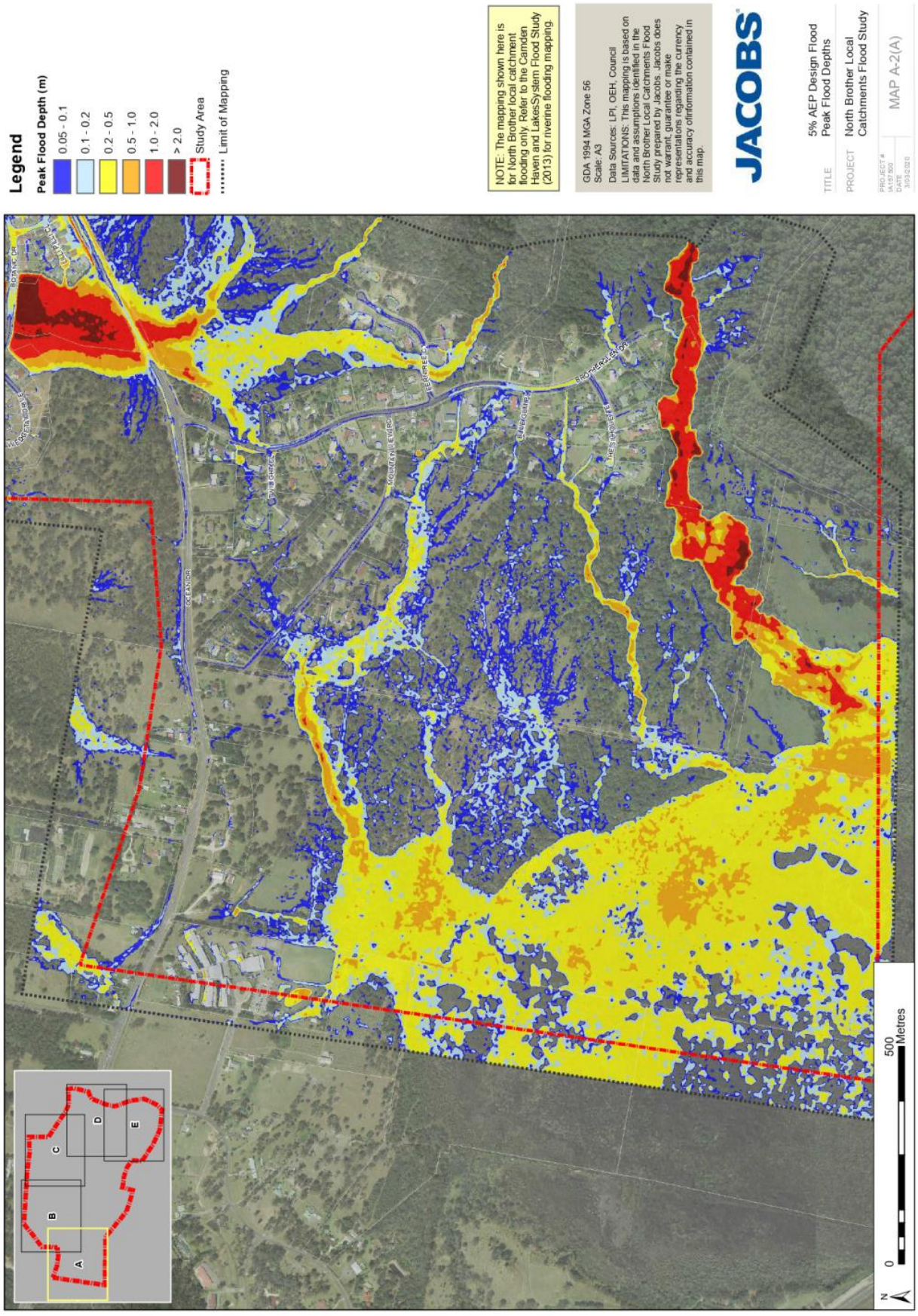

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 0.2EY Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-1(A)
500 Metres
0
N
A
B
C
D
E

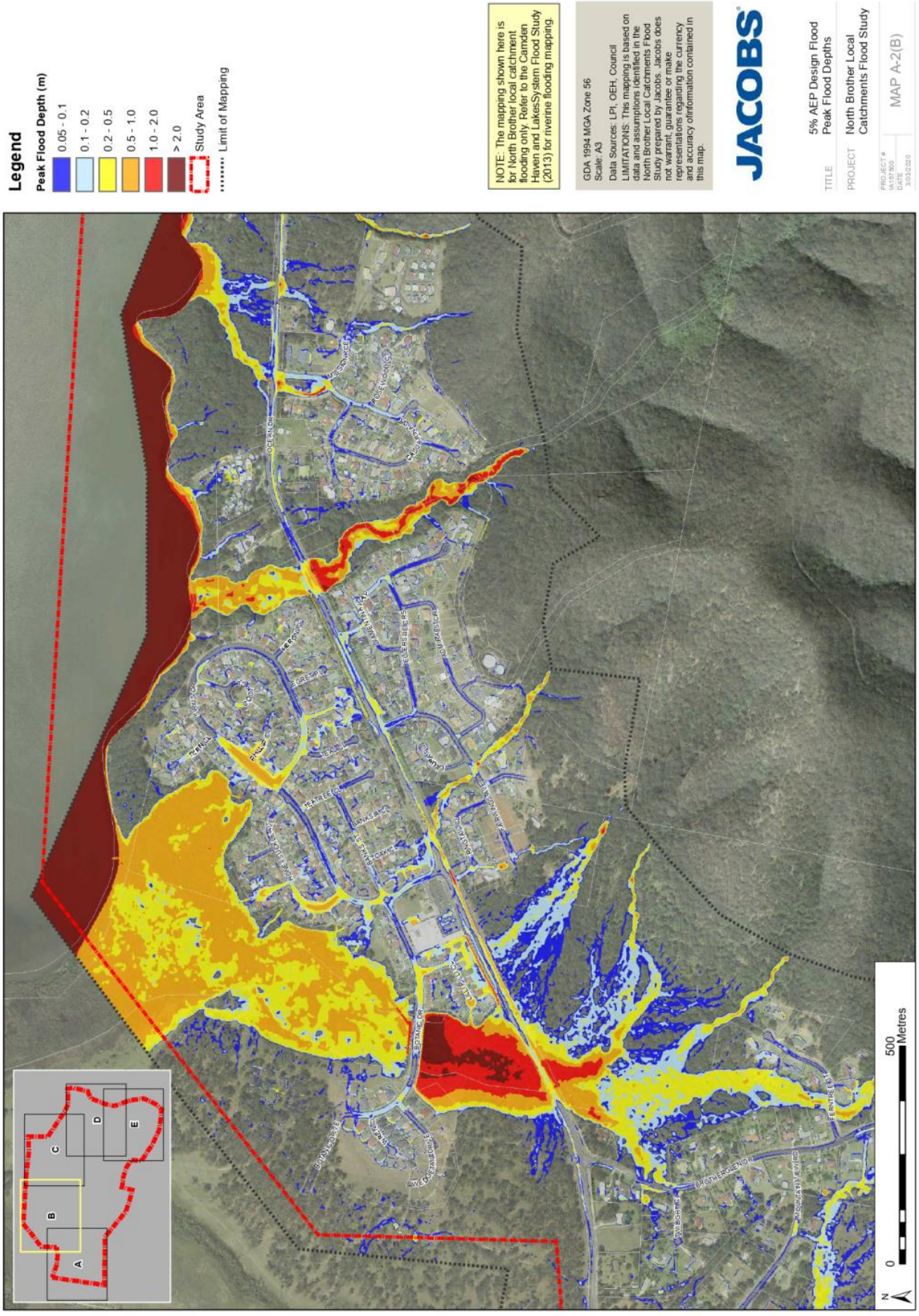

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE 0.2EY Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-1(B)
A
B
C
D
E
0
500
Metres
N

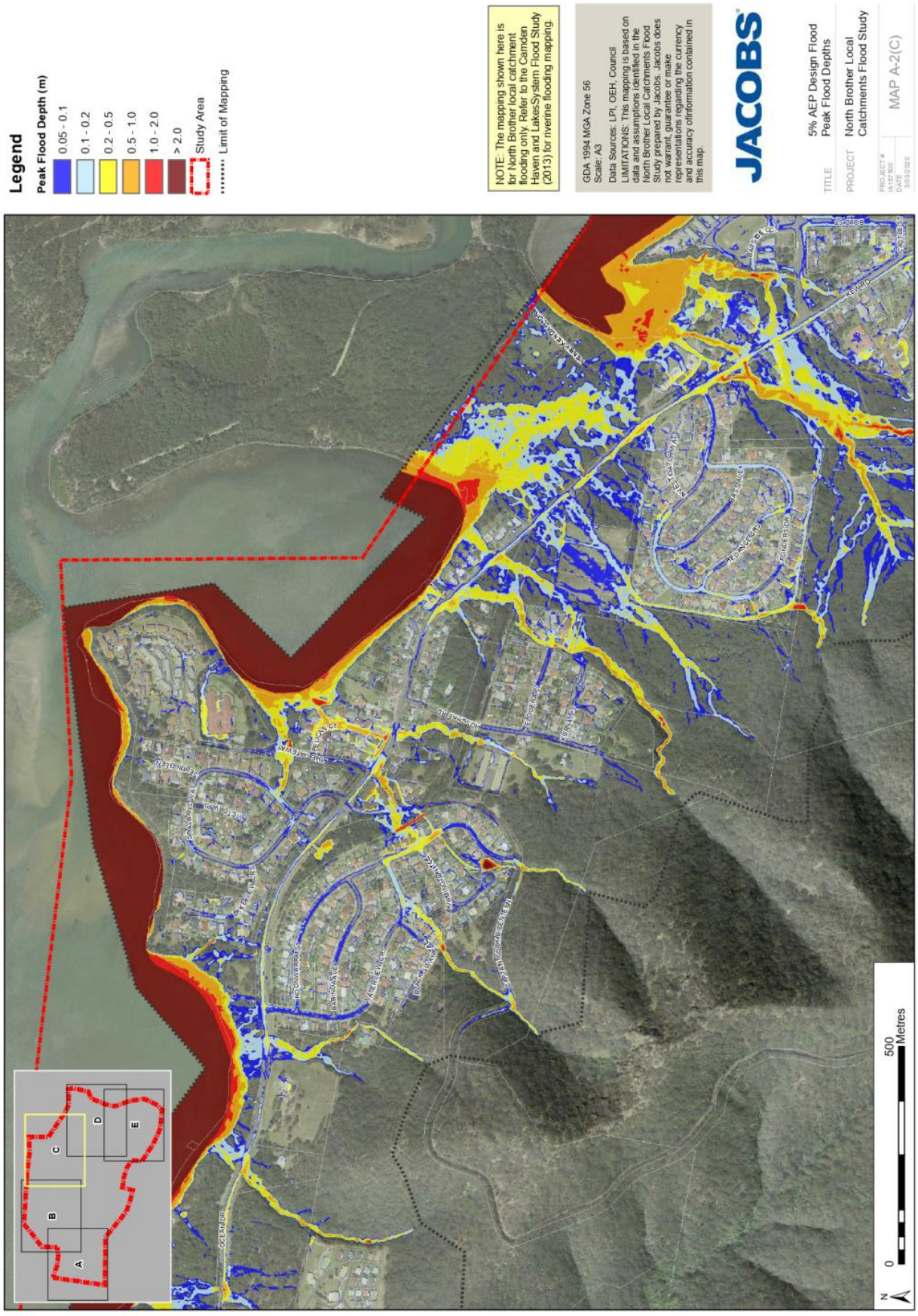

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 0.2EY Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-1(C)
0
500
Metres
N
A
B
C
D
E


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE 0.2EY Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-1(D)
500 Metres
0
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 0.2EY Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-1(E)
500 Metres
0
N
A
B
C
D
E


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 5% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-2(A)
OCEANOR
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 5% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-2(B)
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
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Data Sources: LPI, OEH, Council
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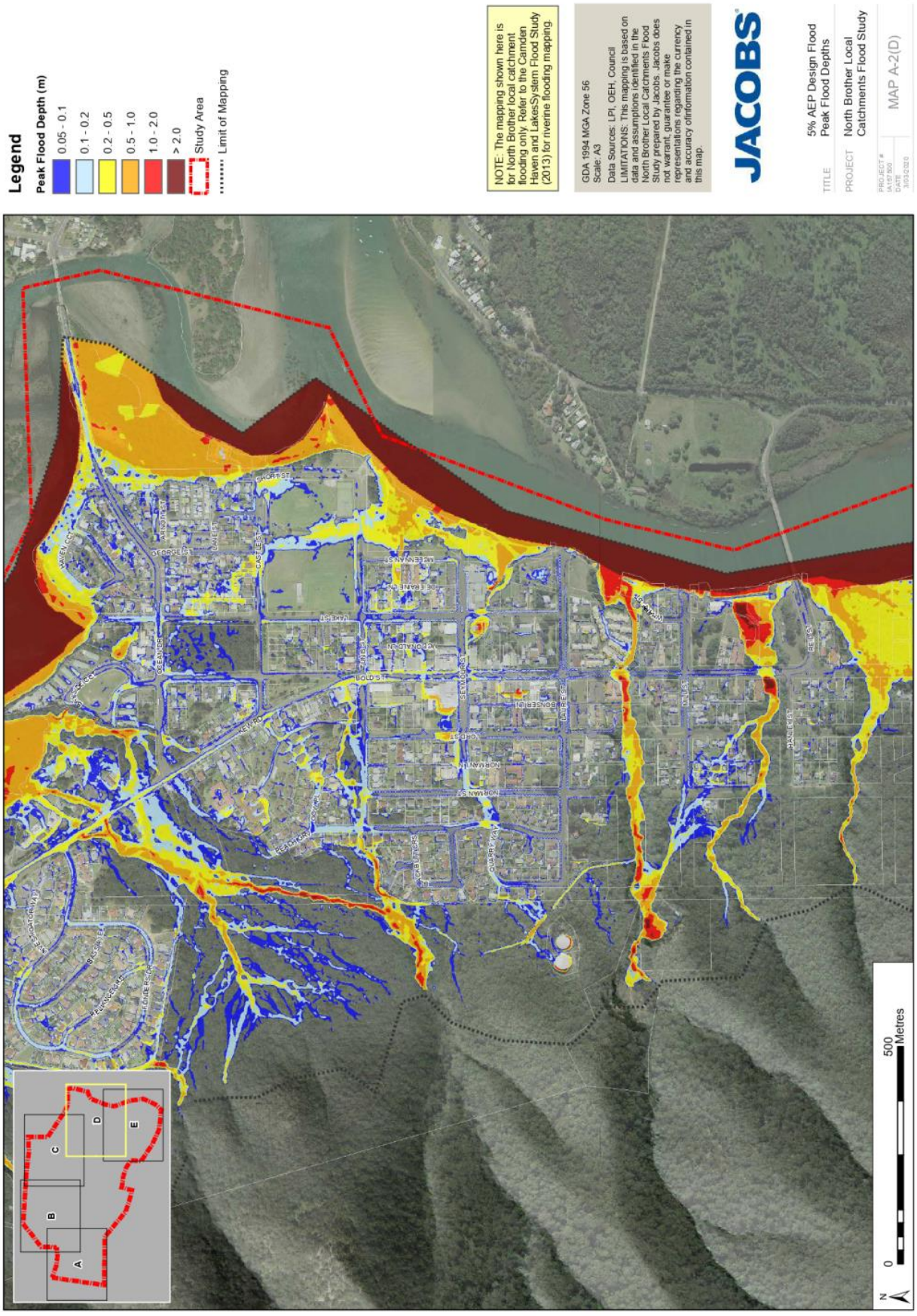
JACOBS
TITLE 5% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-2(C)
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
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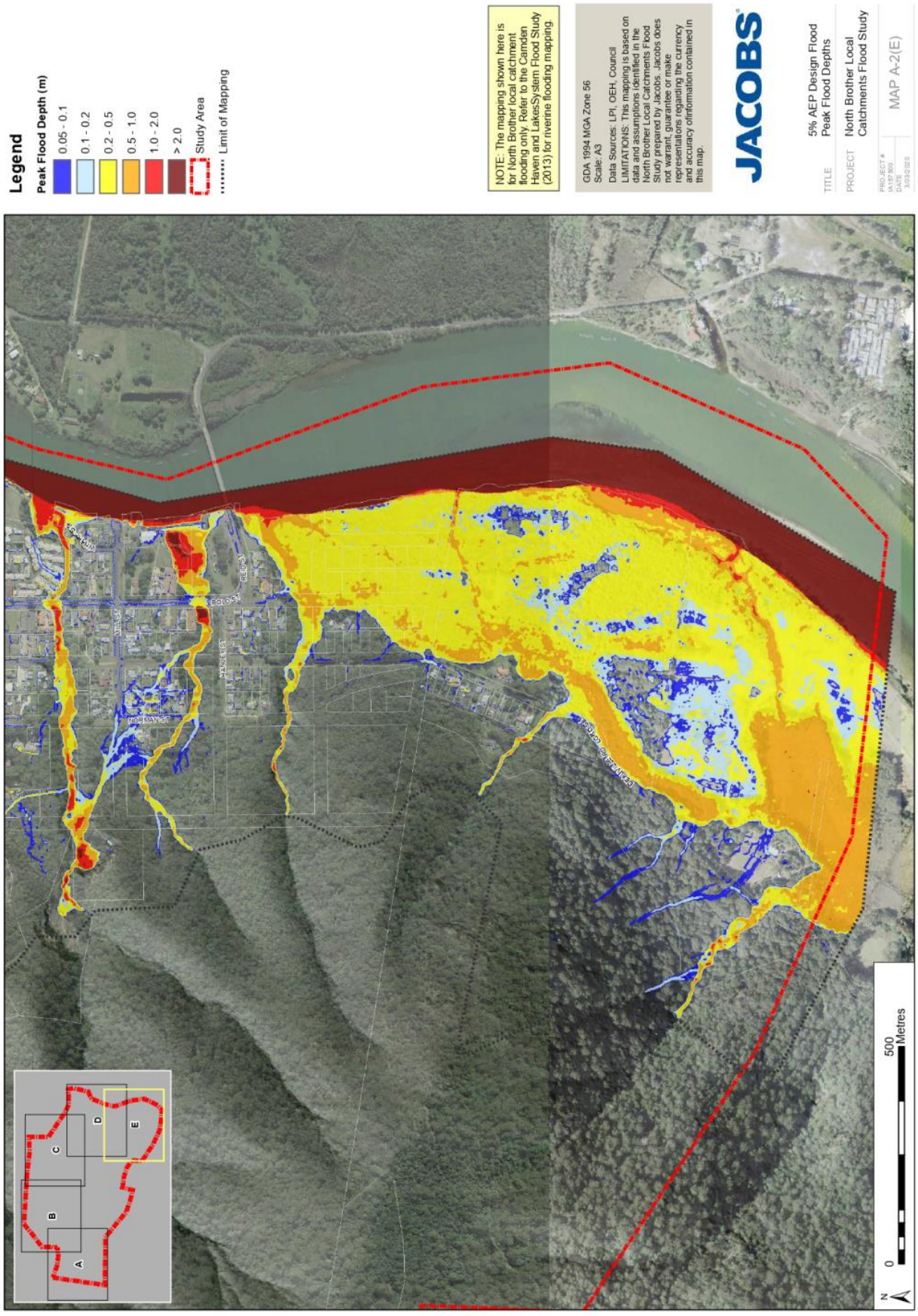
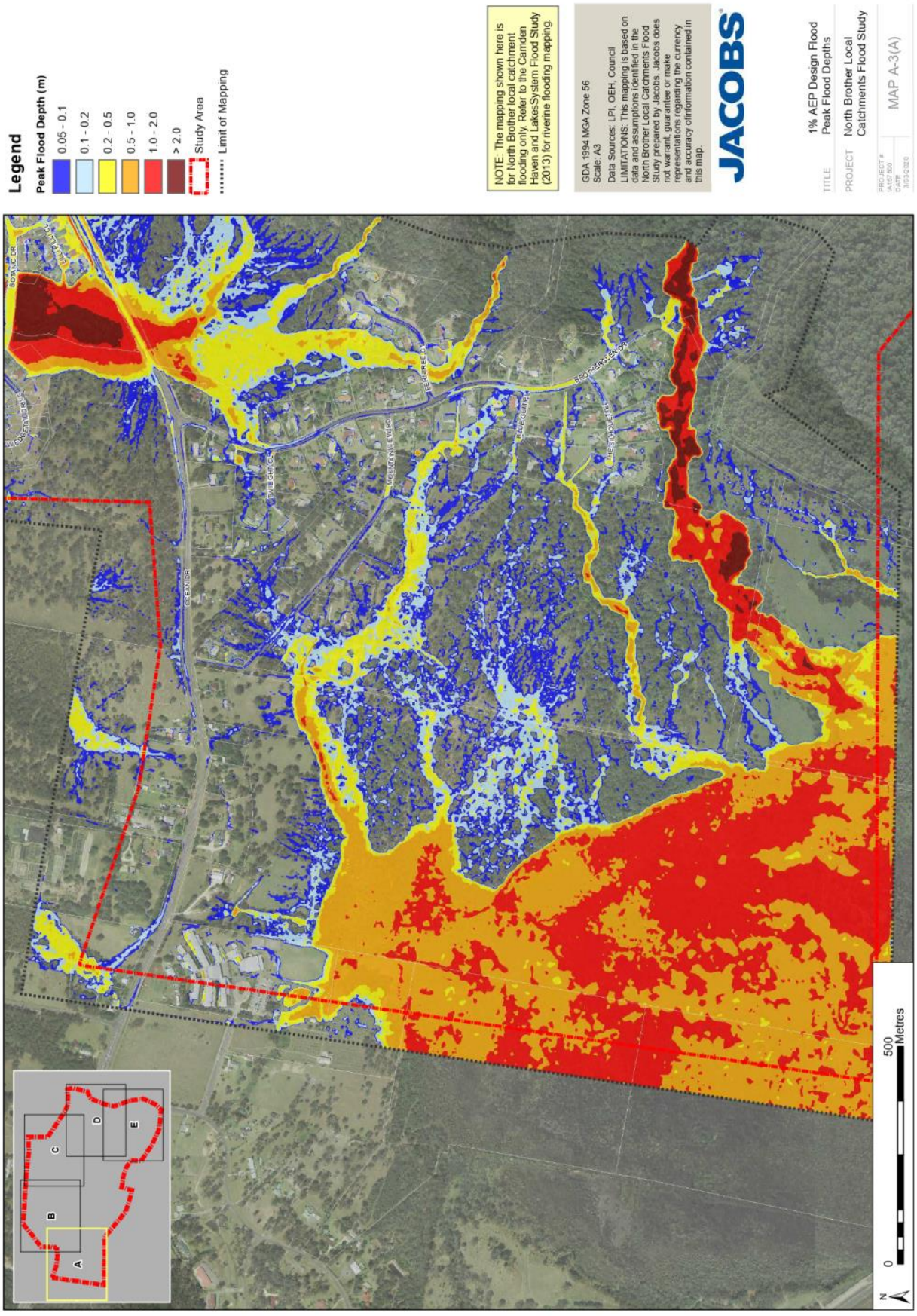
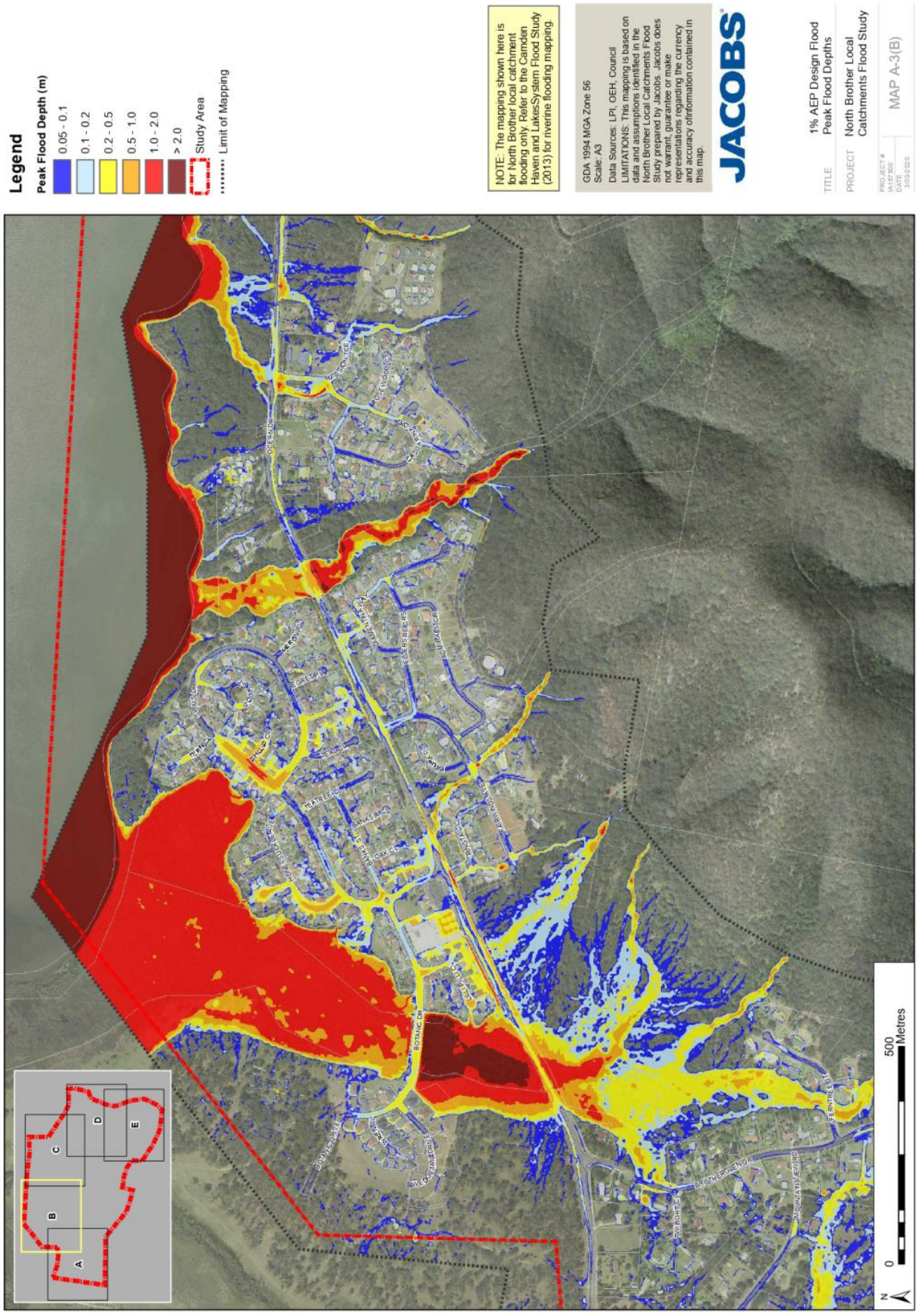
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 5% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-2(D)
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 5% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-2(E)
500
Metres
0
N
A
B
C
D
E


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-3(A)
500 Metres
0
N
A
B
C
D
E


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
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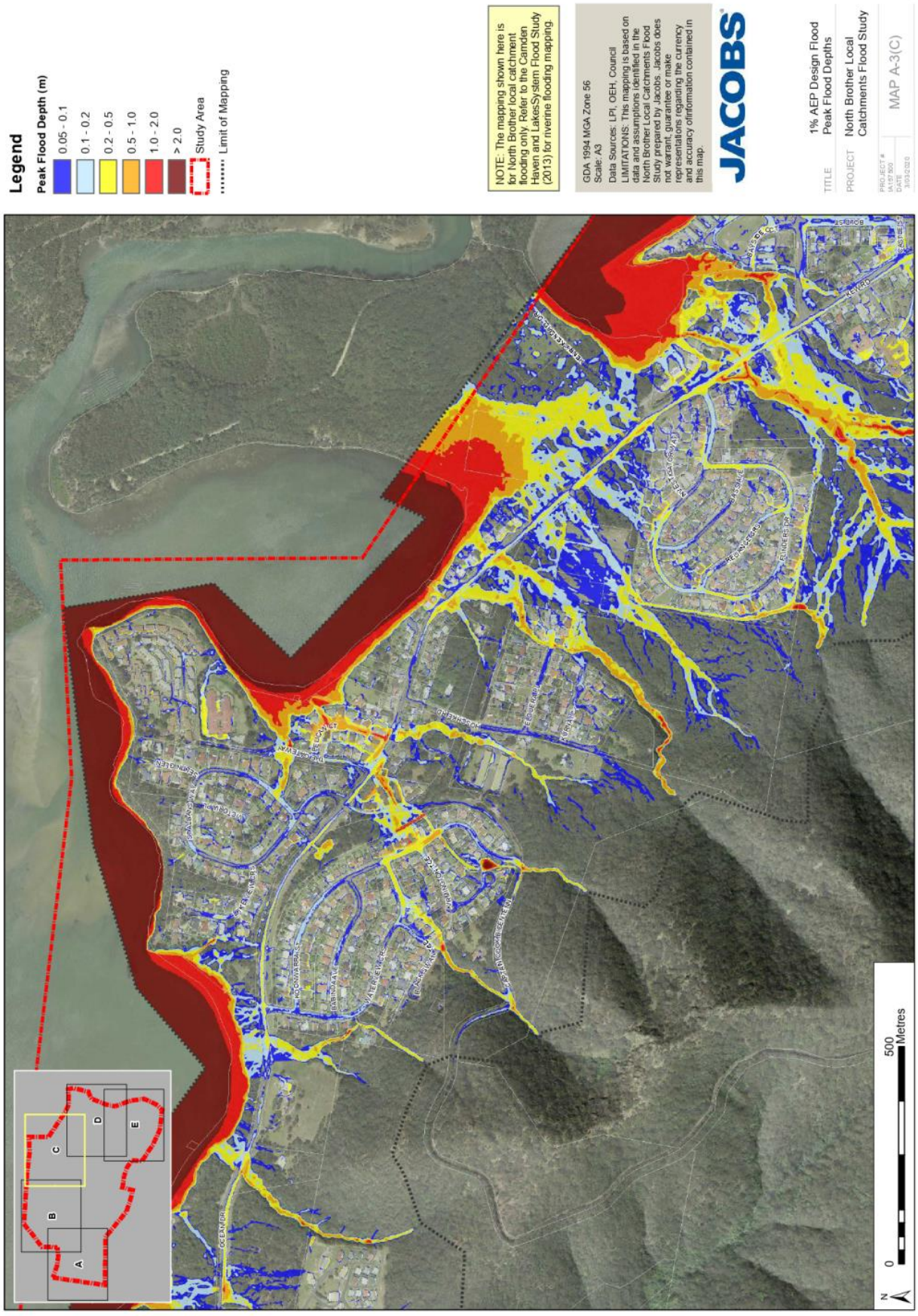
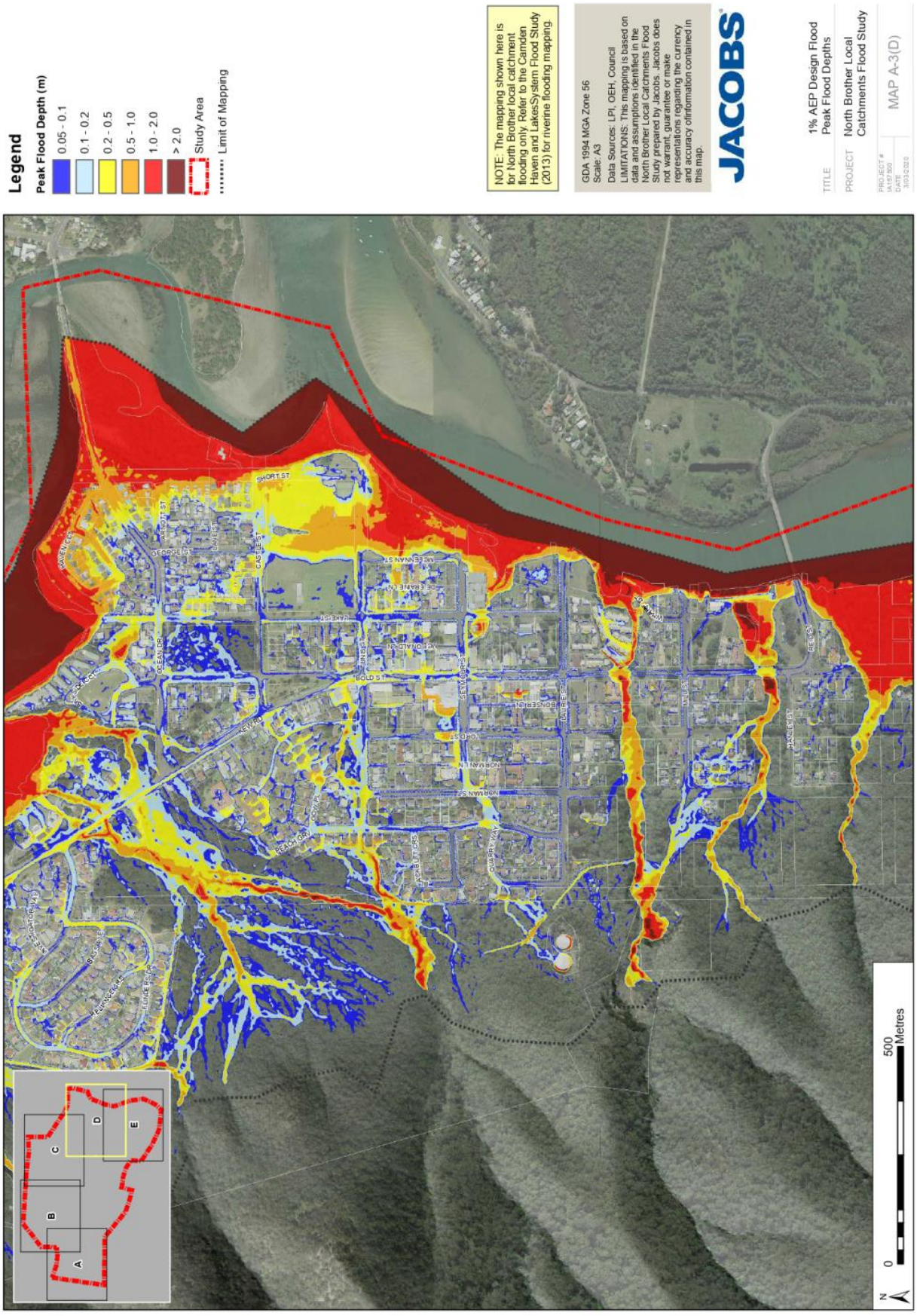
JACOBS
TITLE 1% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-3(B)
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-3(C)
A
B
C
D
E
0
500
Metres
N


Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
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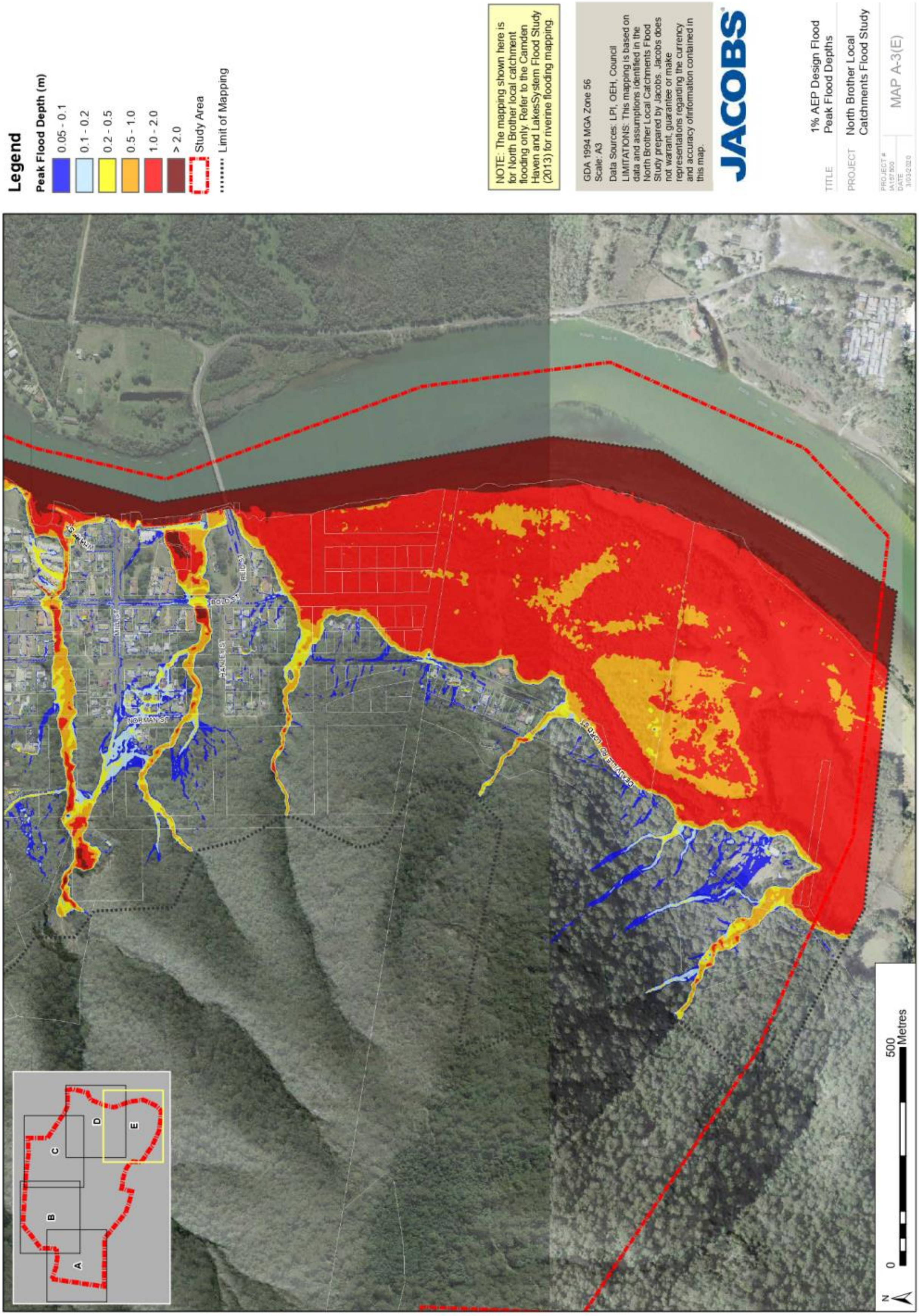
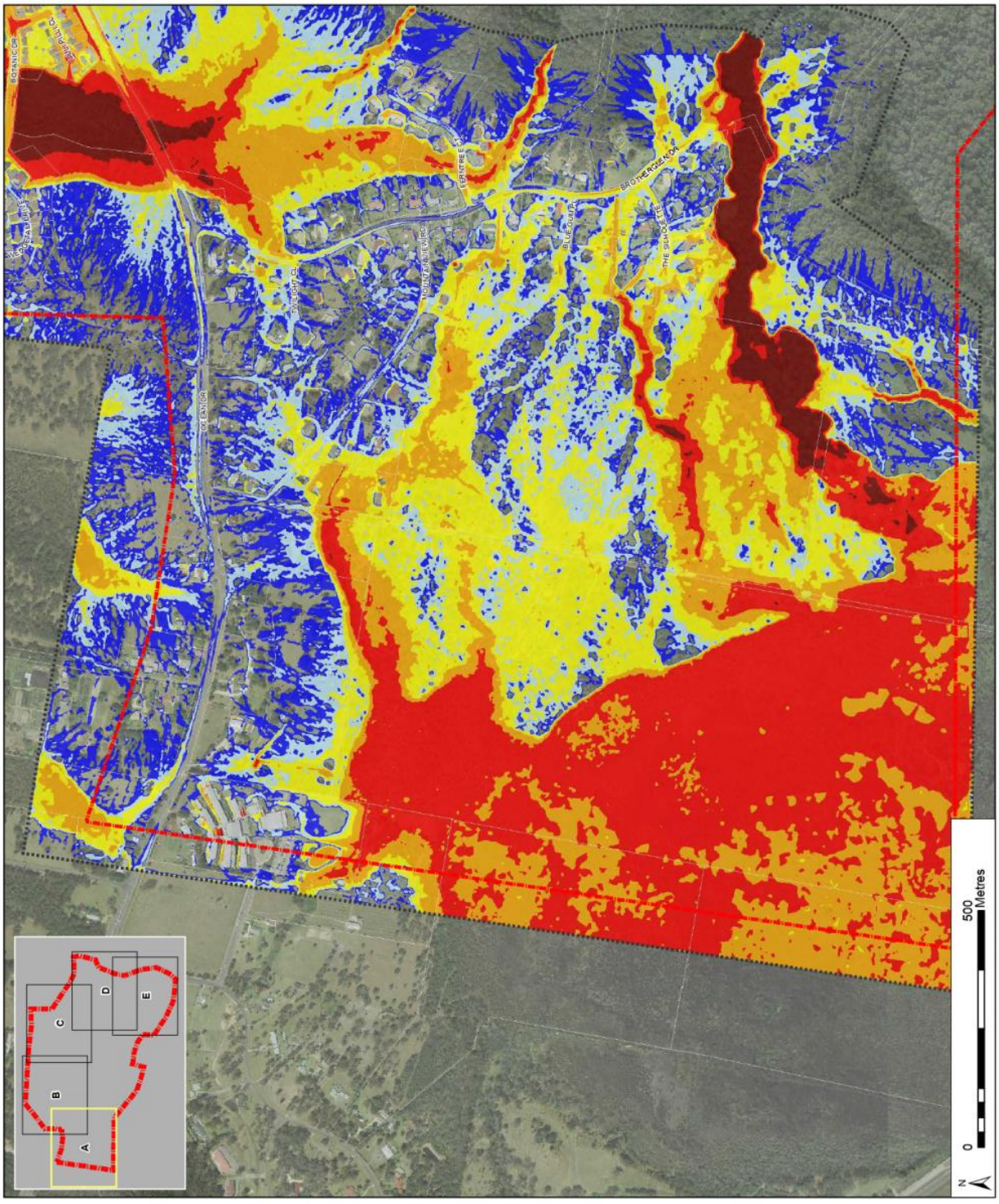
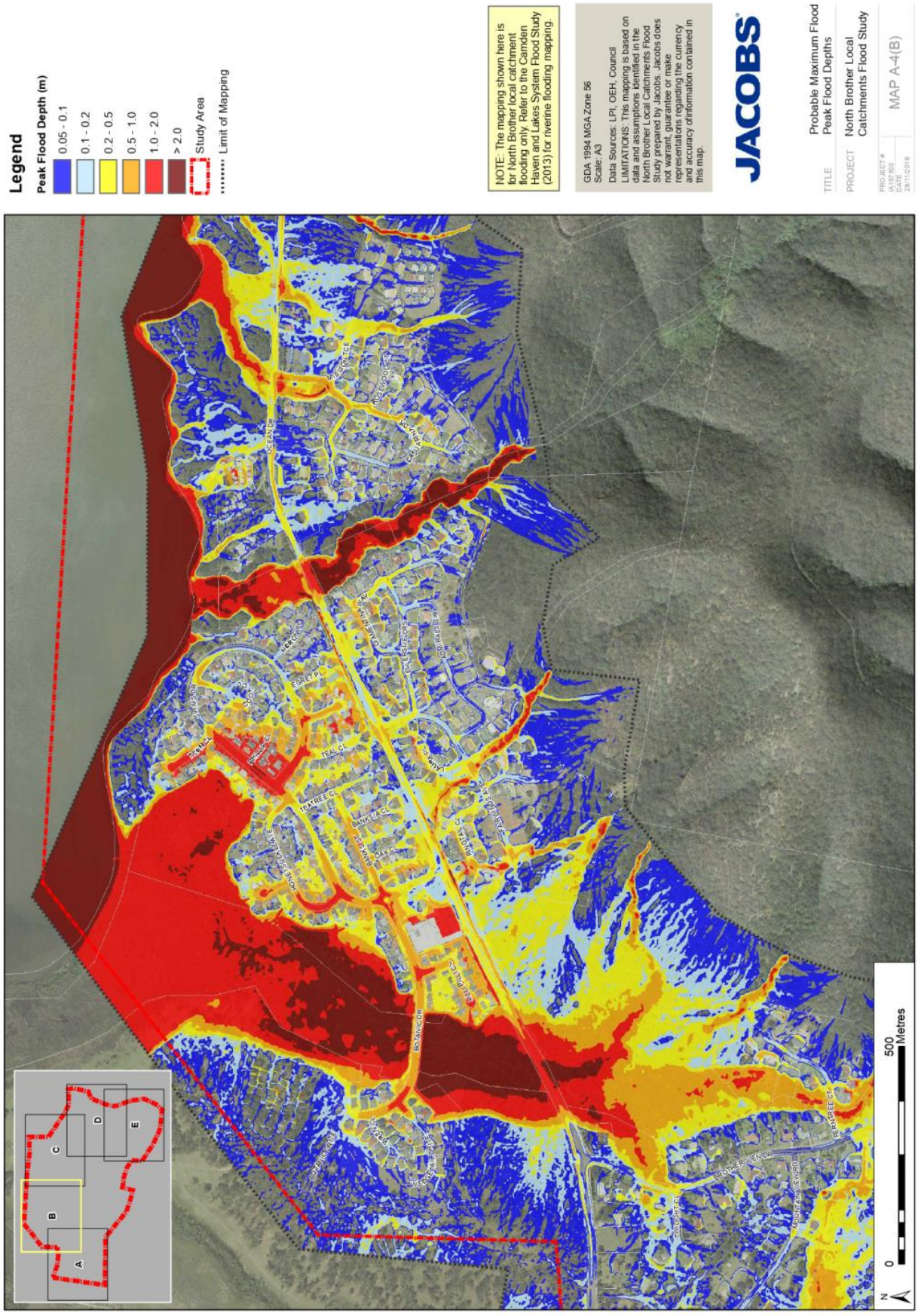
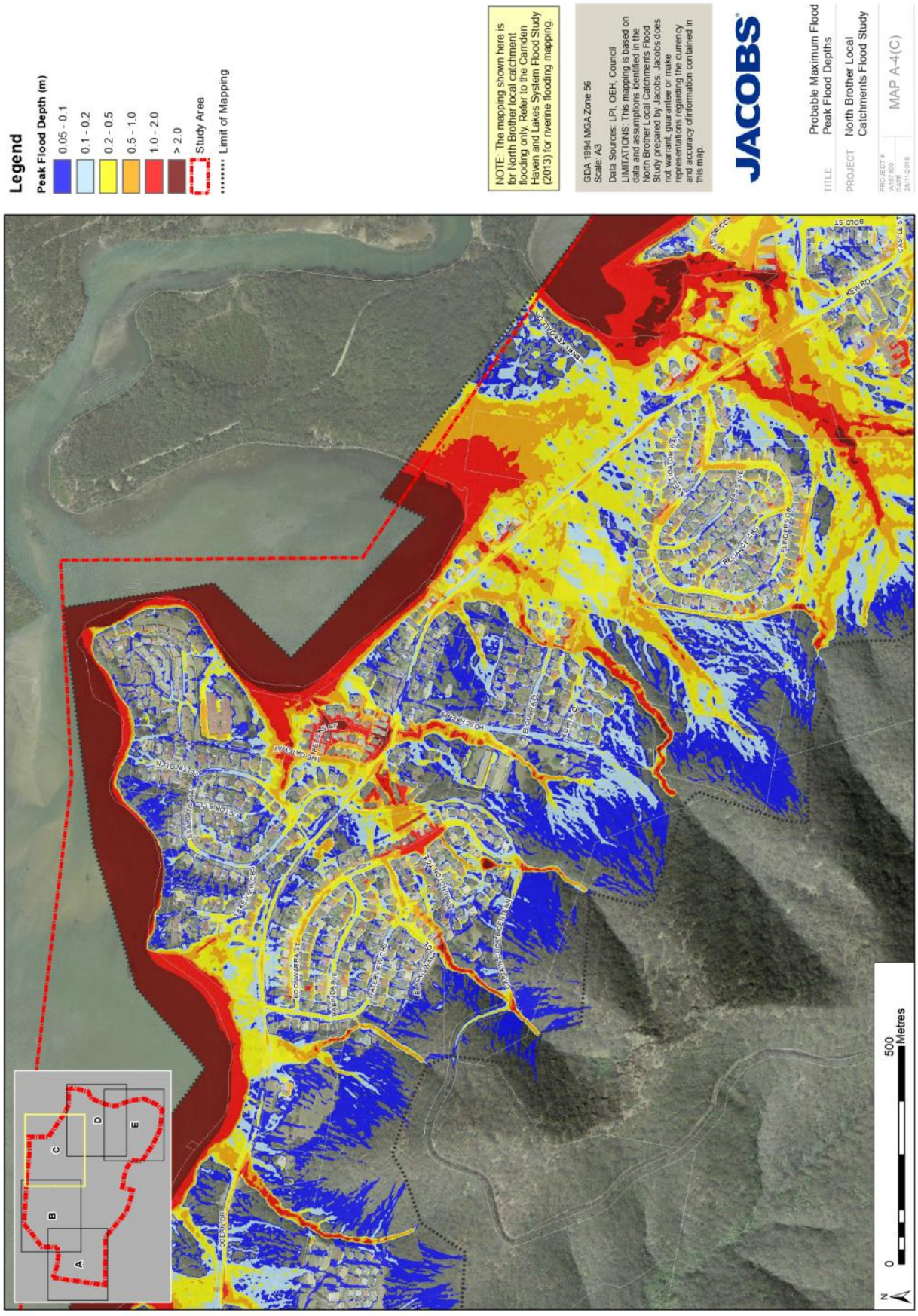
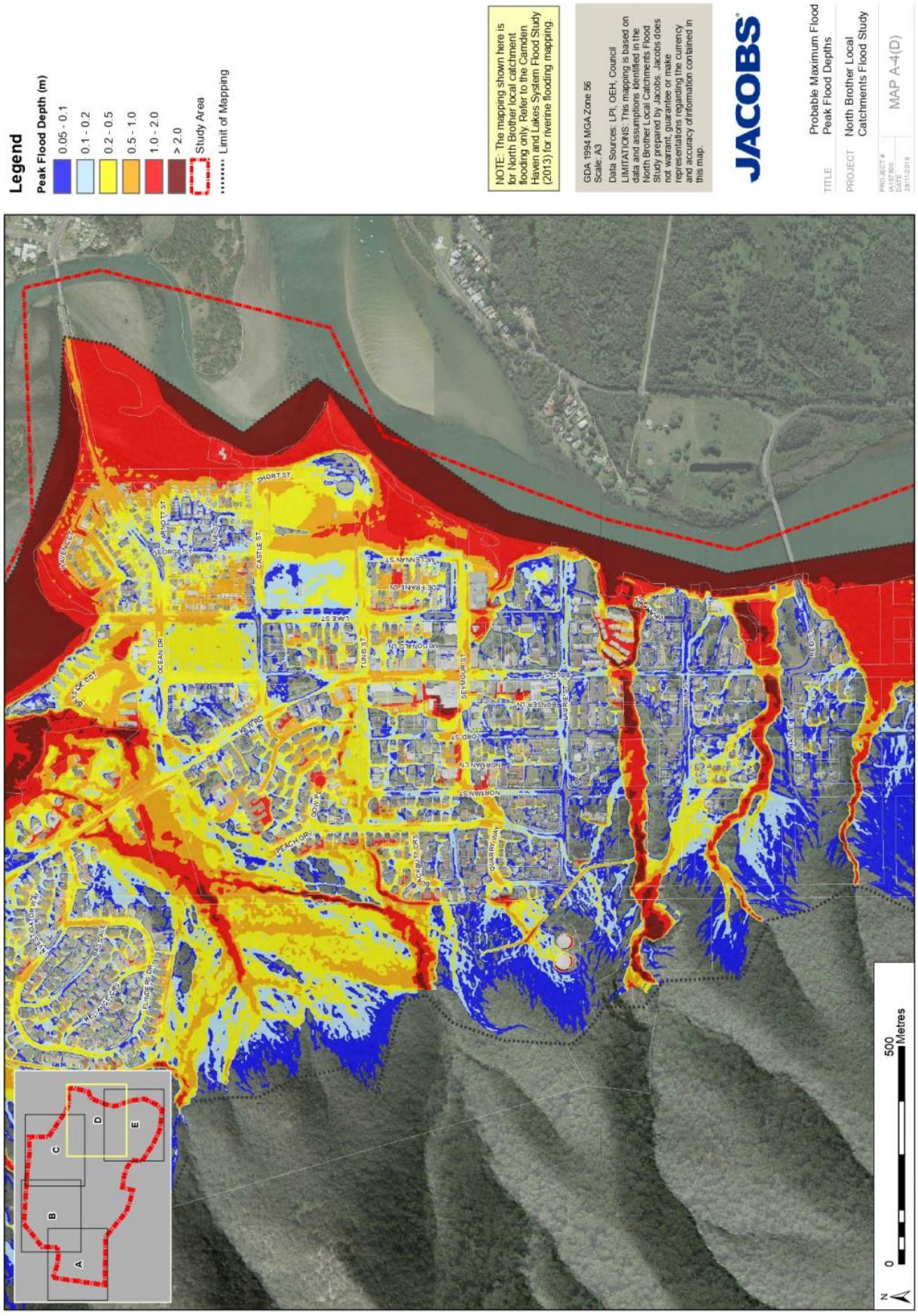
JACOBS
TITLE 1% AEP Design Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-3(D)
500 Metres
0
N
A
B
C
D
E

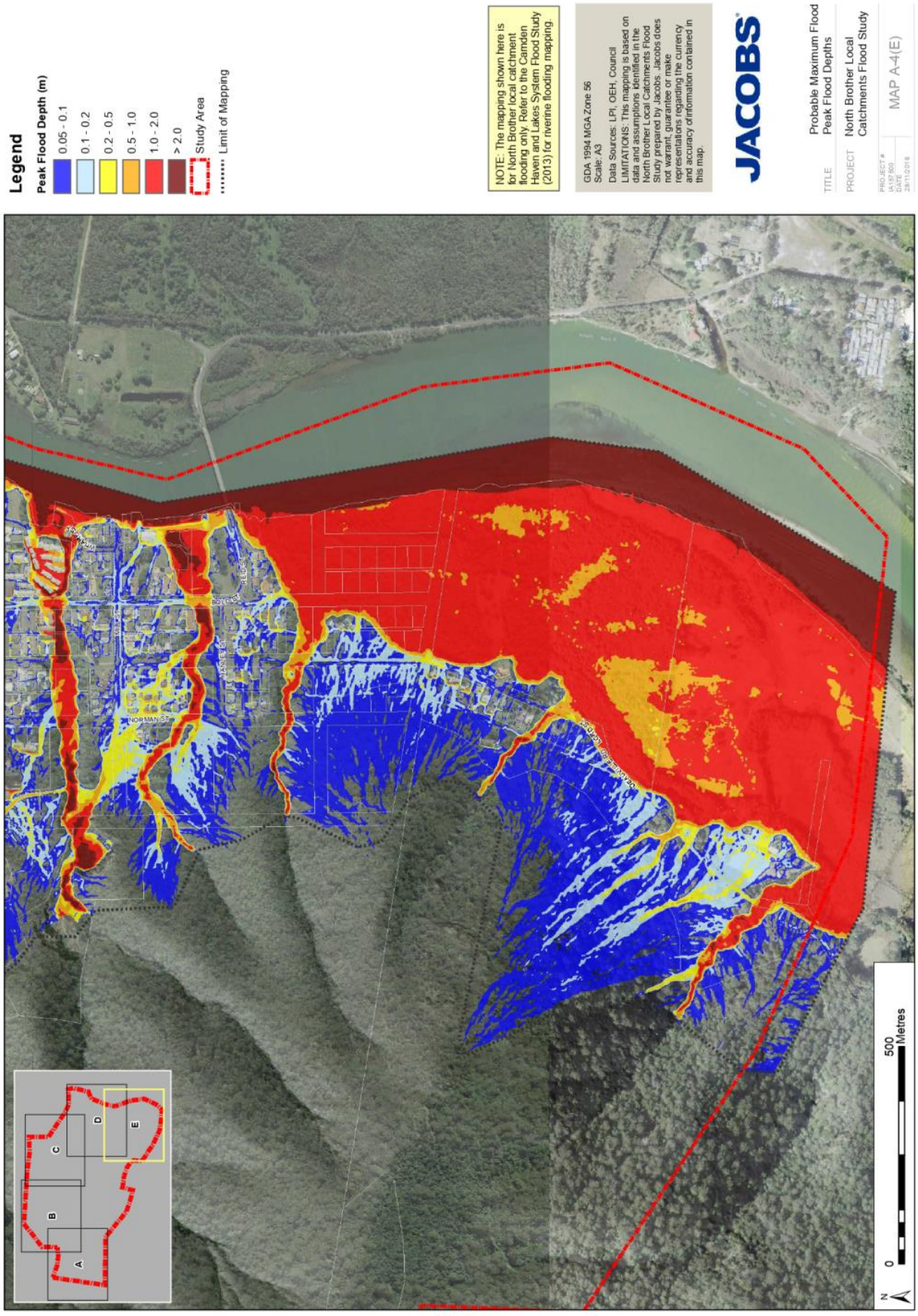

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
TITLE
1% AEP Design Flood Peak Flood Depths
PROJECT
North Brother Local Catchments Flood Study
MAP A-3(E)
0
500 Metres
N

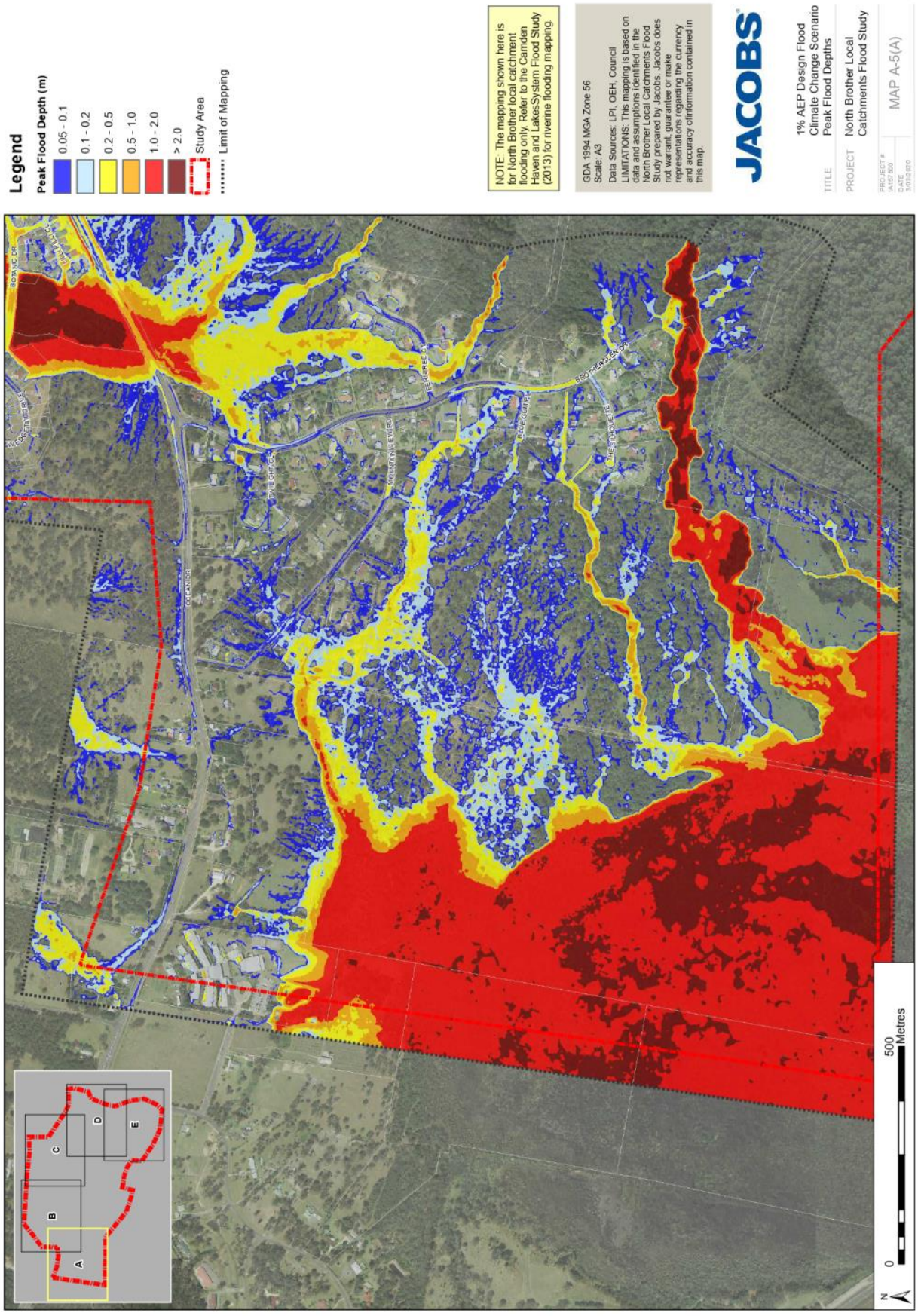

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE Probable Maximum Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-4(A)
A
B
C
D
E
0
500
Metres
N

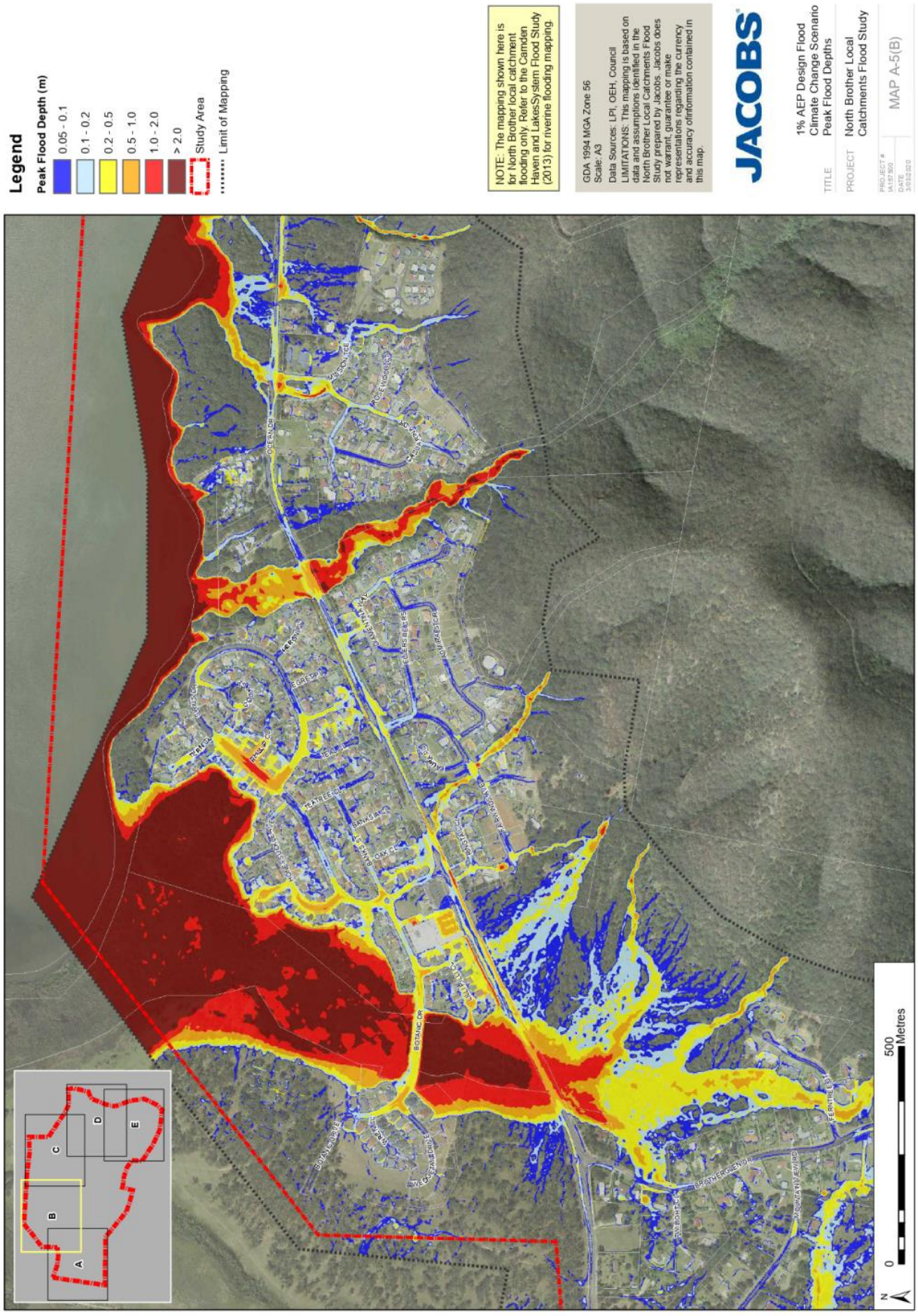

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE Probable Maximum Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-4(B)
A
B
C
D
E
0
500
Metres
N

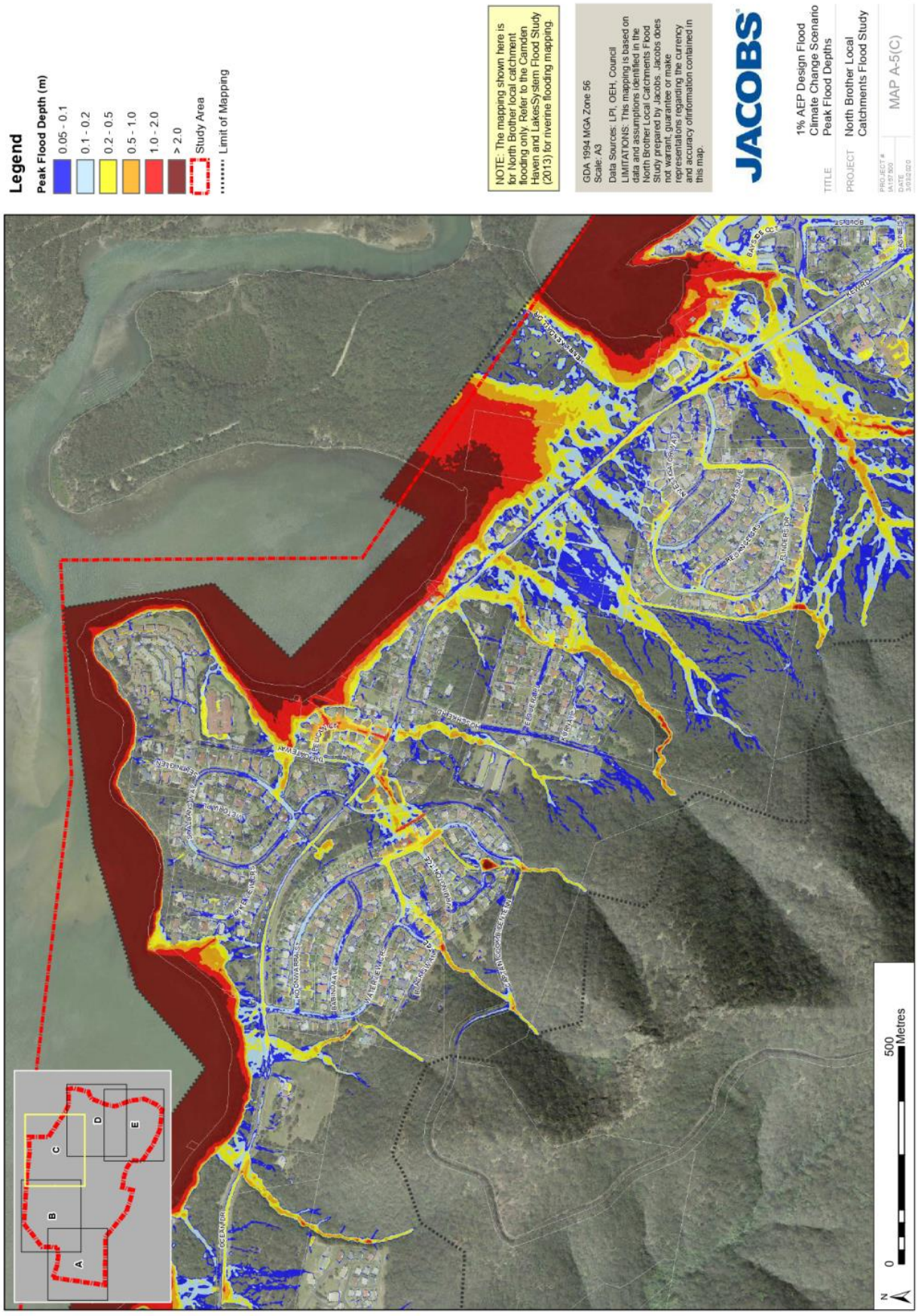

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE Probable Maximum Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-4(C)
A
B
C
D
E
0
500
Metres
N

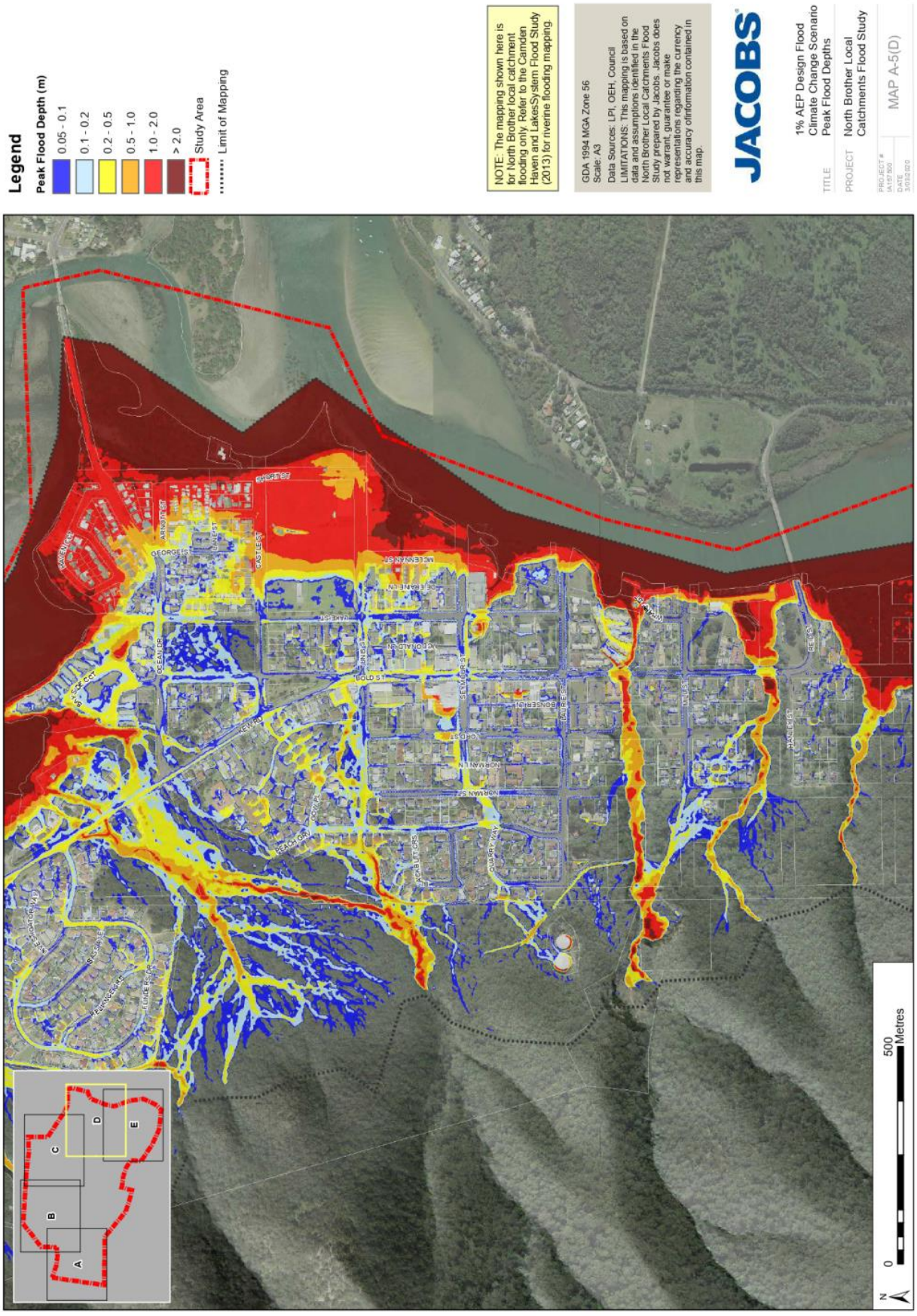

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE Probable Maximum Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-4(D)
500
Metres
0
N
SHORT ST
CASTLE ST
OCEAN DR
LAKE ST
TUNIS ST
SEYMOUR ST
NORMAN ST
LAUREL ST
PEACH DR
QUARRY WAY
A
B
C
D
E

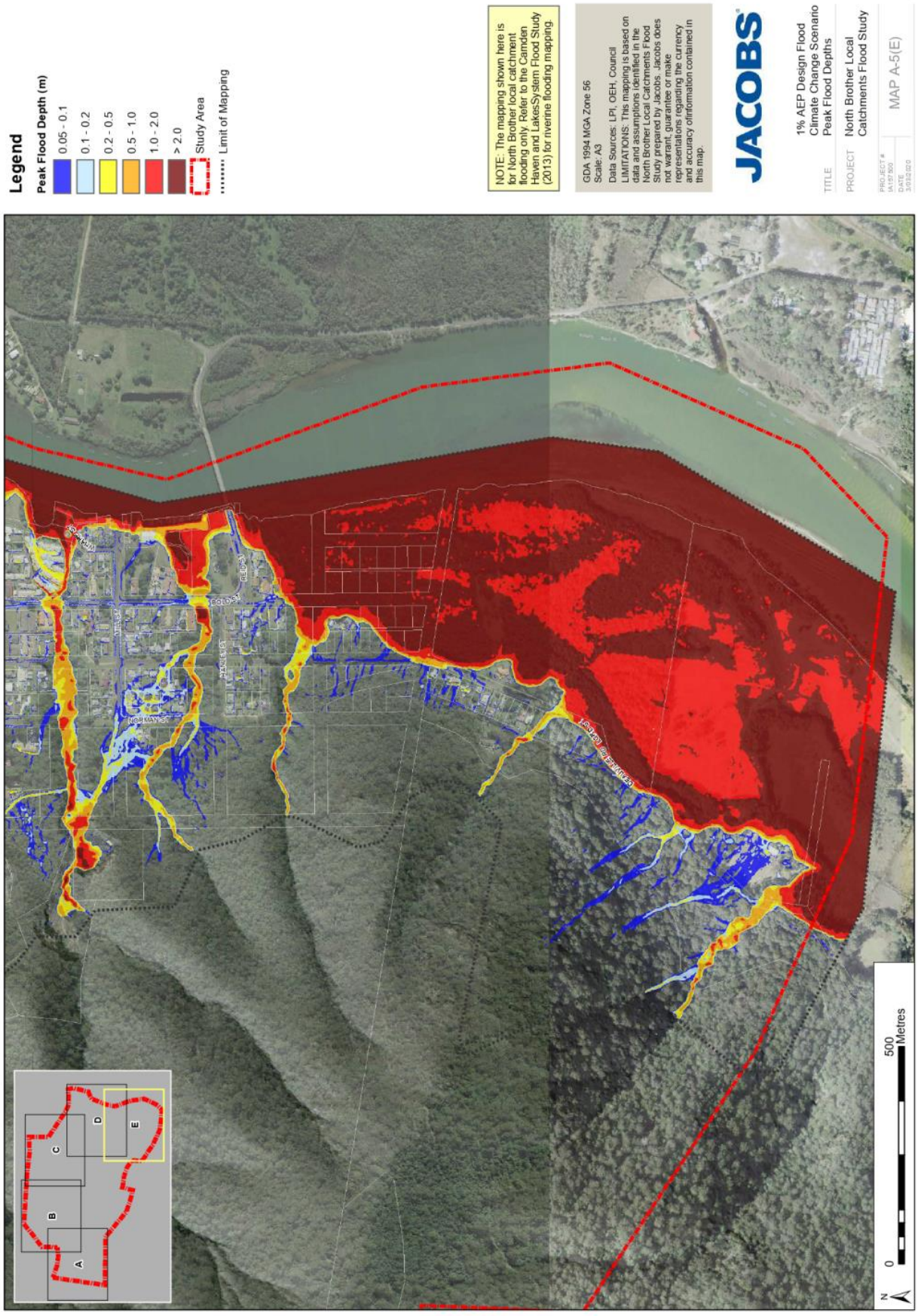

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE Probable Maximum Flood Peak Flood Depths
PROJECT North Brother Local Catchments Flood Study
MAP A-4(E)
NORMAN ST
A
B
C
D
E
0
500
Metres
N

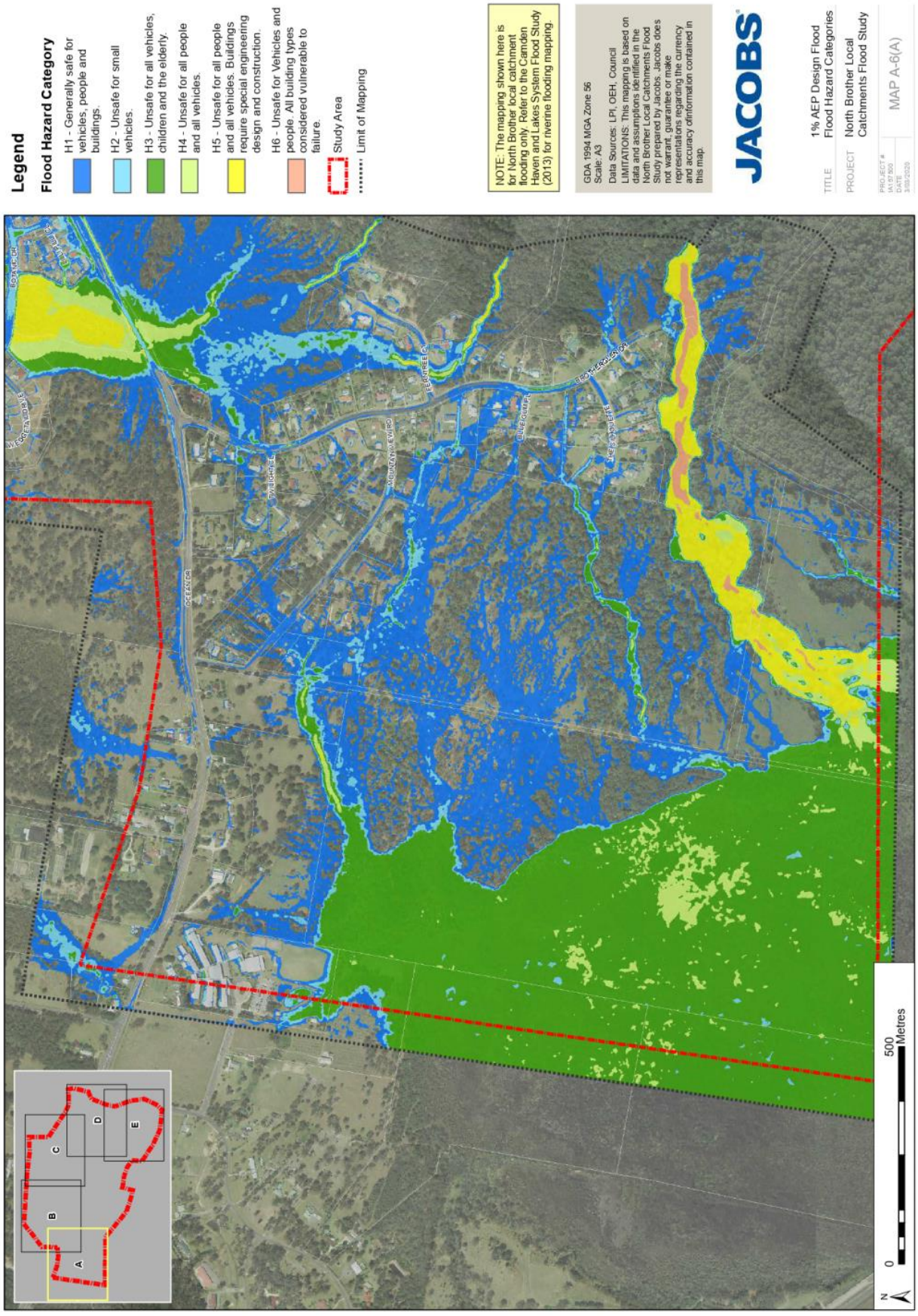

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Peak Flood Depths
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-5(A)
500
Metres
0
N
A
B
C
D
E

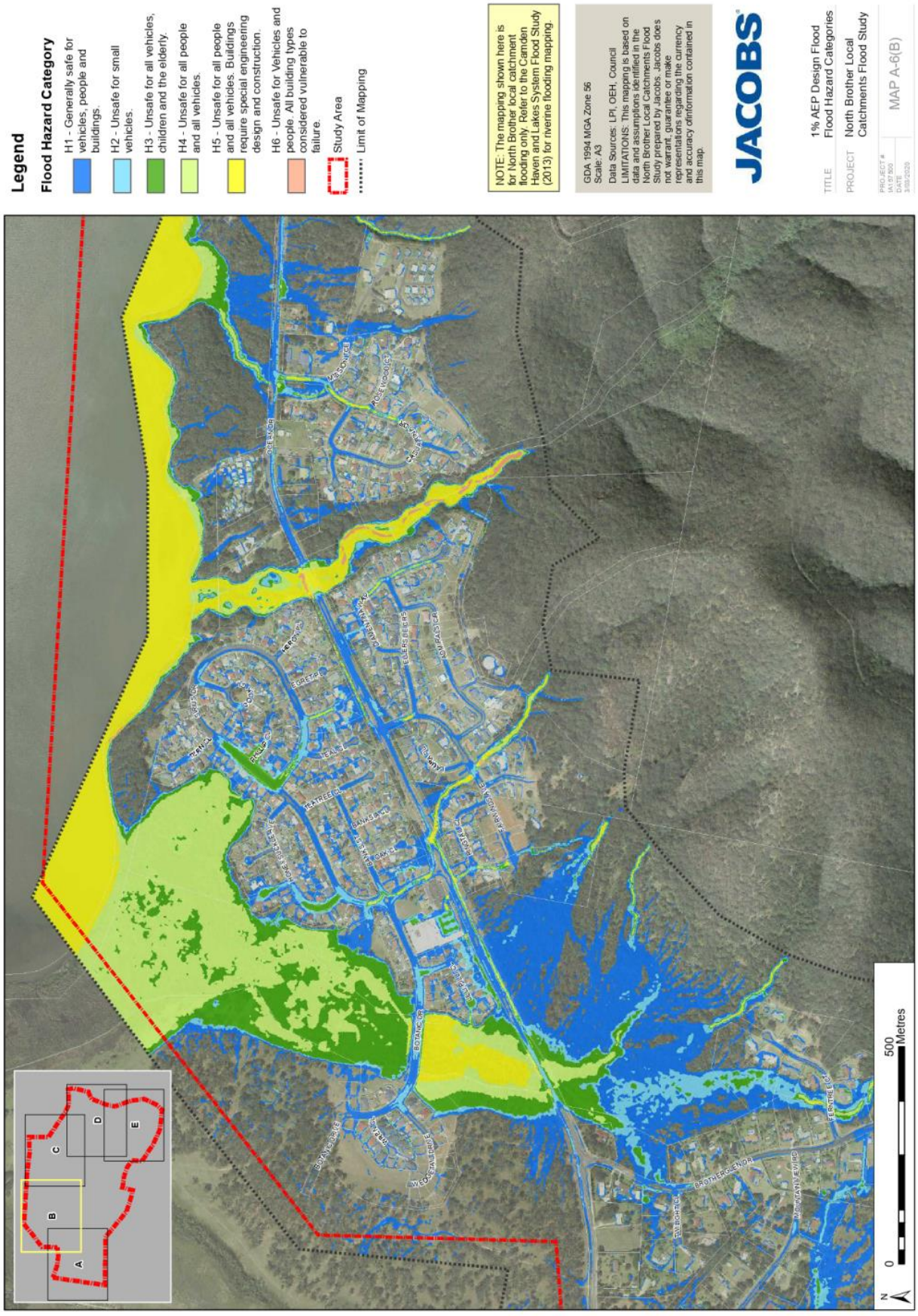

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Peak Flood Depths
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-5(B)
500
Metres
0
N
A
B
C
D
E

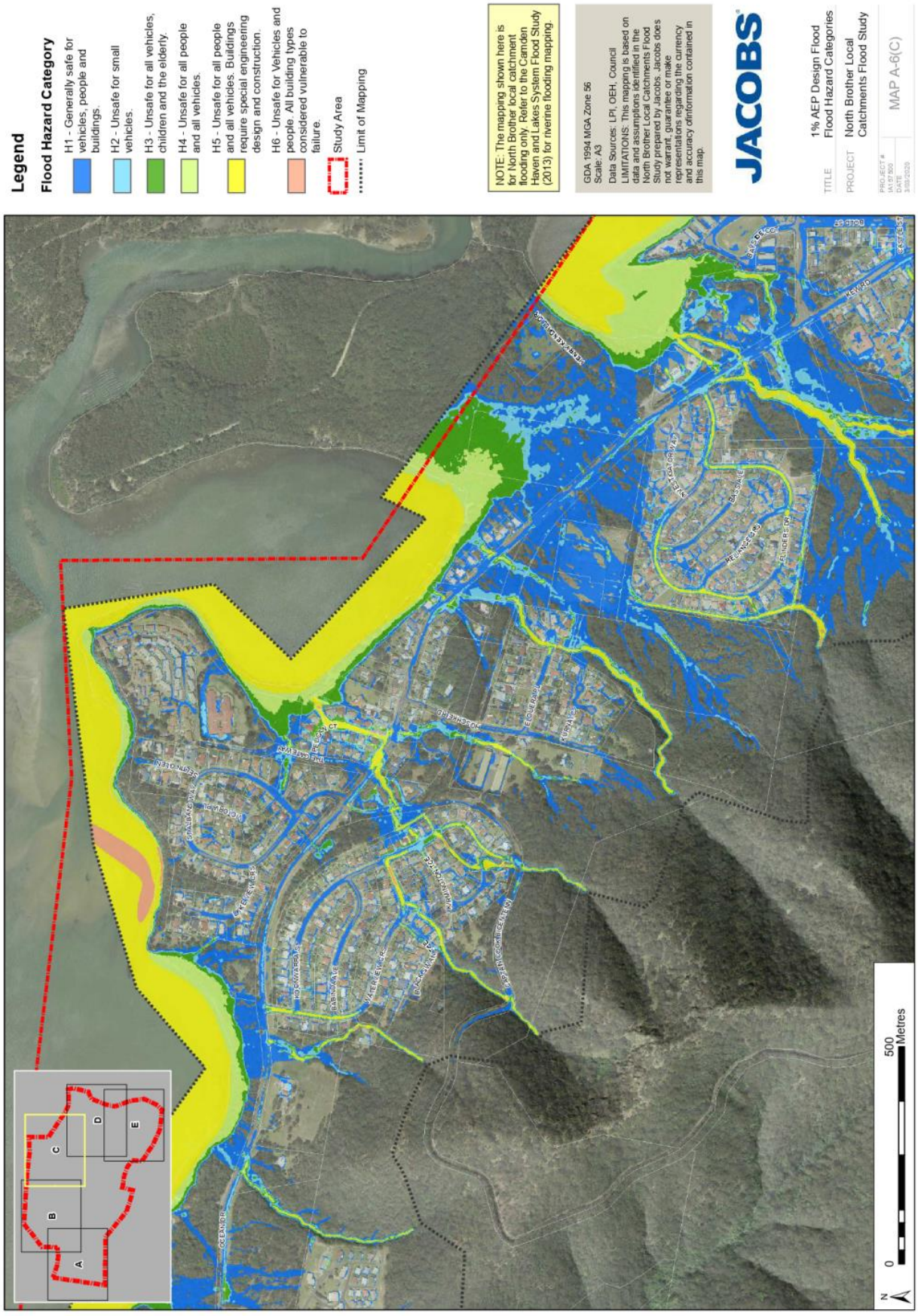

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Peak Flood Depths
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-5(C)
PROJECT #
DATE
A
B
C
D
E
0
500
Metres
N

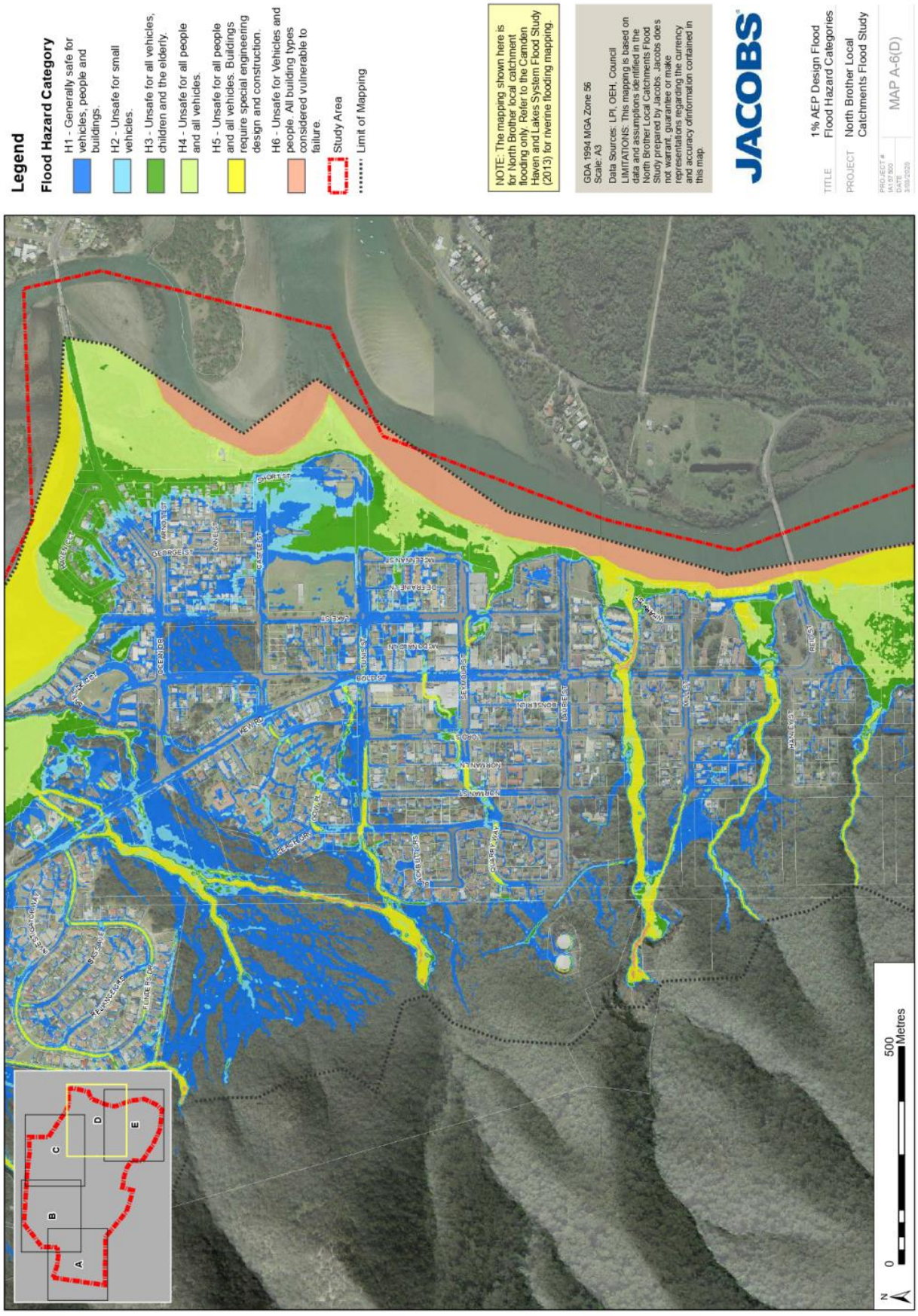

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Peak Flood Depths
TITLE
PROJECT
North Brother Local
Catchments Flood Study
PROJECT #
IA157500
DATE
3/08/2020
MAP A-5(D)
A
B
C
D
E
0
500
Metres
N

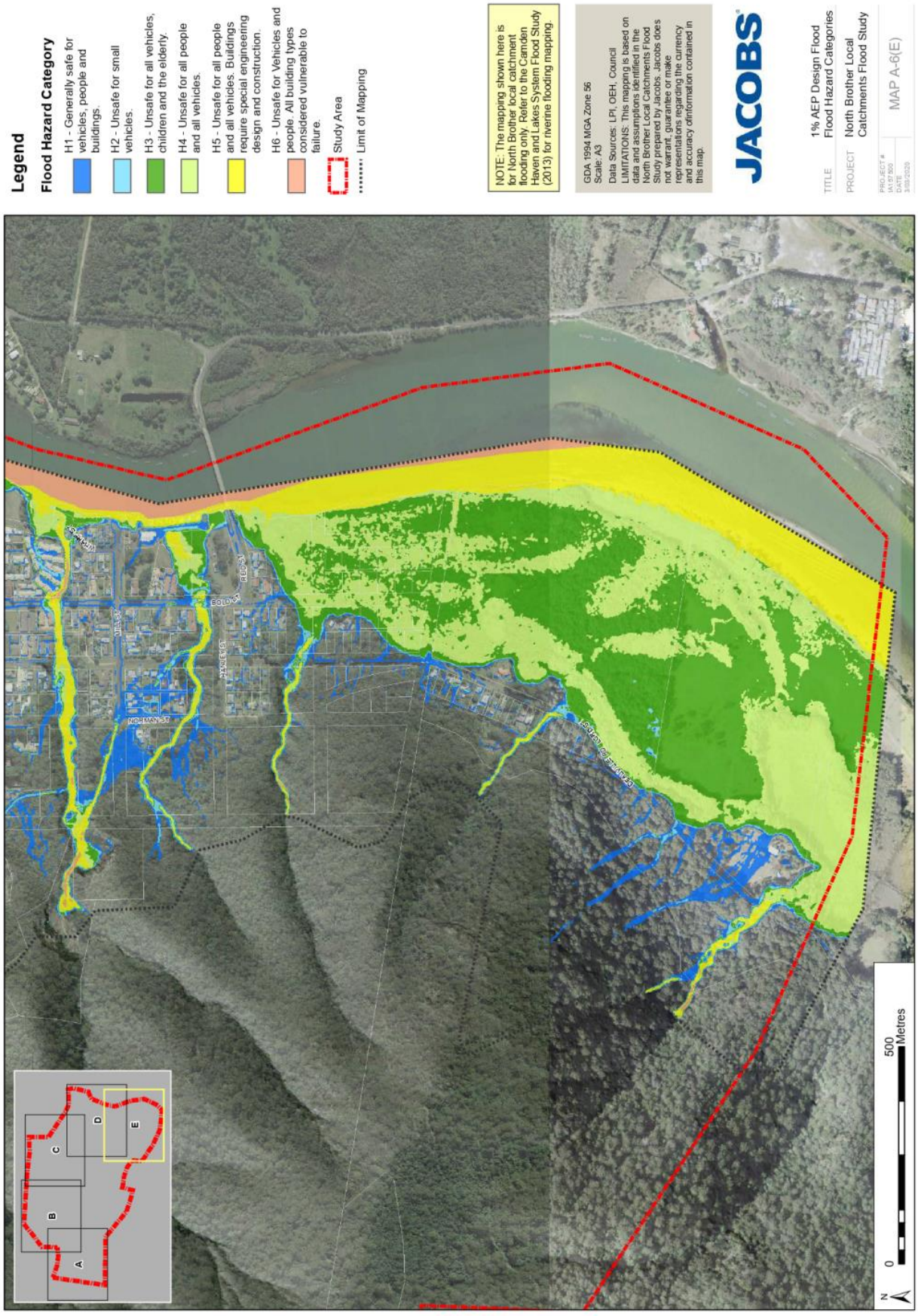

Legend
Peak Flood Depth (m)
0.05 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and LakesSystem Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Peak Flood Depths
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-5(E)
PROJECT #
DATE
500
Metres
0
N
A
B
C
D
E

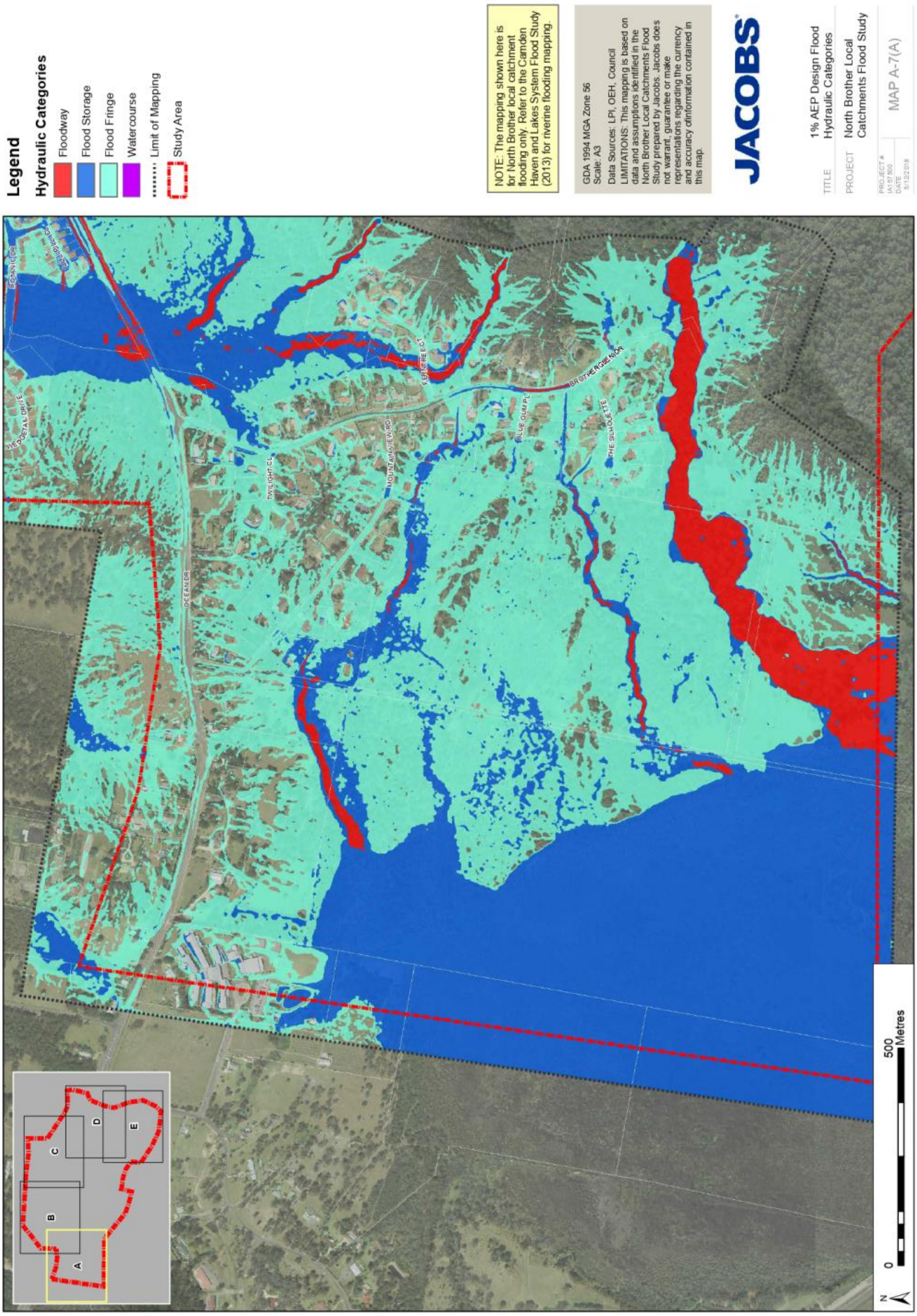

Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Flood Hazard Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-6(A)
OCEAN DR
0
500
Metres
N
A
B
C
D
E

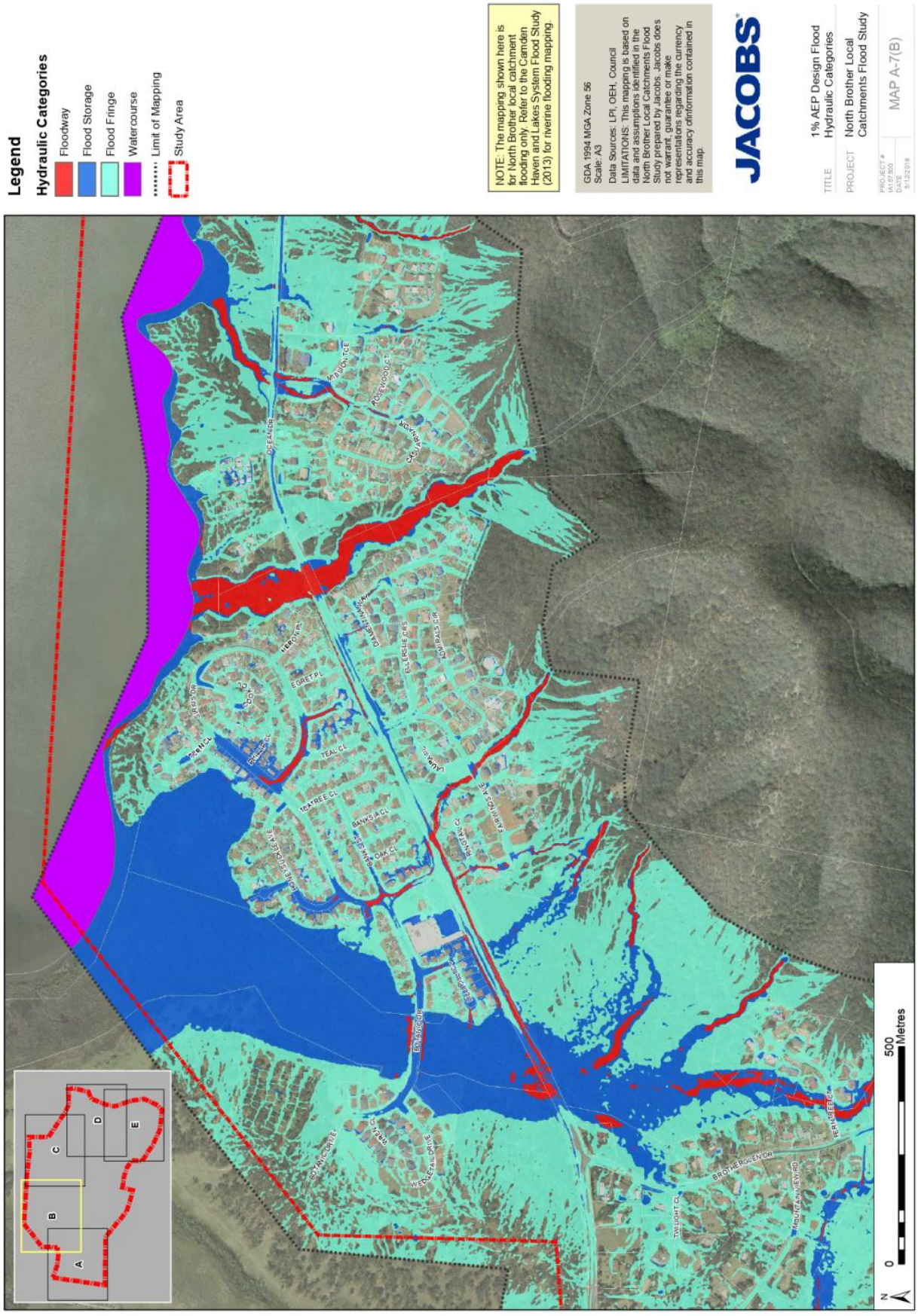

Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Flood Hazard Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-6(B)
A
B
C
D
E
0
500
Metres
N

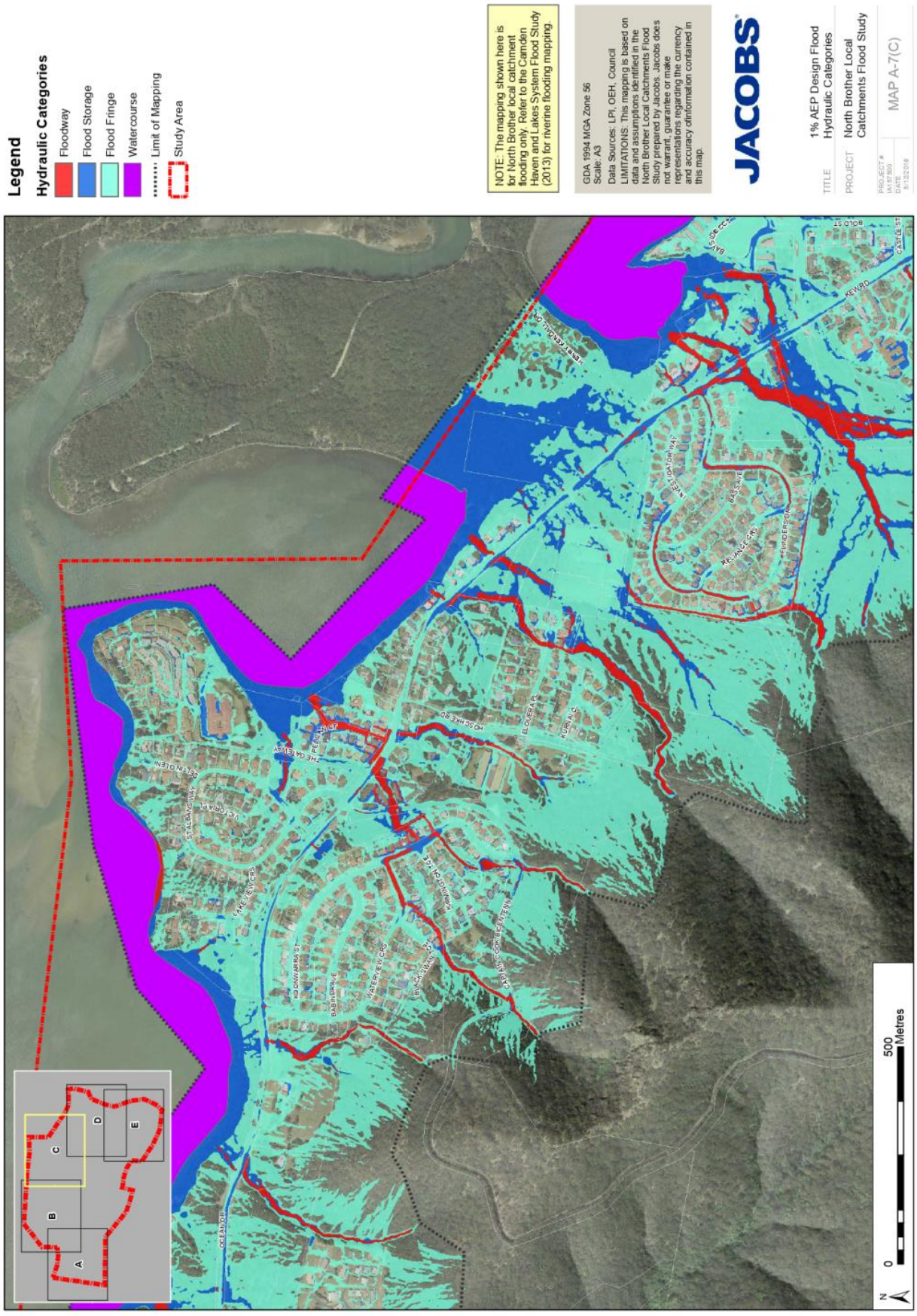

Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE 1% AEP Design Flood Flood Hazard Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-6(C)
0
500
Metres
N

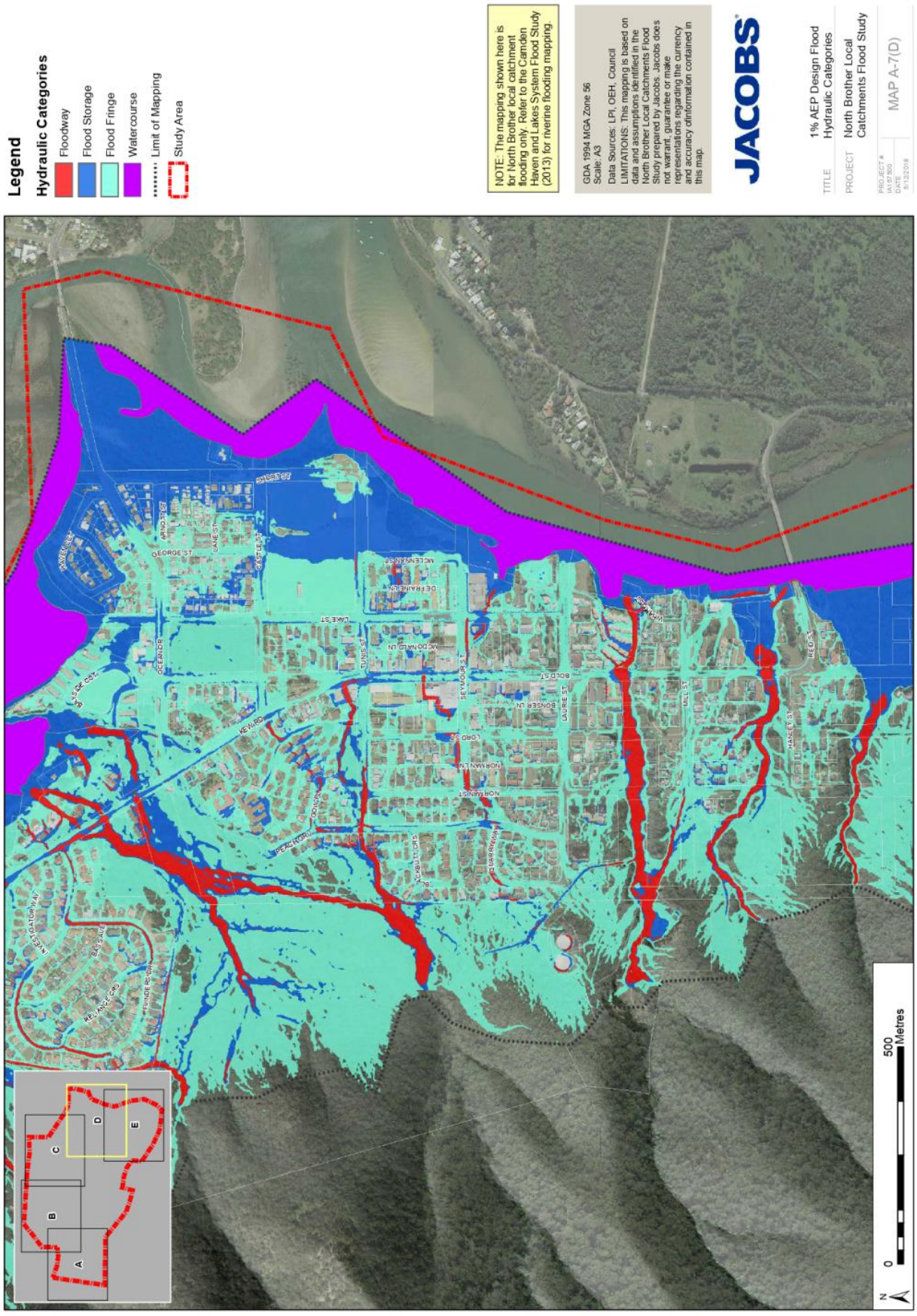

Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Flood Hazard Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-6(D)
500 Metres
0
N
A
B
C
D
E

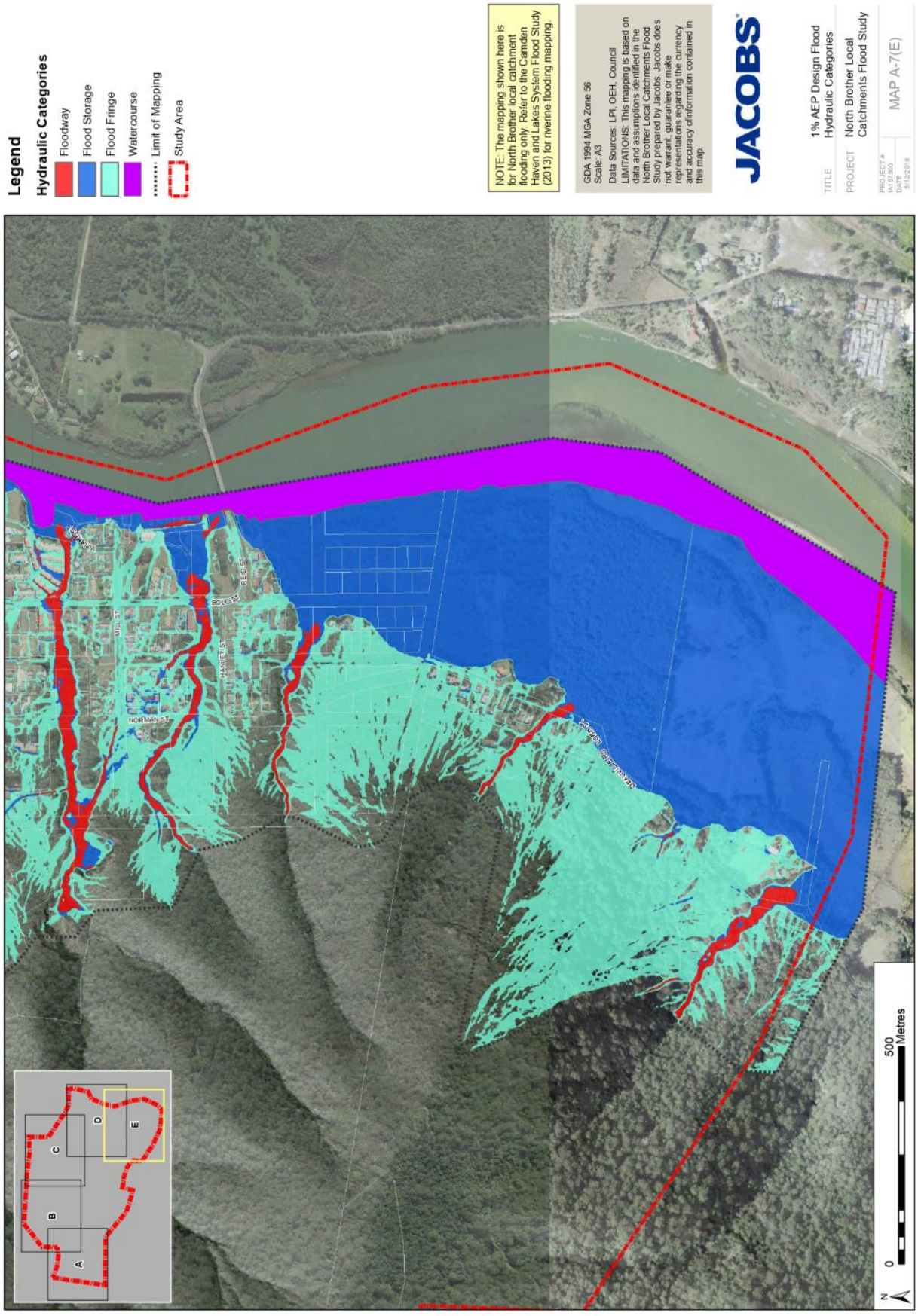

Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Flood Hazard Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-6(E)
500
Metres
0
N
A
B
C
D
E

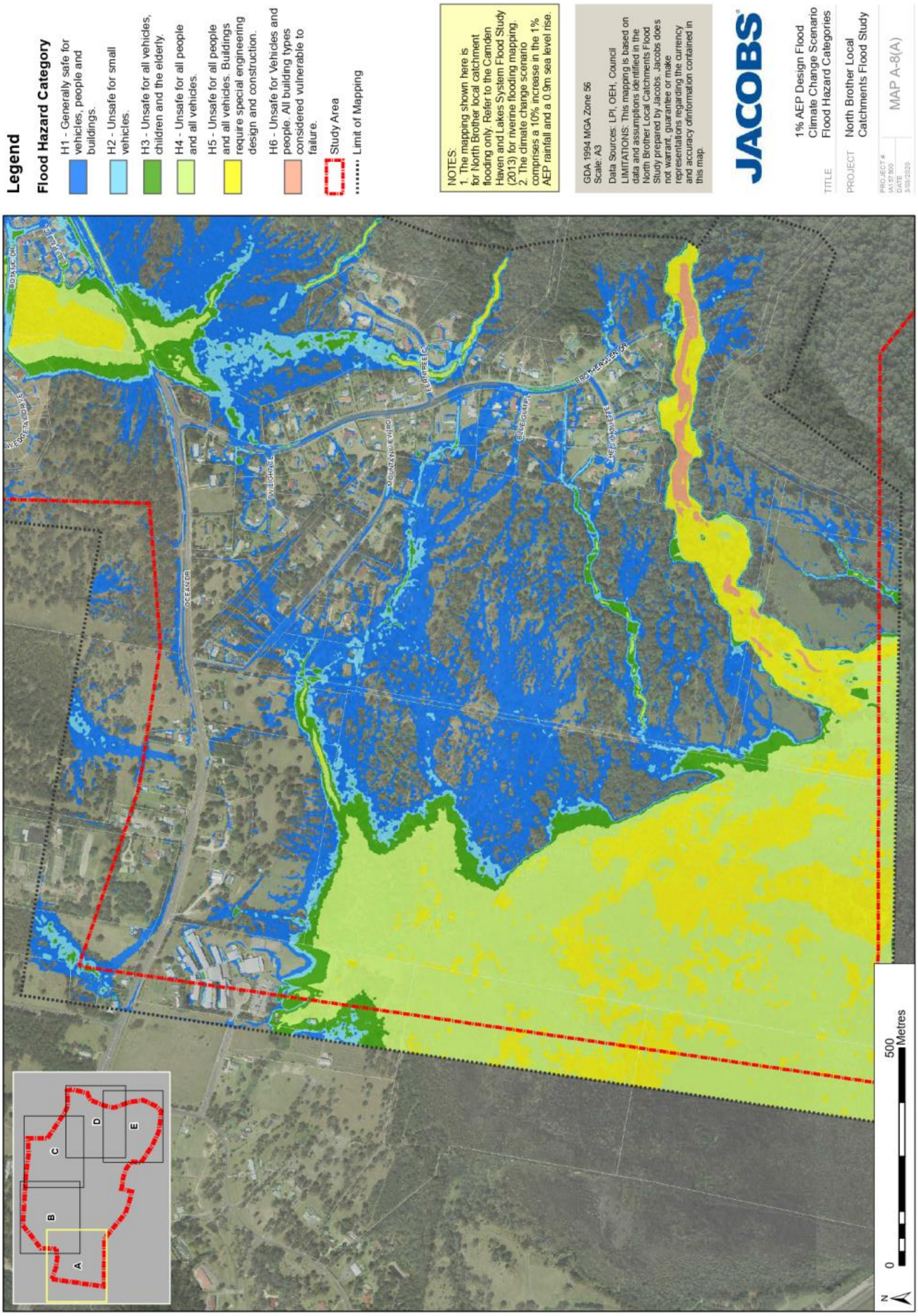

Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Limit of Mapping
Study Area
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE 1% AEP Design Flood Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-7(A)
OCEAN DR
TWILIGHT CL
MOUNTAINVIEW RD
FERNTREE CL
BLUE GUM PL
BROTHER GLEN DR
A
B
C
D
E
0
500
Metres
N

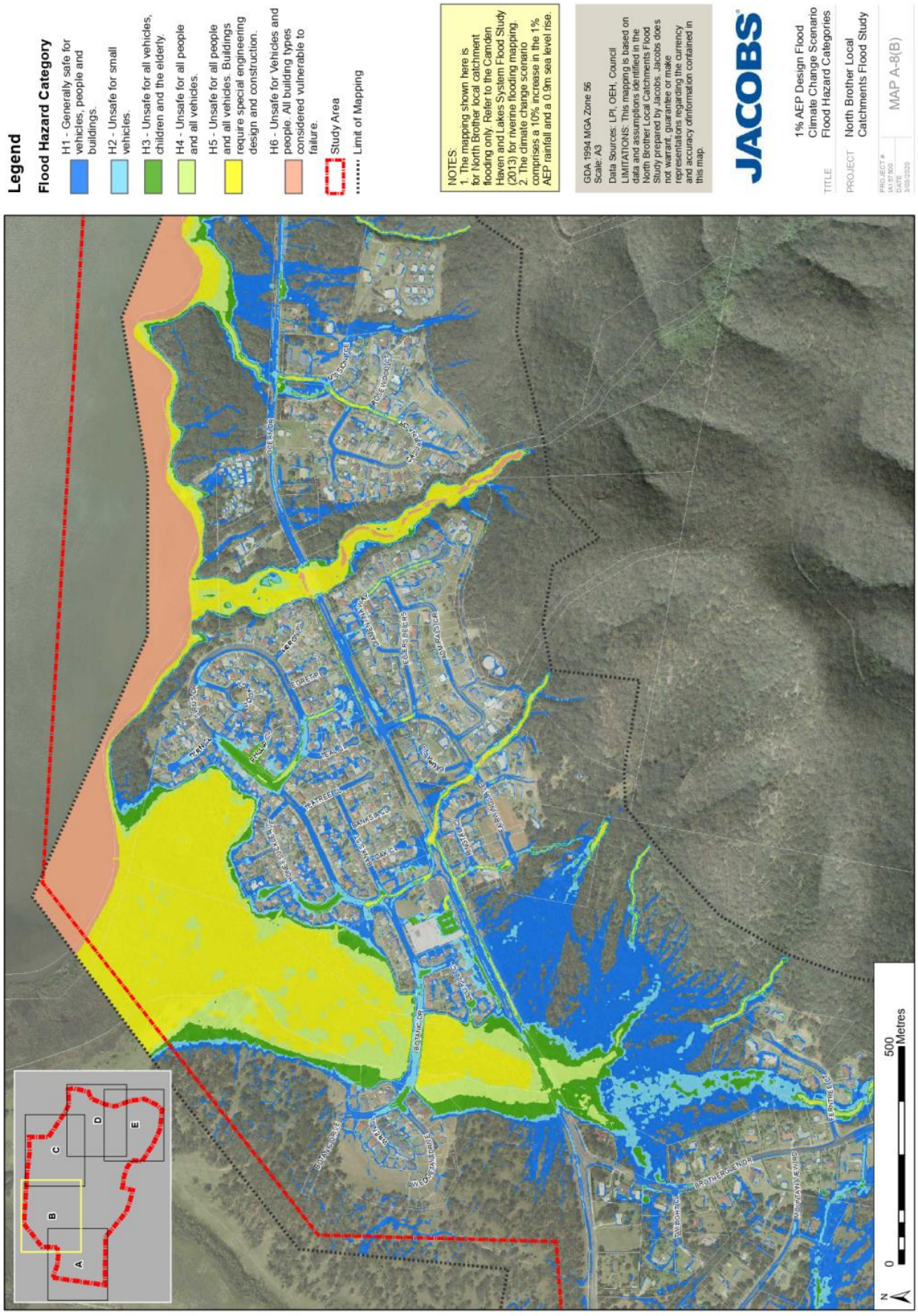

Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Limit of Mapping
Study Area
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-7(B)
500 Metres
0
N
A
B
C
D
E

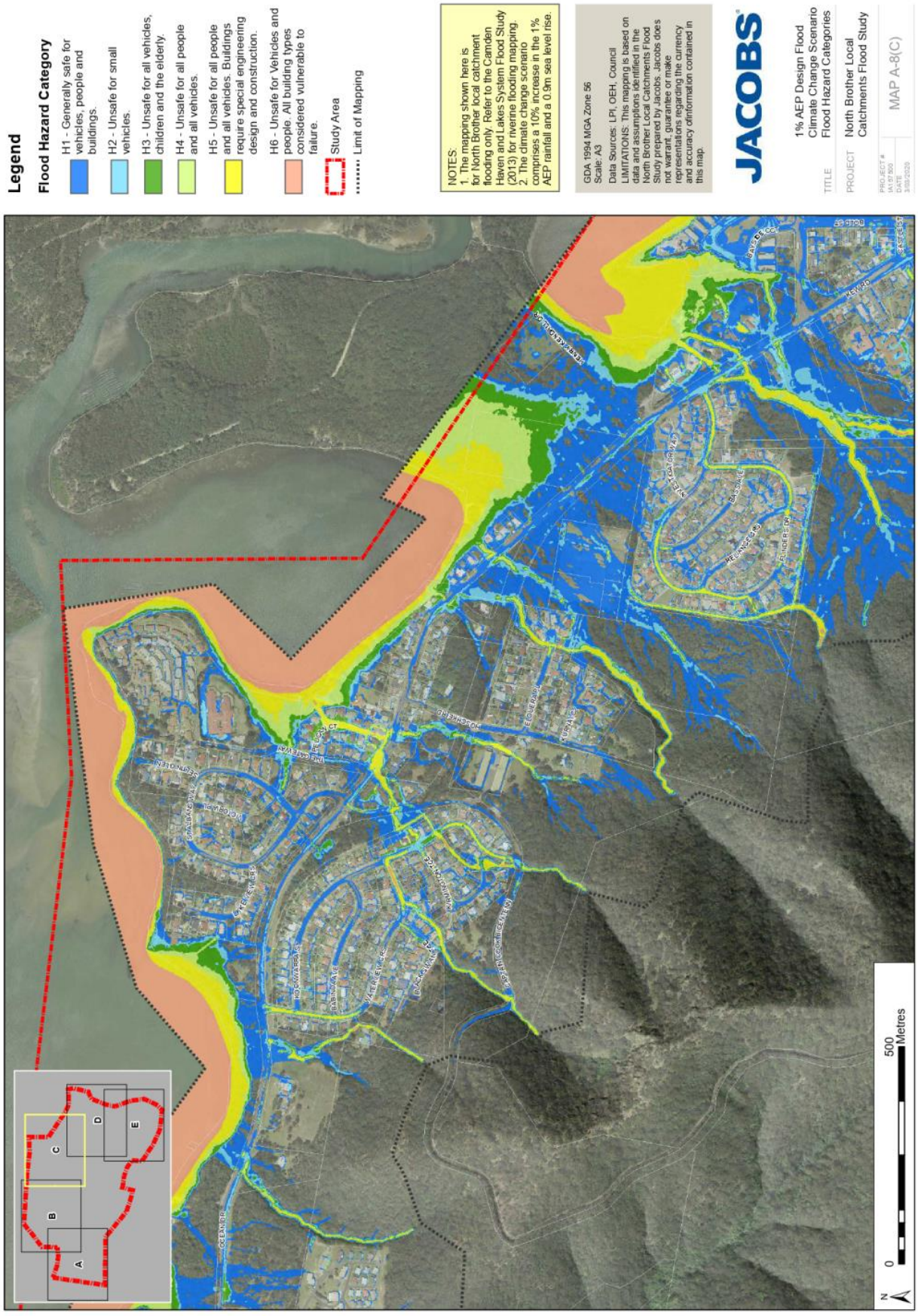

Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Limit of Mapping
Study Area
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
JACOBS
TITLE 1% AEP Design Flood Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-7(C)
500 Metres
0
N
A
B
C
D
E

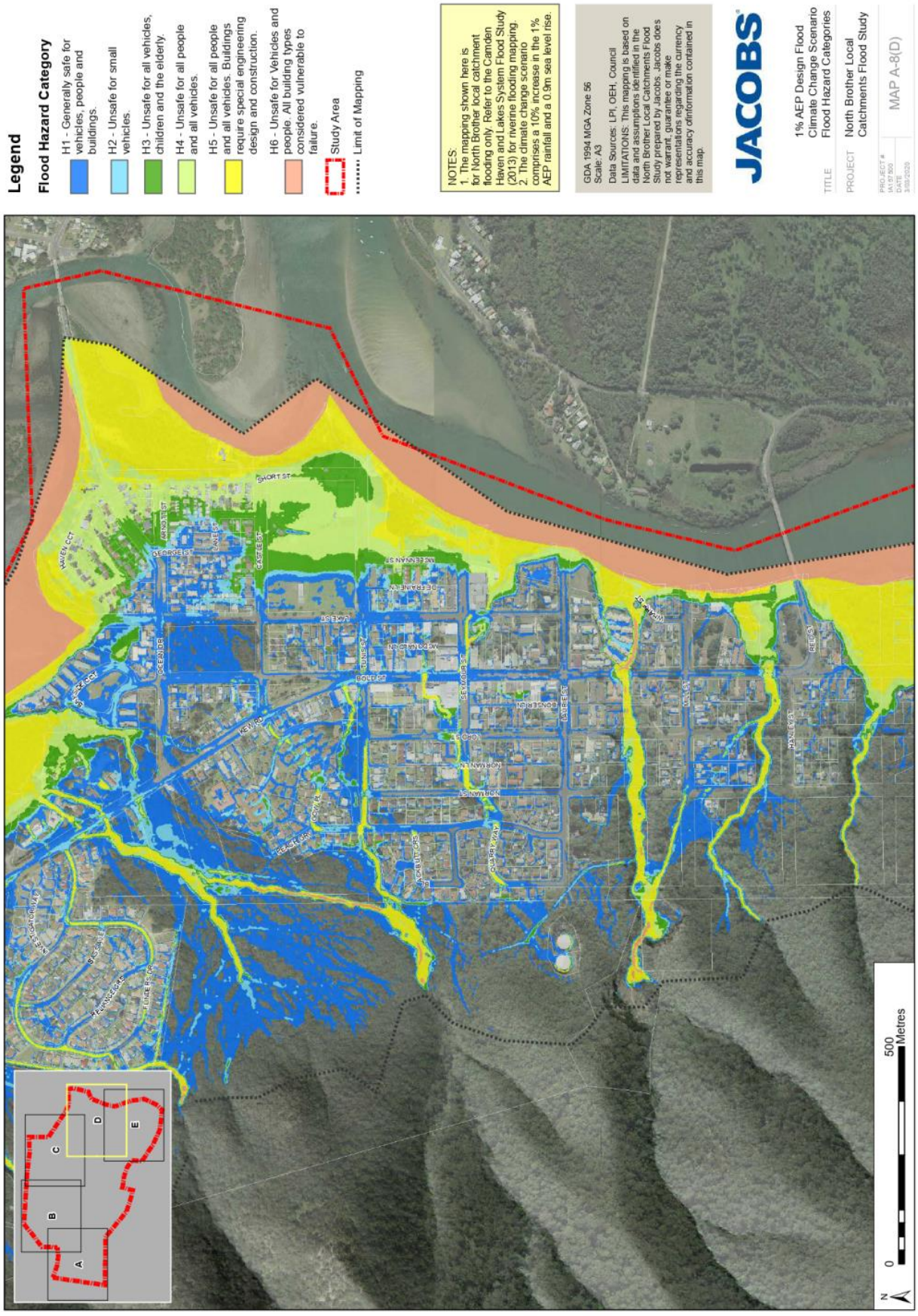

Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Limit of Mapping
Study Area
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-7(D)
500
Metres
0
N
A
B
C
D
E

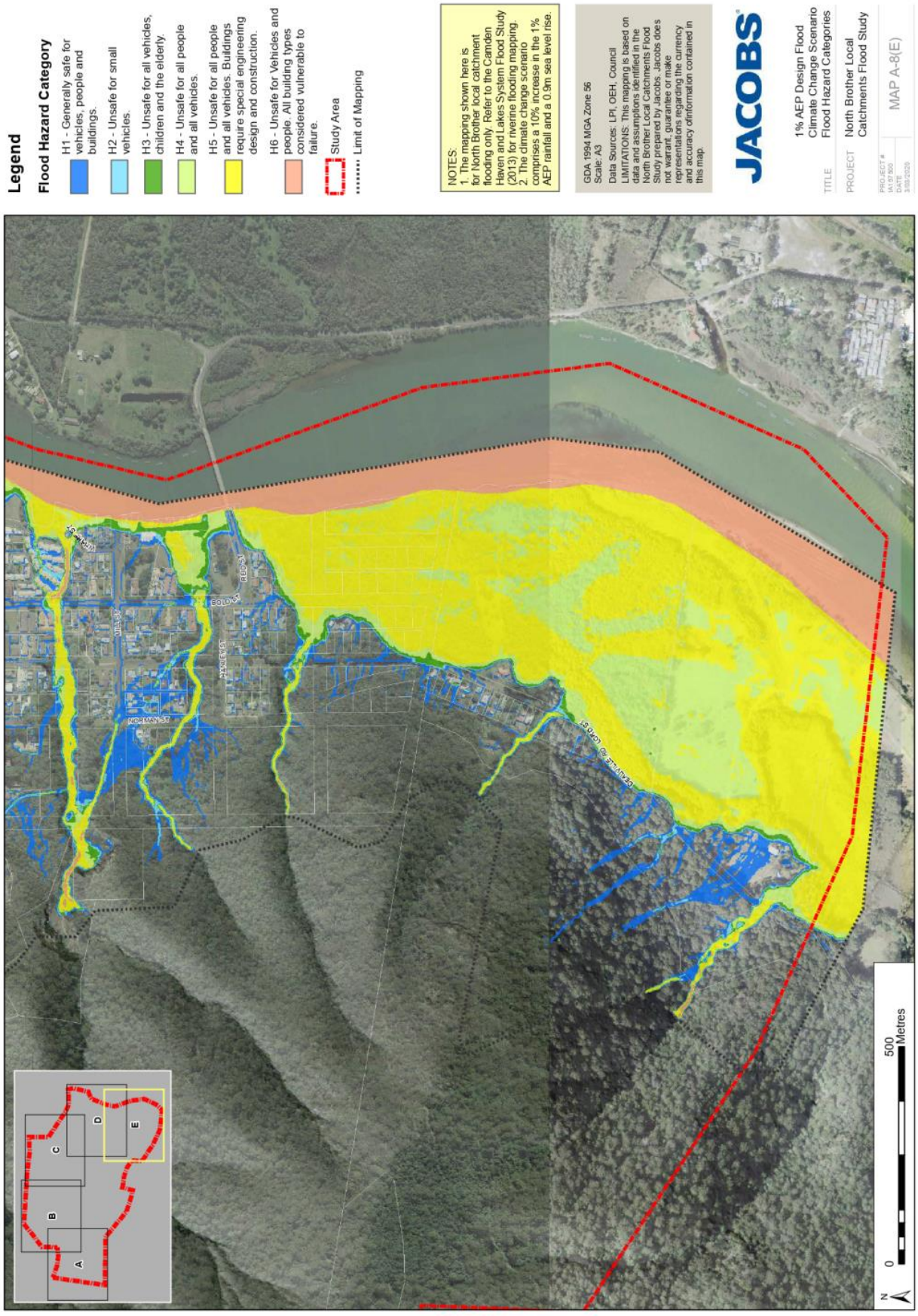

Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Limit of Mapping
Study Area
NOTE: The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE 1% AEP Design Flood Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-7(E)
BOLD ST
RED ST
HILL ST
MANTLE ST
NORMAN ST
A
B
C
D
E
0
500
Metres
N


Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
2. The climate change scenario comprises a 10% increase in the 1% AEP rainfall and a 0.9m sea level rise.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
TITLE
1% AEP Design Flood Climate Change Scenario Flood Hazard Categories
PROJECT
North Brother Local Catchments Flood Study
MAP A-8(A)
A
B
C
D
E
N
0
500
Metres
OCEAN DR
MOUNTAIN VIEW RD
FERNTREE CL
BLUE GUM PL
BOTANIC DR


Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
2. The climate change scenario comprises a 10% increase in the 1% AEP rainfall and a 0.9m sea level rise.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Flood Hazard Categories
TITLE
PROJECT North Brother Local
Catchments Flood Study
MAP A-8(B)
500
Metres
0
N


Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
2. The climate change scenario comprises a 10% increase in the 1% AEP rainfall and a 0.9m sea level rise.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Flood Hazard Categories
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-8(C)
500
Metres
0
N


Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
2. The climate change scenario comprises a 10% increase in the 1% AEP rainfall and a 0.9m sea level rise.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Flood Hazard Categories
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-8(D)
500
Metres
0
N
A
B
C
D
E


Legend
Flood Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for all vehicles, children and the elderly.
H4 - Unsafe for all people and all vehicles.
H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
2. The climate change scenario comprises a 10% increase in the 1% AEP rainfall and a 0.9m sea level rise.
GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant, guarantee or make representations regarding the currency and accuracy ofinformation contained in this map.
JACOBS
1% AEP Design Flood
Climate Change Scenario
Flood Hazard Categories
TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-8(E)
500
Metres
0
N
A
B
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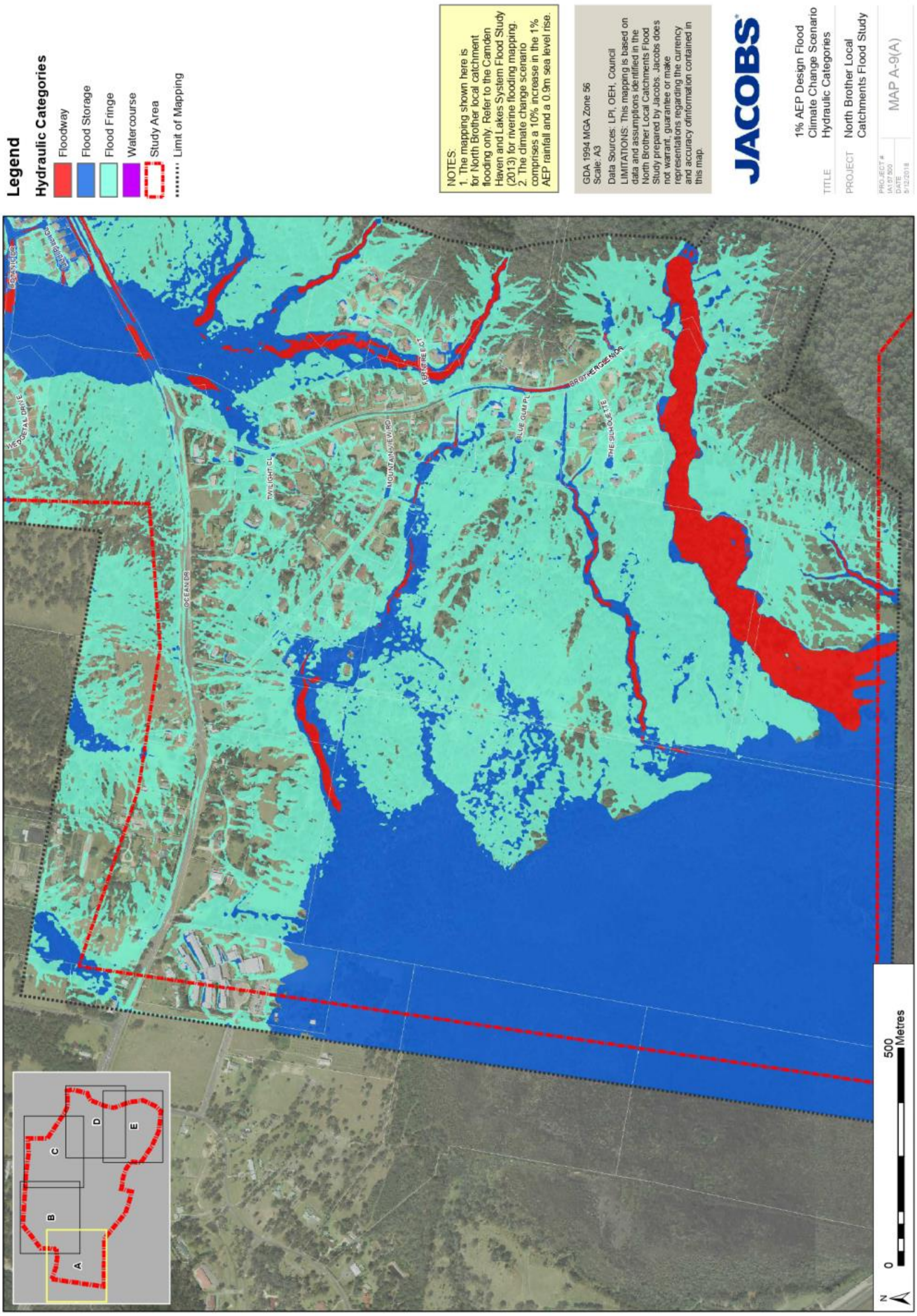
Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
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JACOBS
TITLE 1% AEP Design Flood Climate Change Scenario Hydraulic Categories
PROJECT North Brother Local Catchments Flood Study
MAP A-9(A)
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500 Metres
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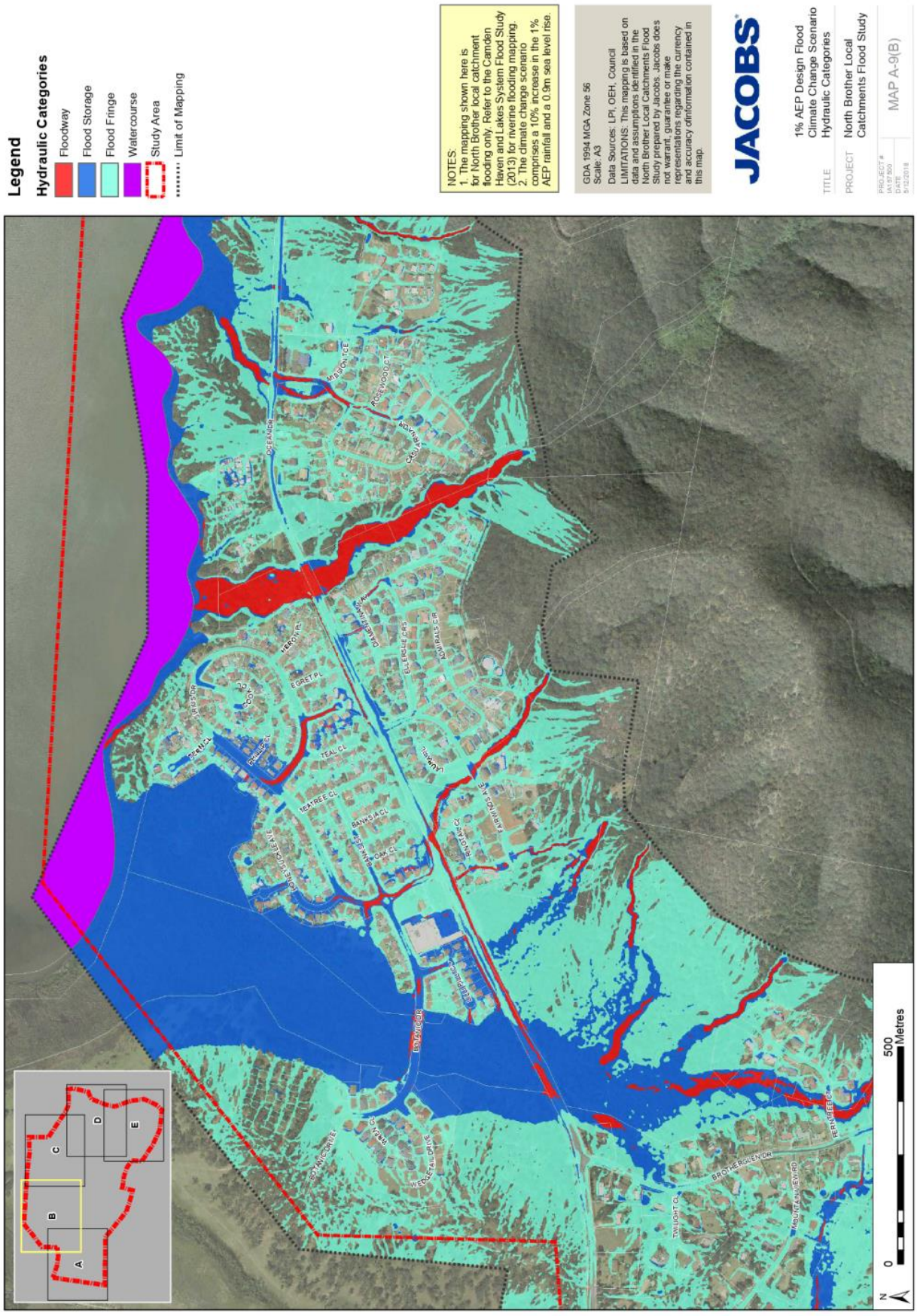
E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Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
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1% AEP Design Flood
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Hydraulic Categories
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PROJECT
North Brother Local
Catchments Flood Study
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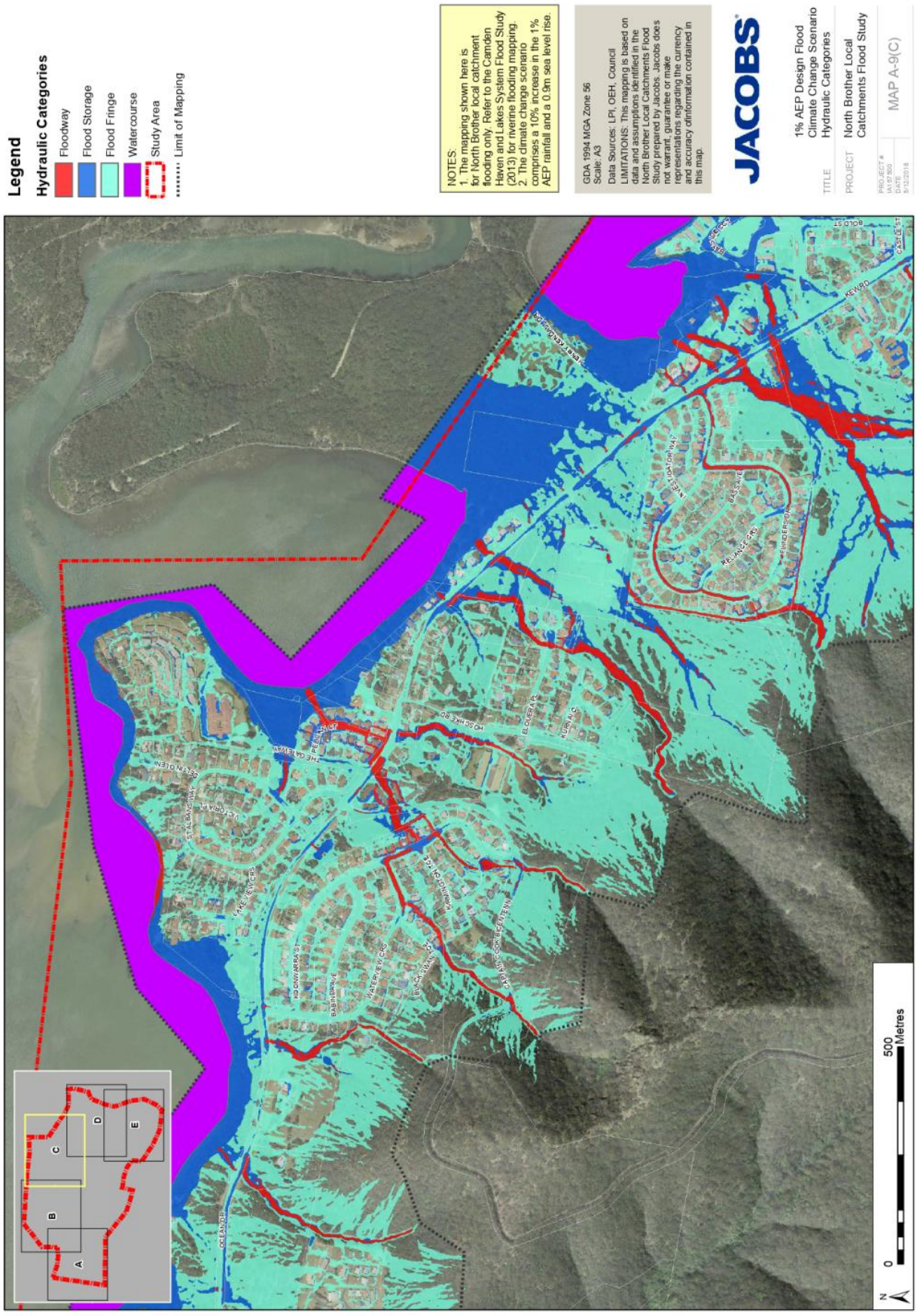
Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
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1% AEP Design Flood
Climate Change Scenario
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TITLE
PROJECT
North Brother Local
Catchments Flood Study
MAP A-9(C)
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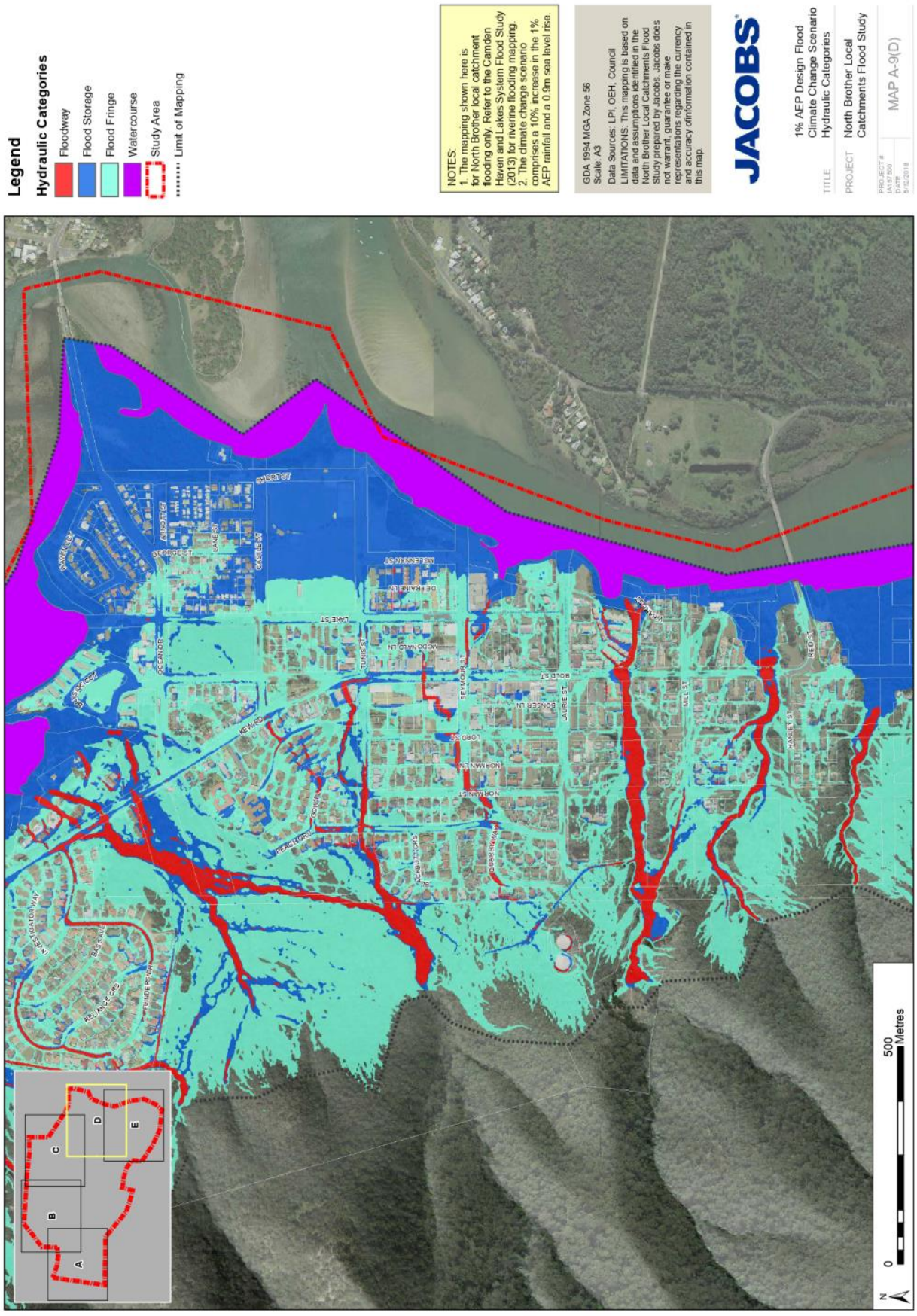
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Flood Storage
Flood Fringe
Watercourse
Study Area
Limit of Mapping
NOTES:
1. The mapping shown here is for North Brother local catchment flooding only. Refer to the Camden Haven and Lakes System Flood Study (2013) for riverine flooding mapping.
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JACOBS
1% AEP Design Flood
Climate Change Scenario
Hydraulic Categories
TITLE
PROJECT North Brother Local
Catchments Flood Study
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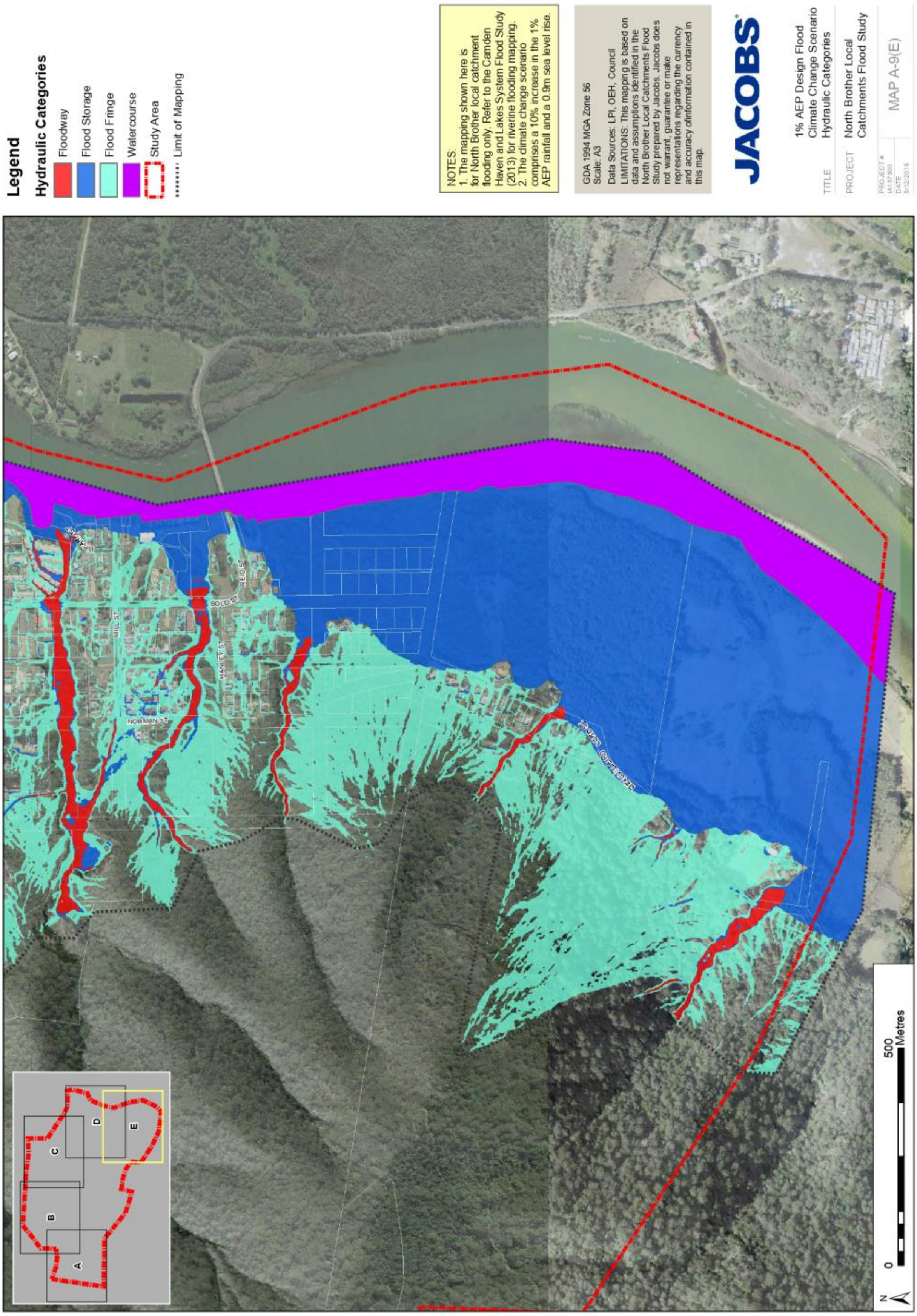
Legend
Hydraulic Categories
Floodway
Flood Storage
Flood Fringe
Watercourse
Study Area
Limit of Mapping
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Scale: A3
Data Sources: LPI, OEH, Council
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JACOBS
TITLE
1% AEP Design Flood
Climate Change Scenario
Hydraulic Categories
PROJECT
North Brother Local
Catchments Flood Study
MAP A-9(E)
BOLD ST
MILL ST
HANLEY ST
NORMAN ST
A
B
C
D
E
0
500
Metres
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Item: **08**

Subject: **COASTAL MANAGEMENT PROGRAM - STAGE 1 - DRAFT SCOPING STUDY**

Presented by: **Development and Environment, Melissa Watkins**

RECOMMENDATION

That the Committee note the report.

Discussion

As part of the NSW Government's new framework to manage the coastal environment Council has commenced Stage 1 of the Coastal Management Program (CMP).

The CMP will set the long-term strategy for the coordinated management of the coastal zone. The CMP will achieve the purpose and objectives of the Coastal Management Act (2016).

Council is at Stage 1 in the CMP process and has produced a Scoping Study (**Attachment 1**), which has been produced in accordance with the prescriptive framework set by the Department of Planning, Industry & Environment (DPIE).

The scoping study aims to:

- Consolidate information gathered during Stage 1 of the CMP process;
- Incorporate information from previous management plans, and;
- Outline the proposed pathway for the following stages of the CMP.

After the Scoping Study is completed, the remainder of the CMP will be undertaken. This has been divided into four 'chapters' based on geographic areas, to better manage localised issues. Each of the stages 2, 3, 4 and 5 will be done repetitiously for the four below chapters to ensure site-specific detail to enable best management of the on-ground issues in each of these areas.

The chapters are:

1. Lake Cathie/Lake Innes and Bonny Hills Estuary & Coastline - incorporating the open coastline from the 4 x 4 access track adjacent to Dirah Street, Lake Cathie to the southern side of Grants Head at Bonny Hills,
2. Hastings River Estuary,
3. Camden Haven River Estuary,
4. Port Macquarie-Hastings Open Coastline (excluding the open coastline that is covered in the Lake Cathie/Bonny Hills area.

PORT MACQUARIE HASTINGS COUNCIL

Council intends to complete the Lake Cathie/Lake Innes & Bonny Hills Estuary & Coastline CMP chapter first. This chapter has been given priority as a result of the risk assessment that has been included in the Scoping Study and as a result of immense community pressure over the past 18 months regarding the management of the Lake system.

Community Engagement and Internal Consultation

The draft Scoping Study has been prepared with input from the Biodiversity & Conservation Division of DPIE.

Council intends to place the draft Scoping Study on public exhibition for 28 days to allow the community to have its say. CE&F committee members are encouraged to review the Scoping Study and make a submission.

Attachments

1⇩. DRAFT CMP Stage 1 - Scoping Study

PORT MACQUARIE-HASTINGS COUNCIL

Coastal Management Program

STAGE 1 - SCOPING STUDY

MAY 2020

TABLE OF CONTENTS

GLOSSARY AND ABBREVIATIONS

TERM	DEFINITION
ASS	Acid Sulphate Soils
CBA	Cost-Benefit Analysis
CEA	Coastal Environment Area
CE&F	Coast, Estuary & Floodplain Advisory Sub-Committee
CM Act	Coastal Management Act 2016
CM SEPP	State Environmental Planning Policy (Coastal Management) 2018
CMP	Coastal Management Program
CP Act	Coastal Protection Act 1979
CSP	Community Strategic Plan
CUA	Coastal Use Area
CVA	Coastal Vulnerability Area
CWLRA	Coastal Wetlands and Littoral Rainforest Area
CZMP	Coastal Zone Management Plan
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
EMP	Estuary Management Plan
ESD	Ecologically Sustainable Development

TERM	DEFINITION
ICOLL	Intermittently Closed and Open Lakes and Lagoons
IP&R	Integrated Planning and Reporting Framework
KSC	Kempsey Shire Council
LEP	Local Environmental Plan 2011
LGA	Local Government Area
Manual	NSW Coastal Management Manual
MCC	Mid Coast Council
NPWS	National Parks and Wildlife Service
NSW CP	NSW Coastal Policy 1997
NSW EP	NSW Rivers and Estuaries Policy
PMHC	Port Macquarie-Hastings Council
SEPP 14	State Environmental Planning Policy Coastal Wetlands No. 14
SEPP 26	State Environmental Planning Policy Littoral Rainforests No. 26
SEPP 71	State Environmental Planning Policy Coastal Protection No. 71
SES	State Emergency Services
TfNSW	Transport for NSW
UGMS	Urban Growth Management Strategy

1. INTRODUCTION

In NSW, coastal management is quickly becoming a high-profile area of concern for coastal councils, public and private asset owners, and the extended community.

Port Macquarie-Hastings Council (PMHC) recognises that the coastline is one of our greatest assets. It is a diverse, complex and dynamic environment made up of sandy open-coast beaches, dunes, rocky headlands, cliffs, rock platforms, estuaries, coastal floodplains, coastal lakes and lagoons. It has a range of unique values, natural and urban landscapes and cultural significance that support our vibrant, healthy and prosperous lifestyle.

The Port Macquarie-Hastings Coastal Zone, from Point Plomer in the north to Diamond Head in the south is characterised by its natural beauty, clear water and numerous inviting sandy beaches. An ever-increasing number of residents and tourists are attracted to the natural, cultural, social and economic values that our coastline offers.

The coastal zone is highly vulnerable to changes over time due to escalating environmental and socio-economic pressures. These pressures combined with social sensitivities to shifts in environmental conditions present unique challenges to coastal zone managers.

The NSW Government is delivering a new legislative and regulatory framework to better equip coastal communities to respond to the dynamic nature of the coast and sustainably manage the coastal environment. Local councils and public authorities are required to manage their coastal areas and activities in accordance with relevant state legislation, policies and plans.

PMHC has resolved to prepare a Coastal Management Program (CMP). A CMP aims to provide a long term, coordinated strategy for managing the coastal zone in accordance with the Coastal Management Act 2016 (CM Act) and local objectives. This management program will be implemented through the coordination between Council, state agencies and other key stakeholders.

In accordance with the NSW Coastal Management Framework, Stage 1 of preparing a CMP is to undertake a Scoping Study. The scoping study aims to consolidate information gathered both during Stage 1 and from previous management plans and outline the proposed pathway for the following stages of the CMP.

Key components of the scoping study include:

- Strategic context for coastal management.
- Purpose, vision and objectives of the CMP.
- CMP scope - issues and areas, including maps of relevant CMAs
- Review of current management practices and arrangements.
- Identification of roles and responsibilities including other councils and relevant public authorities.
- First-pass risk assessment to identify where action is required, including studies to be completed in Stage 2.
- Stakeholder and community engagement strategy.
- Preliminary business case.
- Plan for future stages and timetable for CMP preparation. Include a timeframe for steps in the preparation of a planning proposal if changes to the LEP are proposed.

The CMP will focus on and be guided by understanding, addressing and contributing to solutions around the following topics:

- How do we use our coastal zone?
- How do we balance environmental values with these uses?
- What do want our coastal zones to look like in the future?
- How do we adapt to the increasing challenges of living on the coast?
- Who is responsible for management of the coastal zone?

The methods used to develop the CMP will be guided by existing legislation, such as the CM Act, the NSW Coastal Management Manual and by the values and desires of our community.

1.1 COASTAL MANAGEMENT PROGRAM FRAMEWORK

In 2016, the NSW Government introduced a new framework to manage the coastal environment in an ecologically sustainable way for the social, cultural and economic wellbeing of the residents and visitors of NSW. The cornerstone of this framework, the Coastal Management Act 2016, contains provisions that should be followed to develop long-term strategies for the management of the coastal zone.

The CMP will set the long-term strategy for the coordinated management of the coastal zone. It will achieve the purpose and objectives of the CM Act. The process to write a CMP is prescriptive so that it provides consistency across the NSW.

Each CMP follows a five-stage program that is outlined in the NSW Coastal Management Manual *[[see Figure 1]*.

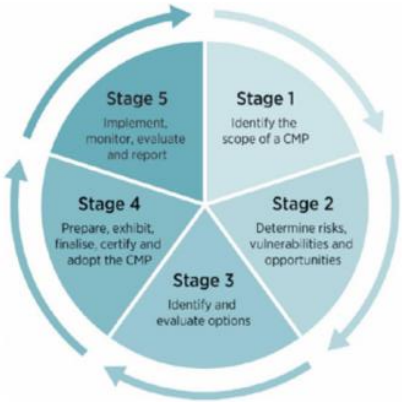


Figure 1: *Stages in preparing and implementing a CMP*

The scoping study is the first stage in the process of preparing a CMP. It will assist councils to identify the community and stakeholders and prepare an engagement strategy, determine the context of coastal management in the local area and establish roles, responsibilities and governance arrangements to deliver management actions across the Local Government Area (LGA). After the scoping study is completed, the remainder of the CMP will be divided into four 'chapters' based on geographic areas, to better manage localised issues. Each of the stages 2, 3, 4 and 5 will be done repetitiously for the four below chapters (areas) to ensure site-specific detail to enable best management of the on-ground issues.

The chapters include:

1. **Lake Cathie/Lake Innes & Bonny Hills Estuary & Coastline** - incorporating the open coastline from the 4 x 4 access track adjacent to Dirah Street, Lake Cathie to the southern side of Grants Head at Bonny Hills (referred to in this document as the Lake Cathie/Bonny Hills chapter for simplicity).
2. **Hastings River Estuary**
3. **Camden Haven River Estuary**
4. **Port Macquarie-Hastings Open Coastline** (excluding the open coastline that is covered in the Lake Cathie/Bonny Hills area

Refer to *Section 13.6 Coastal Management Plan Areas* for further information on the proposed CMP areas.

Each chapter will identify management issues and the actions, specific to the local area, which are required to address these issues in a strategic and integrated way. Each chapter will contain detail regarding:

- Who is responsible for each action?
- How and when those actions are to be implemented?
- Costs and proposed cost-sharing arrangements for each action.

2. PURPOSE, VISION AND OBJECTIVES

2.1 LIMITATIONS

Much like all LGA's, PMHC faces limitations to the scale and extent of coastal zone management it can feasibly achieve. Limitations include land tenure, funding resources, the complexity of stakeholder engagement which requires a balance between multiple government agencies and community needs with possible competing priorities and the legislative complexities that take time to complete. A hurdle in all LGA's is finding a balance amongst the desires of all ratepayers in the LGA. The majority of income derived for projects is from ratepayers and must be divided into various priority areas and competing needs and desires. These priorities include roads, water availability, sewer, recreation, and arts and culture to name a few.

The CMP aims to provide a framework for management of the coastal zone, which acknowledges and reflects the needs of the coastal area but balances this with the reality of the competing needs of the LGA and the various desires/mandates of other stakeholders. Opportunities for funding will be sought often and communication and engagement will be top priority .

2.2 SCOPING STUDY PURPOSE

The purpose of preparing this scoping study is to identify how the coastal zone is currently managed and to consider if further investigations or changes to management actions are required. This assessment includes a review of existing Coastal Zone Management Plans (CZMP) and Estuary Management Plans (EMP) to identify any gaps in knowledge and determine if any further management actions are required in light of the objectives of the new Coastal Management Act 2016.

Stage 1 is designed to assist councils to:

- Review the strategic context for coastal management in the local area.
- Determine the purpose of the CMP and the key outcomes that it is intended to deliver.
- Identify the appropriate scope for the CMP, consider the area and range of issues to be dealt with and identify which organisations and communities need to be involved.
- Determine the adequacy of available information and management actions and identify subsequent stages in the preparation of the CMP, including the possibility of fast-tracking.

In accordance with the Coastal Management Manual:

The scoping study will guide the direction of stages 2, 3, 4 and 5 of the coastal management program. PMHC will engage both the community and relevant stakeholders throughout the process to develop a shared understanding of the current situation and identify any changes to coastal values so that they are integrated into the planning process.

2.3 VISION

Ensure the continued protection, use and enjoyment of Port Macquarie-Hastings's coasts, rivers and estuaries in an ecologically sustainable manner*

This vision aligns with PMHC's overarching vision of "**A sustainable high-quality of life for all**". (*Source: Towards 2030 Community Strategic Plan - Port Macquarie-Hastings Council)*

* It is envisioned that the CMP vision will be refined during further community and stakeholder engagement.

2.4 OBJECTIVES

The purpose of the Coastal Management Program is to provide a framework for the long-term strategic and integrated management of priority coastal hazards, issues and risks to the Port Macquarie-Hastings Coastal Zone, in line with the community's needs, NSW state objectives and legislation. The successful development and implementation of a robust CMP will provide a range of short, medium and long-term outcomes. These objectives will be refined during Stage 2 in consultation with stakeholders and the community so that they are consistently reflecting local issues and conditions. The CMP will also identify who is responsible for delivery of key management actions.

Figure 2. *Tacking Point Light house, Port Macquarie*

3. GOVERNANCE

The CMP covers a large geographic area in the PMHC LGA and lays over various land zones. Within Council's governance structure, the action or manner of governing, there are multiple land managers including the Natural Resources, Recreation and Building, Strategic Planning, and Infrastructure Planning sections that may all need to be consulted before works may be undertaken. In addition to internal consultation, numerous state agencies including Department of Planning, Industry and Environment, Department of Primary Industries Fisheries, National Parks and Wildlife Services, NSW Office of Water, Roads and Maritime, and Crown Lands also own and manage land within the coastal zone and must be consulted with before works can occur. These departments have governance decisions over their land on which Council must seek permission and licensing from before works are undertaken. Other key stakeholders are the Local Aboriginal Land Councils, which must be consulted and give permission for works on land that is owned and managed by the traditional owners of this land.

When discussing governance, it is also important to remember to be a good neighbour and as such when undertaking works near the LGA boundaries of Kempsey and MidCoast Councils, further discussions need to occur to manage the risks of shared estuaries and sediment boundaries.

Consultation will always be a key factor in governance. One way to ensure Council is making sound management decisions is PMHC's internal Coast, Estuary and Floodplain Advisory (CE&F) Sub-Committee that is used for regular review and consultation of policies, projects and studies. Members of this committee consist of representatives from PMHC Councillors, waterways users, community members, development industry, oyster industry, Council staff, Crown Lands, DPI – Fisheries, NPWS, DPIE, TfNSW – Maritime division, and SES.

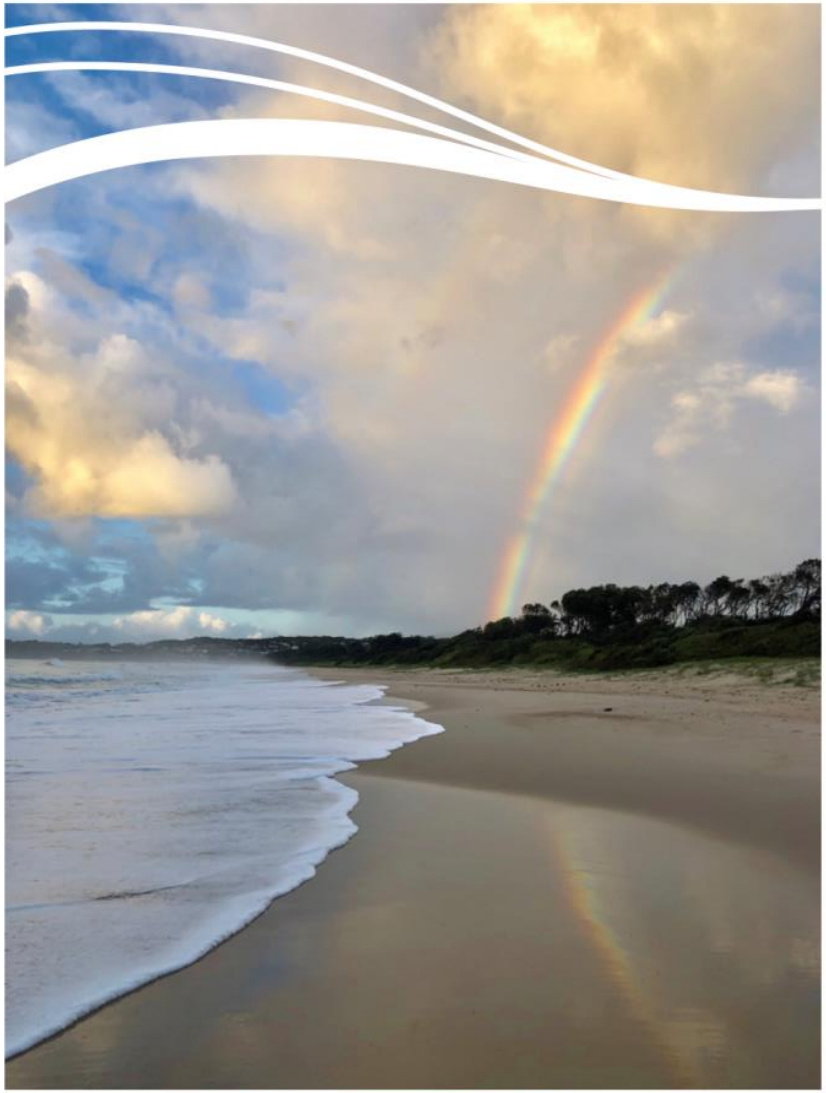


Figure 3. *Rainbow Beach, Bonny Hills*

4. PORT MACQUARIE-HASTINGS COASTAL ZONE

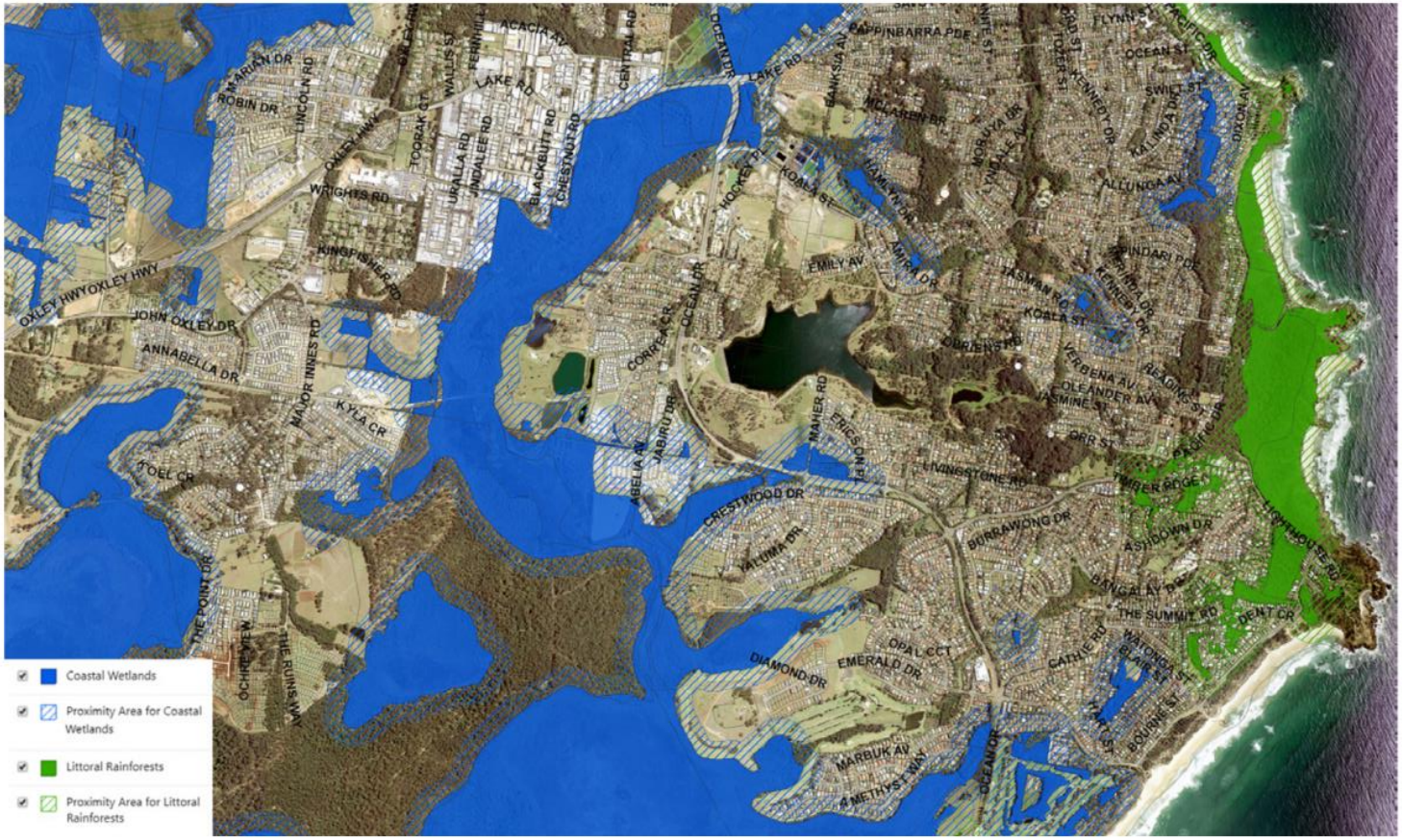


Figure 4. *Example of Coastal Wetlands and Littoral Rainforest map with proximity areas.*

The Coastal Management Act 2016 defines the coastal zone as the area of land comprised within the coastal management areas i.e. coastal wetlands and littoral rainforests area, coastal vulnerability area, coastal environment area and coastal use area. The Coastal Management SEPP 2018 (CM SEPP) identifies these areas and provides mapping for coastal wetlands and littoral rainforests area, coastal environment area and the coastal use area. The CM SEPP states that at the commencement of the policy, no coastal vulnerability area was adopted and therefore this area has not been identified or mapped.

The NSW State Government has generated mapping for the coastal wetlands and littoral rainforests area, coastal environment area and the coastal use area. The mapping for the coastal wetlands and littoral rainforest area includes a proximity area which is included in the definition. The proximity areas include land up to 100 metres area around the defined coastal wetlands and littoral rainforest area *[see Figure 4]*.

Coastal and estuaries within the LGA have historically been managed as separate areas i.e. EMP's and CZMP's. This same principle will be followed within the CMP in order to specify actions and determine priority areas. The following sections identify the Coastal Management Areas mapped or identified in the LGA in context to each area as it applies i.e. estuary, coast or catchment (covering both).

5. VALUES AND RESPONSIBILITIES

Council's Community Strategic Plan (CSP) is an overarching 10-year plan. It is prepared by Council and the community based around community priorities. The current CSP was prepared by Council in 2008 and subsequently reviewed and updated in 2012 and 2016. The plan enables Council to coordinate funding priorities, activities and services to align to community needs and desires. The CSP goals specifically for the Natural and Built Environment are to achieve a connected, sustainable, accessible community and environment that is protected now and into the future. Some of the key priorities of the CSP are:

- A community that is prepared for natural events and climate change.
- Sustainable and environmentally sensitive development outcomes that consider the impacts on the natural environment.
- Infrastructure provision and maintenance that meets community expectations and needs.
- Well planned communities that are linked to encourage and manage growth.
- Accessible and protected waterways, foreshores, beaches and bushlands.
- An environment that is protected and conserved for future generations.

Council is currently in the development of a new Community Strategic Plan (CSP) "Think 2050". This plan needs to be developed before June 2021 to align with the state governments Integrated Planning and Reporting (IPR) framework.

How does the CSP affect the CMP?

In preparing the CMP, Council must integrate the various planning documents and strategies that affect the local community and the state. Being mindful that the CMP will become a reference tool for Council, the community, government agencies and other stakeholders, the document must be practical, achievable and must integrate the actions of the CMP into the larger scope of the Council in order to manage the PMHC coastal zone.

As a way of both understanding the community needs and wants as well as providing guidance to the community regarding how the CMP works, Council staff as well as members of the Coast, Estuary and Floodplain Advisory Committee (including government agency representatives) will be responsible to undertake broad community consultation. This consultation will focus on specific geographical areas and will assist in identifying important assets, issues, risks, solutions and the values and priorities of the community.

Figure 5: *Wildlife at Lake Cathie - Photo: Brett Dolsen*

An overview of some of the identified community values that will be used to guide the long-term outcomes for the CMP are outlined below, Council welcomes more suggestions as we work through the community engagement:

- Unique coastal zone character
- Amenities
- Public access
- Equity and fairness
- Water quality
- Biological diversity
- Ecosystem integrity and resilience
- Recreational use
- Business/employment benefits
- Community benefits

In addition to the broader community, Council is also acutely aware of our neighbouring Councils as we share estuaries and sediment compartments across our Council boundaries. The Camden Haven River Estuary and Tacking Point-Crowdy Head sediment compartment is shared with Mid Coast Council (MCC) and the Hastings River Estuary and the South West Rocks-Port Macquarie sediment compartment is shared with Kempsey Shire Council (KSC). The Coastal Management Act 2016 requires consultation with other local Councils where those Councils share a coastal sediment compartment or estuary. As such, consultation will be undertaken with neighbouring Councils specifically for those actions that effect either a shared estuary or a shared sediment compartment.

6. STRATEGIC CONTEXT

6.1 BACKGORUND

NSW & Local Government have historically managed coasts and estuaries in accordance with the following legislation:

- Coastal Protection Act 1979 (CP Act)
- NSW Coastal Policy 1997 (NSW CP)
- State Environmental Planning Policy Coastal Wetlands No. 14 (SEPP 14)
- State Environmental Planning Policy Littoral Rainforests No. 26 (SEPP 26)
- State Environmental Planning Policy Coastal Protection No. 71 (SEPP 71)
- NSW Rivers and Estuaries Policy (NSW EP)

The NSW State Government undertook coastal reforms in 2016. These reforms repealed the CP Act and replaced it with the Coastal Management Act 2016 (CM Act).

The new framework for managing the NSW coast primarily consists of:

- Coastal Management Act 2016 (CM Act)
- State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP)
- NSW Coastal Management Manual (Manual).
- Coastal Management Programs (CMPs)
- NSW Coastal Council

A CMP is being developed which will provide integrated management of defined coastal areas within the Port Macquarie-Hastings Local Government Area and will replace existing Coastal Zone Management Plans (CZMP) and Estuary Management Plans (EMP) once implemented.

The Manual provides guidance on the development of CMPs and divides the development into five (5) stages, with Stage 1 being a scoping study *[see section 1.1]*.

6.2 HISTORICAL COASTAL MANAGEMENT FRAMEWORK

The coastal zone has historically been managed in accordance with the following legislation.

- **Coastal Protection Act 1979 (CM Act 1979):** Required Council's to develop CZMPs.
- **NSW Coastal Policy 1997 (CP 1997):** This policy provided overarching direction for Council in its preparation and implementation of its CZMP.
- **State Environmental Planning Policy Coastal Wetlands No. 14 (SEPP 14):** This policy provided restriction for development on certain types of land to ensure the protection of coastal wetlands. This SEPP is now repealed and has been replaced with the Coastal Management SEPP.
- **State Environmental Planning Policy Littoral Rainforests No. 26 (SEPP 26):** This policy provided restriction for development on certain types of land to ensure the protection of littoral rainforests. This SEPP is now repealed and has been replaced with the Coastal Management SEPP.
- **State Environmental Planning Policy Coastal Protection No. 71 (SEPP 71):** This policy provided considerations and development conditions on coastal land to ensure developments are suitable and do not impact on the land. This SEPP is now repealed and has been replaced with the Coastal Management SEPP.
- **Environmental Planning and Assessment Act 1979 (EPA Act):** This Act required Council to consider the suitability of the site in assessing proposed development including considering the risks of coastal hazards. It also requires the consideration of the principles of ecologically sustainable development, being an object to the EPA Act. A further section regulating the management of coastal hazards was s149 of the EPA Act, which assisted those applying for a s149 certificate to understand what policies affected the land by restricting development, as well as other relevant matters affecting the land.
- **Environmental Planning and Assessment Regulation 2000:** Clause 92 of this Regulation required Council to consider the provisions of the CP 1997 when determining development applications within a coastal zone.
- **NSW Rivers and Estuaries Policy (NSW EP):** This policy encompassed a suite of component policies each focussing on the protection or management of ecosystem processes and associated values. It also provided for clear management objectives and principles to reflect the State's commitment to resource sustainability.
- **Local Government Act 1993 (LG Act):** This Act requires Council to properly manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of ecologically sustainable development (ESD). The Council's local government area extends to the beach foreshore, being the area between the high watermark and the low watermark. Therefore, Council is required to manage risk in the coastal zone such as foreshore erosion, noting that it should be done so in accordance with ESD and in collaboration with other managing agencies, i.e. Crown Land.

6.3 EXISTING & FORMER MANAGEMENT PLANS

6.3.1. COASTAL ZONE MANAGEMENT PLANS

The Coastal Protection Act 1979 & Coastal Policy suggested that Councils develop and implement Coastal Zone Management Plans (CZMPs) to manage their coastlines. CZMPs were intended to provide management guidance for coastal zones including understanding coastal processes and how the coastal zones were used. For detailed information on existing CZMPs and EMPs refer to Chapter 16 of this scoping study.

The following CZMPs were developed:

- Town Beach Coastal Zone Management Plan (2006). NB. This CZMP was not gazetted as it was not certified by the NSW state government.
- Lake Cathie Coastal Zone Management Plan (2016). NB: This CZMP was gazetted on 27 January 2017.

6.3.2. ESTUARY MANAGEMENT PLANS

The NSW Rivers and Estuaries Policy required Councils to develop EMPs in order to achieve integrated, balanced, responsible and ecologically sustainable use of estuaries which formed a key part of coastal catchments.

The following EMPs were developed:

- Lake Cathie-Lake Innes Estuary Management Plan (1994)
- Hastings River Estuary Management Plan (2001)
- Camden Haven River Estuary Management Plan (2002)
- Saltwater Creek Management Plan (2005)

6.3.3. FLOODPLAIN MANAGEMENT PLANS

Councils also have a role managing floodplain risk. Although these plans coincide with the same geographical area as the coastal zone at times, these management plans are still in effect. No changes in legislation or policy have altered these plans.

The following floodplain risk management plans have been developed and are still in effect:

- Camden Haven Floodplain Risk Management Plan, Bewsher Consulting Pty Ltd, 2004
- Hastings Floodplain Risk Management Plan, Worley Parsons Services Pty Ltd, 2014

6.3.4. OTHER MANAGEMENT PLANS

There are a large number of reserves located in the coastal zone that PMHC manages using Masterplans and Plans of Management. *[See the Other Plans and Reports section of this document for further information]*.

7. NEW COASTAL MANAGEMENT FRAMEWORK

7.1 COASTAL MANAGEMENT ACT 2016

The CM Act establishes the framework and overarching objects for coastal management in New South Wales.

The purpose of the CM Act is to manage the use and development of the coastal environment in an ecologically sustainable way, for the social, cultural and economic well-being of the people of New South Wales.

The CM Act also supports the aims of the Marine Estate Management Act 2014, as the coastal zone forms part of the marine estate.

The CM Act defines the coastal zone, comprising four (4) coastal management areas:

- **Coastal wetlands and littoral rainforests:** areas which display the characteristics of coastal wetlands or littoral rainforests that were previously protected by SEPP 14 and SEPP 26.
- **Coastal vulnerability area:** areas subject to coastal hazards such as coastal erosion and tidal inundation.
- **Coastal environment area:** areas that are characterised by natural coastal features such as beaches, rock platforms, coastal lakes and lagoons and undeveloped headlands. Marine and estuarine waters are also included.
- **Coastal use area:** land adjacent to coastal waters, estuaries and coastal lakes and lagoons.

The CM Act establishes management objectives specific to each of these coastal management areas, reflecting their different values to coastal communities.

Different management objectives exist across the four coastal management areas. New maps defining the coastal management areas were released with the commencement of the Coastal Management SEPP. If multiple areas apply to a single parcel of land, the CM Act imposes a hierarchy as to which coastal management objectives apply.

A Coastal Management Manual has been developed as part of the reform package. The manual contains the mandatory requirements which must be imposed when developing Coastal Management Programs (CMPs).

The Act has abolished the NSW Coastal Panel, and established a new NSW Coastal Council.

TRANSITION FROM OLD TO NEW

The Act has introduced CMP's to replace the Coastal Zone Management Plans (CZMPs) that were implemented under the Coastal Protection Act 1979. Council's must have new CMPs in place and adopted before works can qualify for grant funding. As part of the legislation change no transition arrangements were provided meaning all existing Council adopted Estuary Management Plans are now no longer capable of receiving grant funding.

Hence until a CMP is adopted, no estuary management works will be funded by the NSW State Government. Coastal management works that are contained within a certified CZMP are still eligible for funding, but only until December 2021.

Estuary management works have not been capable of receiving NSW state government grant funding since April 2018 which has significantly impacted on Council's ability to undertake estuary management works.

7.2 STATE ENVIRONMENTAL PLANNING POLICY (COASTAL MANAGEMENT) 2018

The State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP) identifies and maps the coastal zone according to definitions in the CM Act and aims to streamline coastal development assessment requirements.

The CM SEPP identifies development controls for consent authorities to apply to each coastal management area to achieve the objectives of the CM Act. And as such, the CM SEPP establishes the approval pathway for coastal protection works.

Statewide mapping is available for:

- Coastal wetlands and littoral rainforest area
- Coastal environment area
- Coastal use area

At the commencement of the CM SEPP, no Coastal Vulnerability Area Maps were adopted and therefore no coastal vulnerability areas are identified in this policy.

7.3 COASTAL MANAGEMENT PROGRAMS

CMPs will set the long-term strategy for coordinated management of the coast with a focus on achieving the objects of the CM Act. Local Councils in consultation with their communities and relevant public authorities prepare them. Councils are not required to develop a CMP if they choose not to.

If a CMP is proposed, it must:

1. Identify the coastal management issues affecting the areas to which the program is to apply
2. Identify the actions required to address those coastal management issues in an integrated and strategic manner
3. Identify how and when those actions are to be implemented
4. Identify the costs of those actions and proposed cost-sharing arrangements and other viable funding mechanisms for those actions
5. Include a coastal zone emergency action sub-plan if the local Council's LGA contains land within the coastal vulnerability area and beach erosion, coastal inundation or cliff instability is occurring on that land.

A CMP may also include other matters as may be authorised or permitted by the Manual.

7.4 NSW COASTAL MANAGEMENT MANUAL

The Manual provides mandatory requirements and guidance for the preparation, development, adoption, implementation, amendment and review of CMPs.

It provides systematic guidance on how to prepare a CMP and integrate coastal management actions with Councils other strategic and land-use planning processes.

The Manual is comprised of three parts:

PART A
Outlines the mandatory requirements in the CM Act, and the essential elements that councils are required to follow.

PART B
Describes in detail the process for preparing a CMP.

PART C
Provides a technical toolkit with advice on a range of topics.

7.5 NSW COASTAL COUNCIL

The NSW Coastal Council is appointed by the NSW Government to provide independent advice to the Minister on coastal issues. The NSW Coastal Council replaces the NSW Coastal Panel and the Coastal Expert Panel.

Figure 6. *Oxley Beach, Port Macquarie*

7.6 COASTAL AND ESTUARY GRANTS PROGRAM

The Coastal and Estuary Grants program provides funding assistance to help Councils prepare and implement CMPs. Funding has historically been provided for planning and implementation works at a ratio of 1:1, meaning for every one-dollar Council commits, the NSW government will provide a matching one-dollar.

In April 2020 the NSW Government announced that it was increasing financial assistance to Councils to help mitigate coastal erosion risks and restore degraded coastal habitats.

Minister for Local Government Shelley Hancock said the funding ratio for eligible projects under approved Coastal Management Programs will increase to 2:1 meaning the State will now contribute two-dollars to every one-dollar put in by Councils.

These changes are part of 32 supported recommendations from a recent review that examined ways of improving Councils access to funding under the Coastal and Estuary Management program.

The 2:1 funding ratio will bring the Coastal & Estuary Management grants program in line with the Floodplain Management Grants Program.

The 2:1 funding ratio is only applicable to planning and implementation projects where they are in an approved CMP, as such the action items from the certified Lake Cathie CZMP are not eligible for 2:1 funding and will only be able to access funding from the NSW Government at a 1:1 ratio.

Current Coastal & Estuary Grant Program funding is only available until the end of the 2020/2021 financial year. Grant funding arrangements after this time are unknown.

8. STRATEGIC CONTEXT

8.1 STRATEGIC PLANS

PMHC is guided by a number of key strategies and plans which will assist with integrating the aspects of population growth, land use, community values and expectations into the CMP. These strategies and plans are summarised below.

INTEGRATED PLANNING AND REPORTING FRAMEWORK (IP&R)

The Integrated Planning and Reporting (IPR) framework was legislated by the New South Wales Office of Local Government in 2009. It provides councils with a planning framework that is guided by the vision of the community for a 10 year period and gives local governments a structure for establishing local priorities and to link this information to operational functions.

The framework includes a suite of integrated plans that set out a vision and goals and strategic actions to achieve them. It involves a reporting structure to communicate progress to council and the community as well as a structured timeline for review to ensure the goals and actions are still relevant.

The framework is made up of four major elements, which are linked and continually assessed through regulatory reporting channels.

These are the:

- Towards 2030 Community Strategic Plan (CSP) 2017-2021
- Delivery Program (DP) (Revised)
- 2020-2021 Operational Plan (OP)
- Resourcing Strategy (RS)

Under the framework, councils are required to give due regard to State Plan NSW 2021 and other Relevant Regional Plans to inform Council in identifying relevant issues for its Community Strategic Plan. Likewise, Council also have a wide range of plans for consideration, which highlight key local community issues. A number of examples include Urban Growth Management Strategy, Economic Development Strategy, Recreation Action Plan, Biodiversity Strategy, and Cultural Plan.

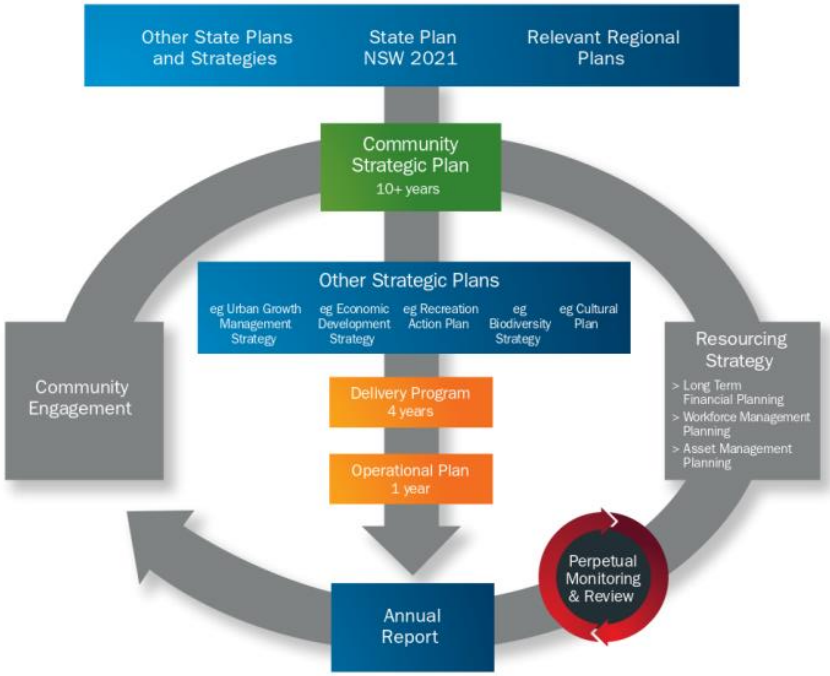
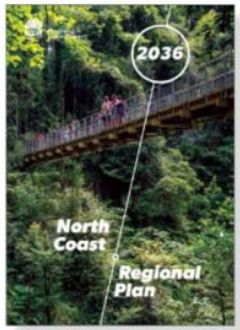


Figure 7. *Integrated planning and reporting framework*

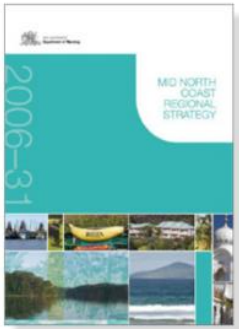
NORTH COAST REGIONAL PLAN 2036

The North Coast Regional Plan 2036 is a broad strategic plan that reflects the community's aspirations and opportunities for the north coast of NSW until 2036.



MID NORTH COAST REGIONAL STRATEGY 2006 - 2031

The Mid North Coast Regional Strategy 2006 – 2031 was released by NSW Department of Planning in March 2009. The primary purpose of the regional strategy is to ensure that adequate land is available and appropriately located to accommodate projected housing and employment needs of the region's population over the next 25 years.



In summary the aims of the strategy are to:

- Protect high value environments and habitat corridors, cultural and Aboriginal heritage and scenic landscapes.
- Provide up to 58,400 new homes by 2031 to cater for a forecast population increase of 91,000. With smaller households and an ageing population, a more suitable mix of housing will be encouraged, including more multi-unit style dwellings.
- Ensure an adequate supply of land is available to support economic growth and an additional 47,000 jobs.
- Encourage the growth and redevelopment of the Region's four major regional centres (Grafton, Coffs Harbour, Port Macquarie and Taree) and six major towns (Maclean, Woolgoolga, Bellingen, Macksville, Kempsey and Forster–Tuncurry) through urban design and renewal strategies.
- Protect the coast by focusing new settlement in areas identified on local strategy maps. Development in places constrained by coastal processes, flooding, wetlands, important farmland and landscapes of high scenic and conservation value will be limited.

PMHC URBAN GROWTH MANAGEMENT STRATEGY (UGMS) 2017-2036

The PMHC UGMS aims to identify opportunities for new economic development and housing that will meet the needs of the growing community. The Community Vision for the Port Macquarie-Hastings is "A sustainable high quality of life for all". The strategy focuses on the coastal area and major towns and villages where urban growth is expected to take place over the next 20 years.

TOWARDS 2030 COMMUNITY STRATEGIC PLAN 2017

The CSP identifies what the community wants for the future of the LGA and what should be prioritised. This plan should be reviewed every 10 years and is the overarching guidance for Councils strategic direction. The Delivery Program and the Operational Plan are the underlying plans of the CSP, which provide more detailed targets and actions to be delivered and how they can be achieved.

The CMP must consider the strategic direction of the Community Strategic Plan to ensure that it coincides with what the community wants for the LGA. This will then have to be integrated into the Delivery and Operational Plans once specific actions are determined.

PMHC's Towards 2030 Community Strategic Plan (CSP) for the natural and built environment aims "to achieve a connected, sustainable, accessible community and environment now and into the future". The results of the CSP will be:

- Effective management and maintenance of essential water, waste and sewer infrastructure
- A community that is prepared for natural events and climate change
- Sustainable and environmentally sensitive development outcomes that consider the impact on the natural environment
- Accessible transport network for our communities
- Infrastructure provision and maintenance that meets community expectations and needs
- Well planned communities that are linked to encourage and manage growth
- Accessible and protected waterways, foreshores, beaches and bushlands
- An environment that is protected and conserved for future generations
- Renewable energy options that are understood and accessible by the community

PMHC continues to look to the future and therefore has already begun preparing the "Think 2050 CSP" which will supersede the current CSP when completed.

THINK 2050 COMMUNITY STRATEGIC PLAN

Port Macquarie-Hastings Council launched the Think 2050 Community Strategic Plan and commenced community engagement on 4 December 2019.

Think 2050 is centered on engaging with everyone in our community including those that live, work, study, attend school or do business, as well as those that shop or visit our beautiful region.

Throughout the first half of 2020 Council will be engaging with community members and asking for ideas, suggestions, and feedback to help plan for the ongoing and future needs of the region. These findings will be incorporated into the CMP as they develop.

9. PORT MACQUARIE-HASTINGS LGA OVERVIEW

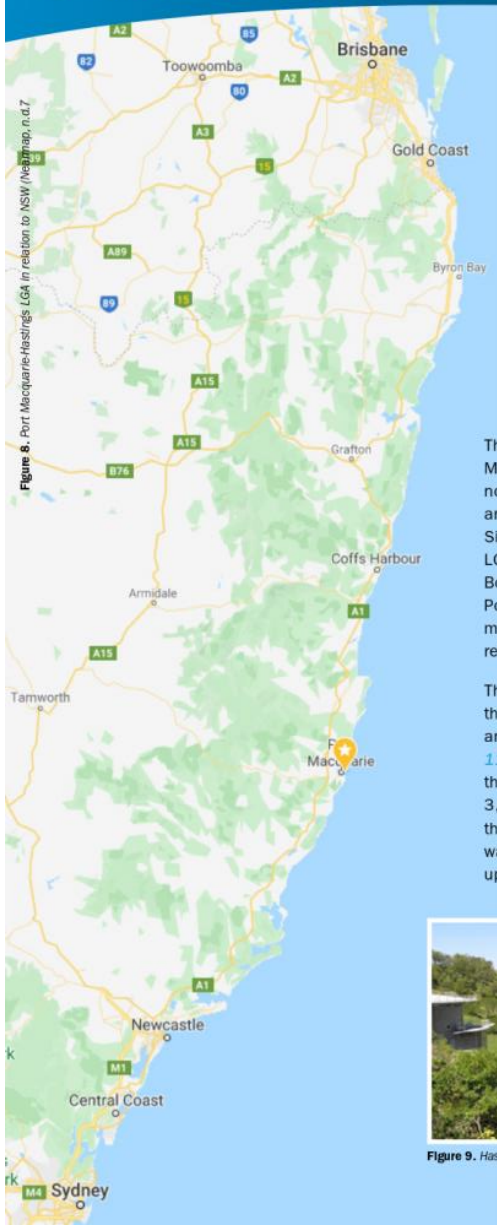


Figure 8. *Port Macquarie-Hastings LGA in relation to NSW (Nearmap, n.d.)*

The mouth of the Hastings River is located at Town Beach Port Macquarie while the Camden Haven River comes out between North Haven and Dunbogan. The Lake Cathie/Lake Innes catchment does not have a major river feeding the system, but instead is fed by a number of small creeks that flow into both lakes. Lake Cathie is an Intermittingly Closed and Open Lake or Lagoon (ICOLL) meaning it does not permanently have open access to the ocean.

The Port Macquarie-Hastings LGA has a remarkable coastline extending from Point Plomer in the north to Diamond Head in the south *[see Figure 12]*. There are numerous beaches in the LGA and among some of the finest in the state, offering a mixture of fine sandy shores, rocky headlands and rainforests. Some of the most visited beaches include Town Beach (Port Macquarie), Light House Beach (Port Macquarie) and Shelly Beach (Port Macquarie). Other notable beaches include Rainbow Beach (Bonny Hills), North Haven Beach and Pilot Beach (Dunbogan).

PORT MACQUARIE-HASTINGS LOCAL GOVERNMENT AREA

The Port Macquarie-Hastings LGA is located on the Mid-North Coast of NSW, about 320 kilometres north of Sydney, 420km south of Brisbane, QLD and has an area 3,687 km2 *[Refer to Figure 8]*. Significant localities situated on the coast in the LGA are North Shore, Port Macquarie, Lake Cathie, Bonny Hills, North Haven, Dunbogan and Laurieton. Port Macquarie is the most populous and attracts most of the coastal activity, especially activities related to tourism.

There are three main catchments in the LGA: the Hastings River, Lake Cathie/Lake Innes and the Camden Haven *[see Figures 9, 10 and 11]*. The Hastings River is the largest of all these catchments and encompasses an area of 3,864km2. The river itself is 165km long and is the source of the majority of the LGA's drinking water supply which is pumped from Koree Island, upstream of Wauchope.

Figure 12. *Port Macquarie-Hastings LGA showing coastal areas*

Figure 9. *Hastings River from Koree Island*

Figure 10. *Lake Cathie looking west*

Figure 11. *Camden Haven River looking towards North Brother mountain*

10. ENVIRONMENTAL CONTEXT

10.1 CLIMATE

The PMH LGA is located in the subtropical region of Australia where it experiences a warm temperate climate. Summers are moderately warm and humid with coastal storms often occurring in the evening during the later summer months. Winters are generally mild with frosts often occurring in the inland areas.

Weather data sampled at the Port Macquarie Airport shows the mean maximum temperature is 23.8° C and the mean minimum temperature is 12.7° Celsius. The mean annual rainfall for the LGA varies depending on proximity to the coast and the higher peaks inland. Generally speaking, the mean annual rainfall for the LGA is approximately 1500mm.

As is the rest of NSW and Australia, PMHC is prone to experiencing prolonged droughts with significantly less than average rainfall occurring throughout the region at times. This leads to lower river levels and increased bushfire intensity and frequency.

10.2 SIGNIFICANT CLIMATIC EVENTS

PMHC experiences a number of coastal storm events with the latest significant event being the East Coast Low of June 2016. This event included strong north-easterly winds (gusts up to 120km/h) with the highest individual wave recorded on the NSW coast of 17.7m at Eden (BOM, Manly Hydraulics Laboratory and OEH, 2016). This event occurred at the same time as the winter solstice spring tide and significant rainfall which both compounded the erosive damage and storm debris to PMHC's coast.

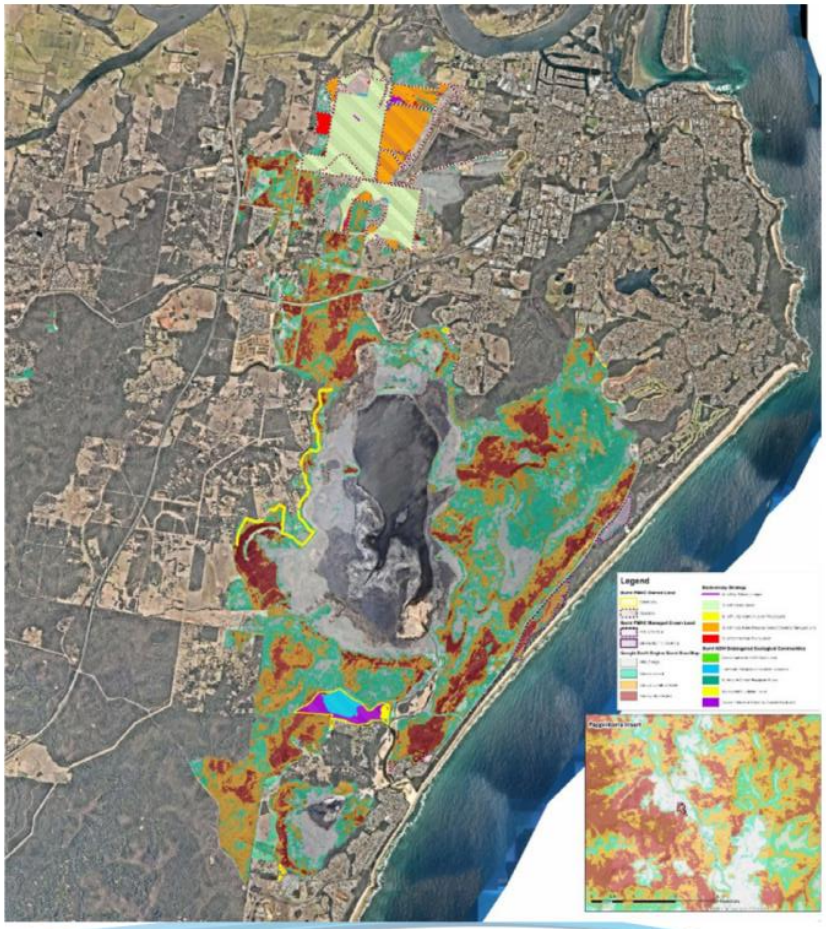
PMHC has experienced some major flood events (1963 and 1968) as well as more frequent relatively minor events (1978, 1995 and 2013). The 1963 flood was the worst in the lower catchments (Hastings & Camden Haven) due to high ocean conditions. This was estimated to be a "1 in 100-year" event and anecdotally the worst Wrights Creek flood recorded. The 1968 flood was also estimated to be a "1 in 100-year" event and mostly affected the upper catchments due to high rainfall. The 1978, 1995 and 2013 Hastings River floods were all approximately "1 in 20 year" events.

Drought has affected most of New South Wales since early 2017 and in 2019 the PMH LGA experienced its lowest recorded amount of annual rainfall (514mm) since 1870. The rainfall deficiencies contributed to the stoppage of water flow in the Hastings River which meant that PMHC and private landholders were unable to extract water for domestic and irrigation purposes from the system. This also led to heavy water restrictions being placed on the local community by PMHC. The Lake Cathie/Innes estuarine system was also adversely affected by the ongoing drought conditions. Council last artificially opened the lake entrance in July 2018 as the lake reached 1.6m AHD and began affecting properties that are susceptible to nuisance flooding. Post opening, a lack of rainfall and small depositional waves naturally closed the entrance and with high temperatures and high evaporation rates following the closure, the lake dropped to very low levels. The lowered water levels within the system exposed extensive foreshore areas comprising ASS, caused elevated water temperatures, low dissolved oxygen levels, hypersalinity and fish kills.

During the extraordinarily damaging bushfire season of 2019-20 approximately 140,000 Ha of land was burned within the PMH LGA. This included 3,572 Ha around the Lake Innes Nature Reserve south to Lake Cathie and around the Queens Lake Conservation Area *[Refer to Figure 13]*. There has been considerable debate regarding the underlying cause of the intensity and scale of the recent fires, including the role of fire management practices and climate change. Bushfires however, are not new to the area, major bushfire events being experienced in the past. Since 2000 there have been significant fires in Limeburners National Park (2002 & 2010), Christmas Bells Plains (2002), Bonny Hills (early 2000's) Dunbogan (2005) and Pappinbarra (2017 & 2019).

Bushfires can have various impacts on waterways both during and post fires. The key contaminants of concern for managers include increased suspended solids and turbidity, increased nutrients, increased risk of toxic algal blooms and increased metal concentrations. Fire also increases the potential for runoff and erosion as well as unburnt organic matter washing into waterways and reducing dissolved oxygen as it decomposes.

Figure 13. *Bushfire map depicting burnt land in the Port Macquarie area during 2019-20*



10.3 PHYSICAL FEATURES AND COASTAL PROCESSES

The coastline is subject to a high energy wave climate. The offshore swell wave climate (wave height, period and direction occurrences) has been recorded by the NSW Government Manly Hydraulics Laboratory with Waverider buoys located at Sydney, Crowdy Head and Coffs Harbour for many years. The wave data show that the predominant swell wave direction is south-southeast (SSE) with over 70% of swell wave occurrences directed from the SSE. The average deep-water significant wave height is measured at 1.6m with the average wave period being 10 seconds as recorded at Crowdy Head (SMEC, 2008).

East Coast Lows (ECLs) have occurred in the area causing coastal erosion and washing up of debris. One large event was recorded in June 2016 *[pictured in Figures 14 to 17 to the right]*. ECLs are intense low-pressure systems that occur off the east coast of Australia. They can form at any time of the year and significant ECLs occur on average about 10 times each year. These storms can have severe consequences in terms of wind damage, storm surge, heavy and damaging surf and flash flooding (AdaptNSW). Climate modelling projects a decrease in the number of small to moderate ECLs in the cool season with little change in these storms during the warm season. However, extreme ECLs in the warmer months may increase in number but extreme ECLs in cool seasons may not change.

The open coastline is made up of sandy beaches and rocky headlands with significant portions of the coastline made up of the Coastal Wetland and Littoral Rainforest Area (CWLRA), and National Parks. Parts of the coast are susceptible to coastal erosion, in particular, Town Beach and Lake Cathie Beach (Lighthouse Beach).

Lighthouse Beach at Lake Cathie is comprised of underlying consolidated or indurated sands (coffee rock) which is more resistant to erosion than typical unconsolidated beach sand. Despite this, erosion of the sand dune happens often after storm events and the close proximity of privately owned houses and public assets to the shoreline means it requires management. Town Beach is the main beach in the LGA. While there are no residential properties under threat, there are a number of assets such as roads and park infrastructure that are exposed to this risk. Other beaches where erosion has been identified, though not studied, are Rainbow Beach, Shelly Beach, North Shore Beach (Corilla Estate) and Dunbogan Beach. These are areas where investigations will be considered during the CMP process.

Figure 14. *Town Beach East Coast Low event June 2016 (before and during)*

Figure 15. *And after looking east towards Kiosk*

Figure 16. *Lake Cathie East Coast Low Event June 2016. Pictured at intersection of Kalang Drive and Bundella Avenue, Lake Cathie. Left photo taken 8 September 2015 and right photo taken 26 July 2016.*

Figure 17. *Lake Cathie East Coast Low Event June 2016 - during early and later phases of event, looking south along Illaroo Road.*

10.4 SEDIMENT COMPARTMENTS

Coastal sediment compartments are defined areas that have similar coastal processes and are based on sediment flows and landforms.

The Australian Government initiated the Coastal Compartments Project which aimed to establish a consistent approach in managing Australia's coastline (Thom, N.D.). This project resulted in sediment compartments being mapped along Australia's entire coastline. These sediment compartments are divided into three levels:

- **Primary level** defined by large landforms e.g. headlands and rivers
- **Secondary level** defined by sediment movement within and between beaches
- **Tertiary level** where sediment moves in the nearshore area e.g. individual beaches

PMHC shares two coastal sediment compartments with neighbouring Councils that are defined as secondary level compartments. The South West Rocks-Port Macquarie sediment compartment *[see Figure 18]* is shared with KSC and the Tacking Point-Crowdy Head sediment compartment *[see Figure 19]* is shared with MCC. These sediment compartments are identified in Schedule 1 of the CM Act.

Figure 18. *South West Rocks-Port Macquarie sediment compartment (Geoscience Australia, 2016)*

Figure 19. *Tacking Point-Crowdy Head sediment compartment (Geoscience Australia, 2016)*

ESTUARY CATCHMENTS AND RIVER CONDITION

Estuaries in the PMHC LGA are the Hastings River estuary, Camden Haven River estuary and Lake Cathie-Lake Innes estuary. PMHC shares two estuaries with neighbouring Councils. The Camden Haven River Estuary is shared with MCC and the Hastings River Estuary is shared with KSC.

Consultation with other local councils on the draft CMP is required by s16 (1) (b) (i) and (ii) of the CM Act where those councils share a coastal sediment compartment or estuary as specified in Schedule 1 of the CM Act. Consultation will occur with each Council in developing management actions for these shared areas

ECOHEALTH MONITORING

Ecohealth reports determine the health of estuaries and rivers in the LGA based on effects from diffuse sources. They are assessed based on Ecohealth indicators (water quality, riparian vegetation, geomorphic condition, macroinvertebrates and plankton) and are provided with a score. Ecohealth Reports were prepared in 2012 & 2017.

The 2017 Ecohealth report (Darren Ryder, 2017) gave the LGA an overall score of "C" which is rated as fair. The Lake Innes/Lake Cathie catchment slightly declined from 2011, the Hastings River catchment declined and the Camden Haven River catchment had no change (Darren Ryder, 2017). Across the Hastings and Camden Haven catchments there was a typical decline in geomorphic condition which highlights the importance of maintaining healthy riparian vegetation to promote bank stability. The best riparian condition was surrounding the coastal lagoons where it was assessed as being in very good condition. The Camden Haven catchment was assessed as having moderate riparian condition while the Hastings River catchment was moderate in the freshwater reaches, but was poor in the Hastings River main stem. Main issues identified were the dominance of invasive weeds, vegetation clearing that has reduced riparian connectivity and damage from livestock.

Water quality was moderate across both Hastings and Camden Haven catchments and had declined from 2011 to 2015, driven largely by high nutrient concentrations, more acidic pH and low dissolved oxygen - all of which were directly linked to very low flows experienced during the study. Aquatic macroinvertebrate condition was moderate across the catchments with a small decline between the two assessments in abundance and richness. Again this was the result of low flows and macroinvertebrate condition did improve in the latter stages of the assessment when stream flows increased, indicating a resilience to extreme low flows. It is noted though that this resilience is reliant on good habitat quality which is linked to good riparian condition.

The management priorities identified in the Ecohealth report (freshwater and estuarine reaches) included:

HASTINGS RIVER CATCHMENT

- Weed monitoring for the movement and spread of weed species.
- Weed control for the removal of various noxious and environmental weed species.
- Native riparian plantings for site rehabilitation, native regeneration assistance, increased riparian width, continuity and connectivity to larger tracts of remnant vegetation.
- Riparian fencing to reduce livestock impact and reduce bank erosion, encourage regeneration of native vegetation, accumulation of woody debris and to increase riparian width, continuity and connectivity to larger tracts of remnant vegetation.
- Investigate subcatchment sources of TN, TP, NOx and SRP to the river.

CAMDEN HAVEN CATCHMENT

- Weed monitoring for the movement and spread of weed species.
- Weed control for the removal of various noxious and environmental weed species.
- Investigate subcatchment nonpoint sources of TN and NOx to the river.
- Phase out exotic dominants - planting of native canopy species to replace strategic removal of exotic canopy and midstory species.
- Riparian fencing to reduce livestock impact and reduce bank erosion, encourage regeneration of native vegetation, accumulation of woody debris and to increase riparian width, continuity and connectivity to larger tracts of remnant vegetation.
- Native riparian plantings: to replace exotic dominants, site rehabilitation and native regeneration assistance, increased riparian width, continuity and connectivity to larger tracts of remnant vegetation.

LAKE CATHIE AND LAKE INNES CATCHMENT

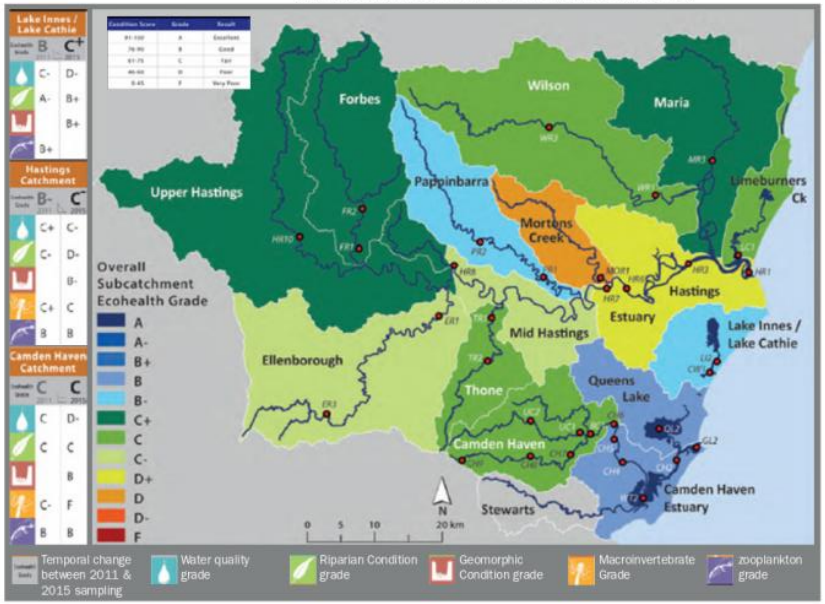
- Weed monitoring for the movement and spread of weed species.
- Weed control for the removal of various noxious and environmental weed species.
- Maintaining adequate riparian width - supports ecological function by buffering against exotic species and environmental impacts while allowing for the accumulation of woody and non-woody debris, which through the provision of niche habitats supports native woody regeneration and native animal species.
- Investigate sub-catchment nonpoint sources of TN, TP and NOx to the estuarine lagoons.

All other sites/sub-catchments investigated produced similar management actions seen in the following table:

Sites	Weed monitoring	Weed control	Native plantings	Fencing	Weed species phase-out	Woody debris	Maintain Riparian width	Water quality	High nutrient concentrations
Black Creek (BC1)	Y	Y	Y	Y	Y		Y	*Poor*	*TN, NOx*
Camden Haven (CH2)	Y	Y	Y				Y	*Moderate*	*TN, NOx*
Camden Haven (CH4)	Y	Y					Y	*Poor*	*TN, NOx*
Camden Haven (CH5)	Y	Y			Y		Y	*Very poor*	*TN, NOx*
Camden Haven (CH6)	Y	Y					Y	*Moderate*	*TN, NOx*
Camden Haven (CH7)	Y	Y		Y	Y		Y	*Poor*	*TN, NOx*
Camden Haven (CH8)	Y	Y		Y			Y	*Moderate*	*TN, NOx*
Camden Haven (CH9)	Y	Y					Y	*Poor*	*TN, NOx*
Lake Cathie (CW1)	Y	Y					Y	*Poor*	*TN, TP, NOx*
Ellenborough River (ER1)	Y	Y	Y	Y			Y	*Moderate*	*TN, TP, NOx*
Ellenborough River (ER3)	Y	Y		Y			Y	*Poor*	*TN, TP, NOx*
Forbes River (FR1)	Y	Y	Y	Y	Y		Y	*Good*	*TN, NOx*
Forbes River (FR3)	Y	Y		Y			Y	*Moderate*	*TN, NOx*
Gogleys Lagoon (GL1)	Y	Y					Y	*Moderate*	*TN, NOx, TP, SRP*
Hastings River (HR1)	Y	Y			Y	Y	Y	*Moderate*	*TN, NOx, SRP*
Hastings River (HR3)	Y	Y	Y	Y		Y	Y	*Moderate*	*TN, NOx, SRP*
Hastings River (HR6)	Y	Y	Y	Y	Y		Y	*Poor*	*TN, NOx, SRP*
Hastings River (HR7)	Y	Y	Y	Y	Y		Y	*Poor*	*TN, NOx, SRP*
Hastings River (HR8)	Y	Y	Y	Y			Y	*Moderate*	*TN, TP, NOx*
Hastings River (HR10)	Y	Y	Y	Y			Y	*Poor*	*TN, TP, NOx*
Limeburners Creek (LC1)	Y	Y					Y	*Moderate*	*TN, NOx, SRP*
Lake Innes (LI1)	Y	Y					Y	*Poor*	*TN, TP, NOx*
Mortons Creek (MOR1)	Y	Y		Y	Y		Y	*Moderate*	*TN, NOx*
Maria River (MR1)	Y	Y		Y			Y	*Very poor*	*TN, NOx*
Pappinbarra River (PR1)	Y	Y		Y	Y		Y	*Moderate*	*NOx*
Pappinbarra River (PR2)	Y	Y		Y			Y	*Good*	*NOx during low flows*
Queens Lake (QL2)	Y	Y					Y	*Poor*	*TN, NOx, TP, SRP*
Thone River (TR1)	Y	Y	Y	Y			Y	*Moderate*	*TN, TP, NOx*
Thone River (TR2)	Y	Y	Y	Y			Y	*Moderate*	*TN, TP, NOx*
Upsalls Creek (UC1)	Y	Y		Y	Y		Y	*Moderate*	*TN, NOx*
Upsalls Creek (UC2)	Y	Y					Y	*Moderate*	*TN, NOx*
Watson Taylors Lake (WT2)	Y						Y	*Poor*	*TN, NOx, TP, SRP*
Wilson River (WR1)	Y	Y	Y	Y	Y		Y	*Poor*	*TN, NOx*
Wilson River (WR3)	Y	Y	Y	Y	Y		Y	*Moderate*	*TN, NOx*
Total	34	33	13	21	12	2	34	N/A	N/A

Table 1. *A summary of recommendations to improve riparian condition at each of the 34 Hastings - Camden Haven Ecohealth study sites.*

Figure 20. *Echohealth 2017 rating of each catchment. (Darren Ryder, 2017)*



The University of New England (UNE) with funding from PMHC has historically undertaken the Ecohealth reports. Consideration will be provided to committing to long-term funding for this project.

NSW ESTUARY HEALTH RISK DATASET

The NSW Government is leading a water quality initiative to improve the management and co-ordination of urban and rural diffuse source water pollution in New South Wales (NSW) as part of their requirements to implement the Marine Estate Management Strategy 2018–2028 (MEM Strategy). A key approach to delivering this initiative is to adopt the Risk-based framework for considering waterway health outcomes in strategic land use planning decisions (Risk-based Framework).

In May 2017, the former Office of Environment and Heritage (OEH) and the NSW Environment Protection Authority released an introductory resource on the Risk-based Framework in response to 3 years of consultation on urban planning and wider catchment management.

The former OEH applied the first two steps of the Risk-based Framework and produced the NSW Estuary Health Risk Dataset to help inform Stage 1 scoping studies during the preparation of coastal management programs under the NSW Coastal Management Manual (2018). The dataset can be used to map (spatially prioritise) where further studies and/or management actions in a catchment would help achieve outcomes for coastal environment areas and coastal wetlands and littoral rainforests areas specified in the Coastal Management Act 2016. These outcomes are specifically to:

- protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons
- enhance natural character, scenic value, biodiversity and ecosystem integrity of coastal environments
- reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change
- maintain and improve water quality and estuary health
- support social and cultural values of coastal waters, estuaries, coastal lakes and lagoons
- protect coastal wetlands and littoral rainforests in their natural state, including their biodiversity and ecosystem integrity
- promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests
- improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration
- support the social and cultural values of coastal wetlands and littoral rainforests
- promote the objectives of NSW Government policies and programs for wetlands or littoral rainforest management.

SEAGRASS MAPPING

Seagrass meadows are a vital habitat for many estuarine species and make valuable contributions to estuarine ecology. Multiple studies have shown that seagrasses within NSW estuaries have suffered long-term declines over the last 50 – 60 years. NSW estuaries have even had reported losses of up to 85% of seagrasses during this time (West, 2006). A review of the existing literature suggests that the long-term decline in seagrass biomass is likely a result of anthropogenic impacts on our estuarine systems and their catchments. Urbanisation, dredging and poor catchment management practices are perhaps the leading contributors to the decline and these issues need to be addressed and closely managed if the long-term losses are to be reduced.

Seagrass mapping was undertaken in 2012 and meadows exist in both the Hastings River Estuary and the Camden River Estuary. No seagrass meadows are shown to exist in Lake Cathie/Lake Innes, which is not uncommon for an ICOLL. Reports in fish and prawn stock declines in the Camden Haven Estuary may be associated with a decline in seagrass and may also be associated with known Acid Sulphate Soil (ASS) discharge emanating from the western side of Watson Taylor Lake. Collaborating with Mid Coast Council will be necessary to investigate management options for the ASS. An investigation may be undertaken on an LGA-wide scale to try to identify changes in seagrass distribution and abundance.

POSSIBLE FUTURE ACTIONS

An audit and development of a maintenance plan may be completed for all existing ASS infrastructure.

ACID SULPHATE SOILS (ASS) MANAGEMENT

The LGA has 19,513ha of high risk ASS and 6,874ha of low risk mapped ASS. Many management actions were undertaken in past EMPs and 5,122ha of ASS has been remediated including 145km of excavated drains and channels.

There are multiple solutions for managing ASS issues. These may include engineered weir structures such as what was installed in partnership with Partridge Creek landholders or to fill the drains completely but many of these are on private land. Works may involve a joint venture with Kempsey Shire and with Mid Coast Council to achieve management actions for Watson Taylor Lake, Stewarts River and surrounding lands.

Estuaries and rivers in the LGA are under an ever-growing threat of encroaching development. Managing development and its impacts is a key management action for the CMP.

10.5 HABITAT CONDITION

The PMHC LGA is an area rich in biodiversity supporting a diverse range of both terrestrial and aquatic plants and animals. The area includes specific areas of biological importance. Limeburners Creek Nature Reserve for example, is one of only two coastal wilderness areas in NSW. Lake Innes Nature Reserve has been considered the 'engine room' for Koala populations in the LGA and has historically contained a 'nationally significant population' (as defined by Federal Government criteria). Sea Acres Nature Reserve and adjoining council land are some of the largest remaining patches of littoral rainforest, particularly outside far northern Queensland.

The estuaries and foreshores of the Camden Haven and Hastings Rivers are of immense importance for migratory shorebirds listed under international conventions and agreements.

The PMHC LGA has, until recently, been identified as an area that held the largest remaining coastal population of koalas. A lot of work has been done, and continues to be done, in maintaining these populations which continues to be challenging given the significant increase in development over a number of years and increased bushfire severity and intensity.

NATIVE VEGETATION

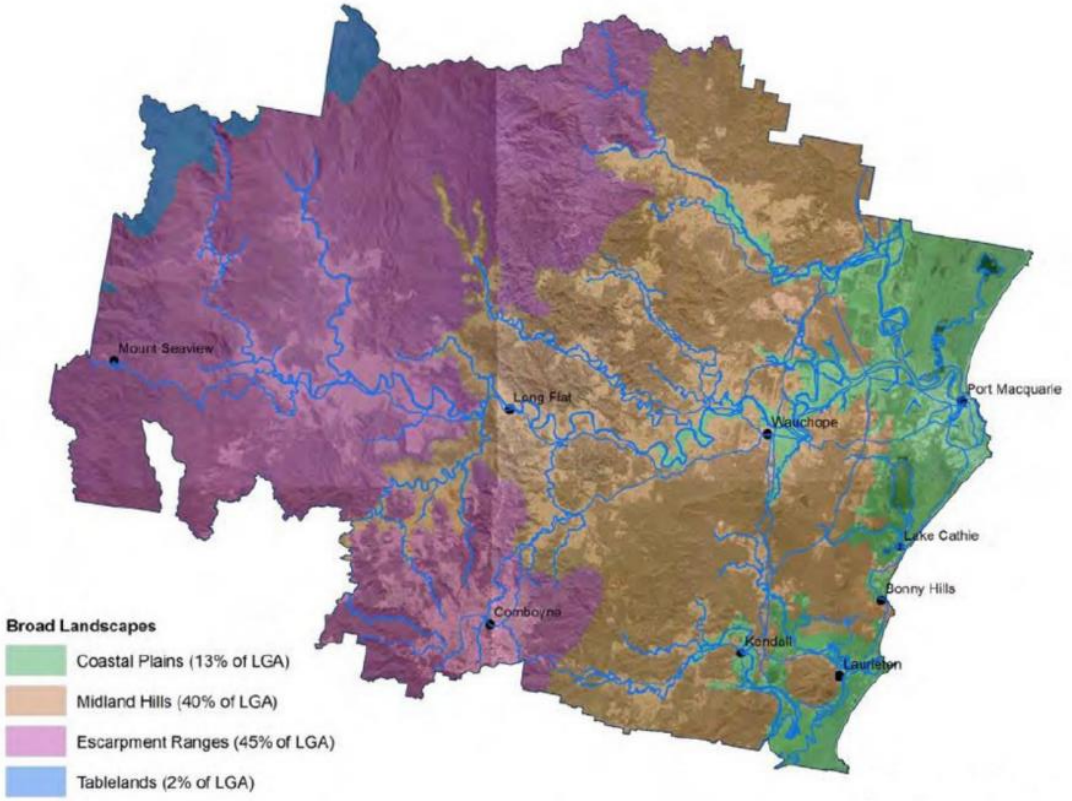
The PMHC LGA can be broadly divided into four landscapes: Coastal Plains, Midland Hills, Escarpment Ranges and Tablelands *[see Figure 21]*. Each of these different landscape units has different biophysical factors (e.g. geology and climate) and therefore supports a different assemblage, or mix, of plants and animals.

Broadly speaking, PMHC has a good coverage of remaining native vegetation however the Coastal Plains Landscape has undergone the most extensive development and has the lowest percentage (56%) of remaining vegetation.

PMHC has completed detailed vegetation mapping which shows all remnants outside state forests and national parks. There are 83 vegetation communities that have been mapped. There are approximately 1,890 native plant species and 621 native animal species recorded in the PMHC LGA. Of these, there are approximately 140 threatened animals, 50 threatened plants and 9 threatened ecological communities. These numbers are approximations only given the dynamic nature of these lists and limited knowledge.

PMHC is attempting to align the Port Macquarie Vegetation Communities with the plant community types used under the

Figure 21. *Broad Landscapes of PMHC LGA (Port Macquarie-Hastings Council, 2017).*



Biodiversity Conservation Act. The Biodiversity Conservation Act 2016 dictates that environmental impacts be calculated relative to these plant community types. At the local level, Councils may wish to conduct their own vegetation community mapping, which further splits NSW plant community types into locally recognised discrete communities. Mapping plant community types is not easy because areas frequently include components of two community types — this is particularly true where the communities occur adjacent to each other (in what are called ecotones). PMHC is confident that current mapping accurately represents local plant communities.

10.6 ESTUARINE AND COASTAL WETLANDS AND COASTAL LAKES

Estuarine wetlands, coastal floodplain wetlands and coastal lakes are ecologically, socially and economically important. They provide many ecosystem functions, ecosystem services and habitats for a wide range of animals (e.g. waterbirds, fish, frogs and invertebrates) and water-dependent plants (e.g. sedges, rushes and various tree species), including many threatened species and ecosystems. Estuarine and coastal wetlands and coastal lakes also provide shelter, breeding grounds and nurseries for a variety of fauna, particularly insects, fish, frogs and waterbirds, including migratory birds listed under various international agreements including the Bonn Convention and the bilateral migratory bird agreements with Japan, China and the Republic of Korea.

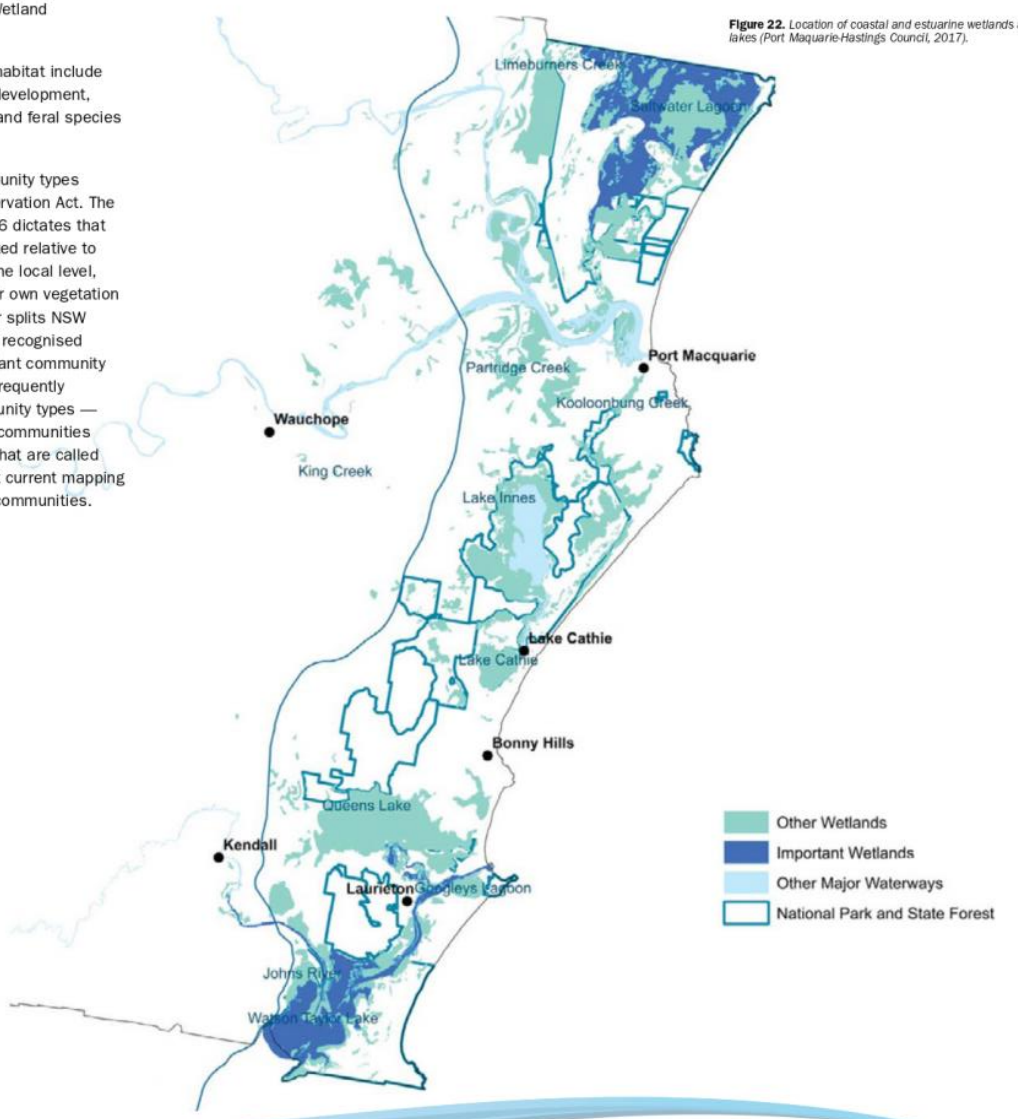
The PMH LGA has some very significant estuarine and coastal wetlands and coastal lakes located along its coastal strip. These include wetlands within Limeburners Creek Nature Reserve (listed on the Directory of Important Wetlands in Australia), Partridge Creek, Lake Innes, Saltwater Lake, Lake Cathie, Googleys Lagoon (Watson-Taylor Lake) and Queens Lake. Such areas are highly valued by the community and biodiversity alike. Saltwater Lake is considered to be in near pristine condition as per 'EcoHealth' Assessments undertaken by the University of New England (Darren Ryder, 2017). The location of these important biological assets (as identified and classified by the Northern Rivers Biodiversity Management Plan (Northern Rivers Catchment Management Authority, 2010)) is shown in *[Figure 22]*. (Port Maquarie-Hastings Council, 2017).

With its coastal location and long history of agriculture and housing development on the rich coastal floodplains, the PMHC LGA supports numerous Threatened Ecological Communities (TECs) & Endangered Ecological Communities (EEC's). The LGA is an important stronghold for many types of TEC's & EEC's, such as Littoral Rainforest, Lowland Rainforest, Coastal Floodplain Forest communities and various Wetland communities.

Historical and ongoing threats to habitat include clearing of vegetation, increased development, restricted distribution of habitats and feral species invasions.

Communities with the plant community types used under the Biodiversity Conservation Act. The Biodiversity Conservation Act 2016 dictates that environmental impacts be calculated relative to these plant community types. At the local level, Councils may wish to conduct their own vegetation community mapping, which further splits NSW plant community types into locally recognised discrete communities. Mapping plant community types is not easy because areas frequently include components of two community types — this is particularly true where the communities occur adjacent to each other (in what are called ecotones). PMHC is confident that current mapping accurately represents local plant communities.

Figure 22. *Location of coastal and estuarine wetlands and lakes (Port Maquarie-Hastings Council, 2017).*



10.7 CLIMATE CHANGE

The future threats of sea level rise, increasing temperatures and changes to rainfall will place increasing pressure on species, ecosystems and human settlements in general. The range of potential impacts due to climate change is significant for coastal areas and it is necessary that they be considered in coastal management planning.

The changes in rainfall will directly impact on PMHC's water supply planning due to Council relying heavily on extraction from the Hastings, Wilson, Thone and Camden Haven for its water supply.

By 2050:

- Temperatures are expected to rise by an average of 1.5 degrees
- Rainfall is expected to reduce by 3.5% pa with significant seasonal changes
- Evaporation is expected to increase by 6% pa
- Annual streamflows are expected to reduce by 10.8% pa but will be affected by seasonal differences
- Annual water demands are expected to increase by 4.3% pa (mostly in spring).

There are also assumed changes in river flows which may be coupled with rising residential water demands. The modeling suggests that there is an expected increase on residential water demand by 4.3% pa while streamflows are predicted to drop by more thatn 10% pa. In a drought event both predicted changes are likely to coincide, making the impacts on water supply and the environment are potentially worse off.

Climate change projections for the north coast of NSW have been modelled by the NSW and ACT Regional Climate Modelling (NARCliM) project. The following snapshot provides climate predictions for 2020-2039 (near future) and for 2060-2079 (far future).

Long-term trends on the North Coast indicate that temperatures in the region have been increasing since around 1960, with the largest increase in temperature occurring in the most recent decades. It is expected that the North Coast will experience an increase in all temperature variables (average, maximum and minimum) for the near future and the far future, with projections of more hot days (maximum temperature greater than 35°C) and fewer cold nights (minimum temperature less than 2°C) (OEH, 2014).

10.7.1 RAINFALL

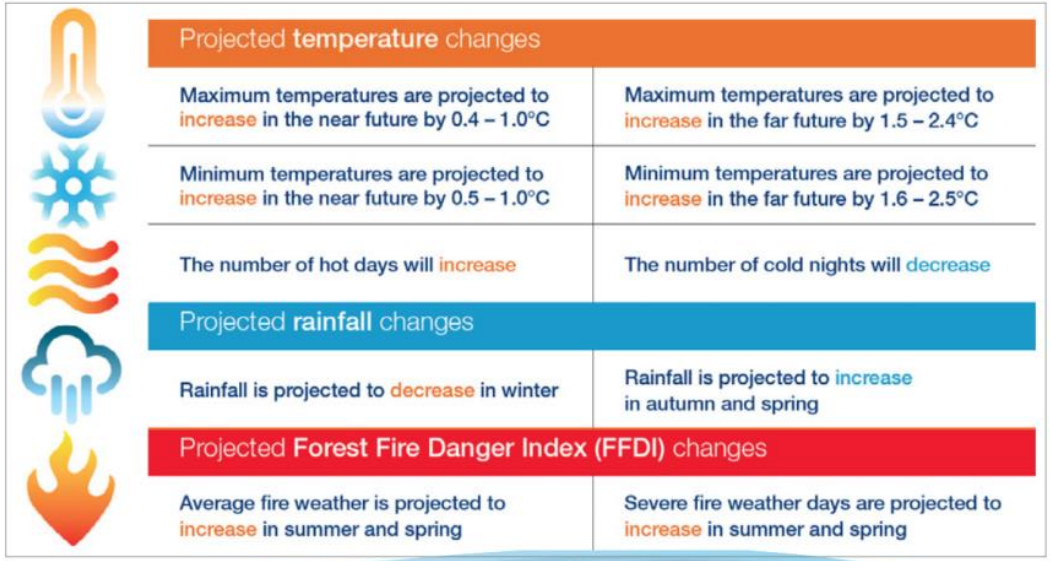
Extreme rainfall events are often associated with large storms and can cause damage to property and infrastructure, flash flooding, soil erosion and impacts on water quality. In recent research by the NSW and ACT Regional Climate Modelling (NARCliM) to assess the potential for the frequency and intensity of extreme rainfall events in the future it was found that:

- Rainfall extremes are projected to increase in the near future (2030) and far future (2070).
- The increases in the near future are not considered significant - the changes fall within the range of inter-annual rainfall variability recorded in the past.
- In the far future, significant increases in several rainfall extreme indices are projected for some regions of NSW.
- The Simple Precipitation Intensity Index (SDII) is the only index to have significant increases over large parts of NSW. This suggests that the mean rainfall intensity will increase even though the more extreme indices do not show significant changes.
- Over most of NSW, little change is projected in the maximum wet spell. A small but not significant increase projected in the maximum dry spell is a reverse of the decreasing trend apparent in past rainfall records.

The frequency and intensity of floods and storms are likely to be affected by climate change and whilst these events as well as East Coast Lows (ECLs) can be damaging and costly, it is important to remember they are also essential for water security bringing the heavy soaking rainfall that fills dams along the coast and tablelands (AdaptNSW, n.d.).

In the past NSW has experienced periods of very stormy weather and this should be considered in future risk assessment and planning.

Figure 23. *Projected climate change. Source: OEH 2014*



10.7.2 SEA LEVEL RISE

On a global scale, sea levels are rising which is increasing the risk to coastal communities from inundation and erosion. Of all the potential impacts from climate change, the projected rise in sea levels is concerning for long-term management of the coastal zone.

Some potential impacts over time due to sea level rise include:

- Higher projected storm surge and inundation levels.
- Landward recession of sandy shorelines. Depending on the rate and scale of sea level rise, the environmental, social and economic consequences of recession within low lying inter-tidal areas, in particular, may be significant in the medium-long term.
- Salt water intrusion and landward advance of tidal limits within estuaries. This may have significant implications in the medium-long term for freshwater and saltwater ecosystems and development margins, particularly building structures and foundation systems within close proximity to the shoreline.
- Existing coastal gravity drainage, stormwater infrastructure and sewerage systems may become compromised over time as mean sea level rises.
- Sea level rise will influence the entrance opening regimes for intermittently closed and open lakes and lagoons (ICOLLs) and alter catchment flood behavior over time.
- The level of protection provided by existing seawalls and other hard engineering structures will decrease over time due to the increasing threat from larger storm surges and inundation at higher projected water levels.

The potential implications of climate change and sea level rise will be considered by PMHC during all Stages of the CMP. Whilst the NSW Government has repealed the NSW Sea-level rise Policy Statement 2009, PMHC believes this is the best available information and work will be undertaken using the benchmarks of 400mm sea level rise above 1990 mean sea levels by the year 2050 and 900mm rise by the year 2100.

10.7.3 FIRE

There is considerable uncertainty surrounding the nature and effects of climate change on fire regimes and fire management, particularly the effectiveness of prescribed burning and the effects on biodiversity. Future climate change is expected to increase bushfire risk through more adverse fire weather including a projected increase in the number of days of severe fire danger, and a potential lengthening of the fire season, over much of New South Wales.

Fire weather is largely monitored in Australia using the Forest Fire Danger Index (FFDI). The Bureau of Meteorology issues Fire Weather Warnings when the FFDI is forecast to be over 50 and average FFDI values are often used to track the status of fire risk.

The North Coast region is expected to experience an increase in both severe and average FFDI values in the near future and the far future (OEH, 2014).

Hazard reduction burning and wildfires under a changing climate will affect the ability of species to persist under a changing fire regime, which has potential implications for catchment management strategies. It is critical to identify likely thresholds of species decline for each component of the fire regime and apply these thresholds to ongoing fire management.

10.7.4 WATER QUALITY

Increased water temperatures and an increase in extreme hydrological events including floods and droughts are anticipated to affect water quality and intensify various forms of water pollution - from nutrients, pesticides, pathogens, dissolved organic carbon, sediments and sewage, as well as changes to thermal pollution with possible implications for ecosystems and human health. Ocean acidification is also linked to climate change as carbon dioxide (CO_2) from the atmosphere is being absorbed in larger amounts. As sea water takes up more CO_2, it becomes more acidic which lowers pH and affects the chemistry of the water making it harder for many animals to build skeletons and shells. This process could potentially be damaging for oyster production in our estuaries.

When considering the impacts of climate change, it will be important for planning and management programs to be adaptive and able to respond to a wide range of possible climate futures.

Figure 24. *Looking across the Hastings River towards Settlement Point*

11. SOCIAL CONTEXT

11.1 COMMUNITY DEMOGRAPHICS AND POPULATION

The PMH LGA has an estimated population of 84,525 as of 30 June 2019 (*Australian Bueeau of Statistics, ERP 2019*) with a population density of 0.23 persons per hectare. The population is expected to grow to approximately 104,000 by 2036 *[as shown in Table 2]*. This growth is expected to be concentrated in the major town and villages, particularly in Port Macquarie which is comprised of many significant coastal areas. This population increase will create demand for approximately 10,000 more dwellings by 2036.

Port Macquarie-Hastings Council area	Forecast year				
	2016	2021	2026	2031	2036
Population	79,905	86,183	92,240	98,123	103,993
Change in population (5yrs)	–	6,278	6,057	5,884	5,870
Average annual change	–	1.52%	1.37%	1.24%	1.17%
Households	34,097	36,646	39,185	41,649	44,077
Average household size	2.31	2.31	2.31	2.31	2.31
Population in non-private dwellings	1,277	1,639	1,899	2,019	2,229
Dwellings	37,024	39,626	42,273	44,899	47,496
Dwelling occupancy rate	92.09	92.48	92.70	92.76	92.80

Table 2. *Forecast population, households and dwellings (.id, 2017)*

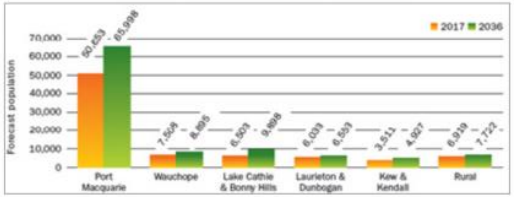


Figure 25. *Forecast Population Growth for key centres in PMHC LGA to 2036, UGMS. PMHC, 2018.*

PMHC has developed an Urban Growth Management Strategy to ensure that land use and population growth will be managed to maintain and enhance quality of life for all persons in the community in a balanced way for current and future generations. A "balanced way" means that social, economic and ecological objectives are balanced with each other (Urban Growth Management Strategy - Port Macquarie-Hastings Council). This strategy is closely integrated with PMHCs Towards 2030 Community Strategic Plan

The UGMS has identified that the main areas planned for new residential development are located in Port Macquarie, Lake Cathie/Bonny Hills and near Kew in the Camden Haven. Future growth is being directed westward of Port Macquarie due to several constraints including national parks and flood-prone lands. (PMHC, 2018). The majority of existing developed land is within close proximity to the coast and needs to be managed for any risks accordingly.

The PMHC LGA experiences a large influx of tourists during the summer months and school holidays. Port Macquarie is the most affected by this influx along with other key coastal centres such as Lake Cathie and Bonny Hills. Coastal areas are used extensively throughout these periods, especially beaches and foreshore reserves, which places pressure on PMHC to ensure that these areas are not adversely affected.

Port Macquarie-Hastings Council area Total persons (usual residence)	2016			2011			Change
	Number	%	Regional NSW %	Number	%	Regional NSW %	2011 to 2016
Babies and pre-schoolers (0 to 4)	3,820	4.9	5.8	3,985	5.5	6.3	-165
Primary schoolers (5 to 11)	6,473	8.2	8.9	6,165	8.5	9.0	+308
Secondary schoolers (12 to 17)	5,694	7.2	7.3	5,715	7.9	8.2	-21
Tertiary education and independence (18 to 24)	4,637	5.9	7.9	4,338	6.0	8.1	+299
Young workforce (25 to 34)	6,634	8.4	11.0	5,706	7.8	10.4	+928
Parents and homebuilders (35 to 49)	13,023	16.6	18.0	13,322	18.3	19.5	-299
Older workers and pre-retirees (50 to 59)	10,903	13.9	13.8	10,156	14.0	13.9	+747
Empty nesters and retirees (60 to 69)	11,852	15.1	13.1	10,549	14.5	11.9	+1,303
Seniors (70 to 84)	12,523	15.9	11.4	10,315	14.2	10.3	+2,208
Elderly aged (85 and over)	2,981	3.8	2.7	2,446	3.4	2.3	+535
Total	78,540	100.0	100.0	72,697	100.0	100.0	+5,843

Table 3. *PMHC's age structure from the 2011 and 2016 Census compared with Regional NSW. PMHC generally has a higher proportion of older age groups.(.id, 2017)*

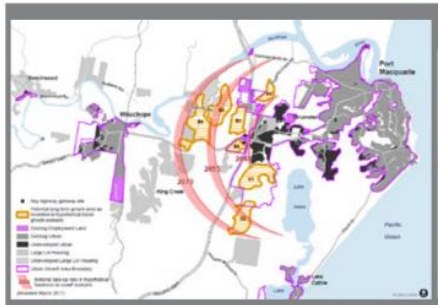


Figure 26. *Forecast growth areas for Port Macquarie & Wauchope, 2036 & beyond,UGMS. PMHC, 2018*

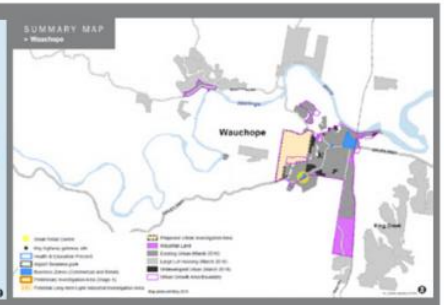


Figure 27. *Forecast Wauchope & Beechwood growth areas to 2036, UGMS. PMHC, 2018.*

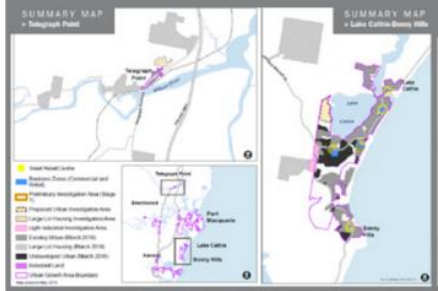


Figure 28. *Forecast Telegraph Point, Lake Cathie & Bonny Hills growth areas to 2036, UGMS. PMHC, 2018.*

Figure 29. *Forecast Camden Haven growth areas to 2036, UGMS. PMHC, 2018.*

11.2 CULTURE AND HERITAGE

The LGA has four Aboriginal representative bodies under the Aboriginal Land Rights Act 1983:

- Birpai Local Aboriginal Land Council
- Bunyah Local Aboriginal Land Council
- Kempsey Local Aboriginal Land Council
- Taree-Purfleet Local Aboriginal Land Council

An LGA-wide Aboriginal heritage study is planned to be undertaken in the near future.

The Birpai people are the original occupants and inhabitants of the land in and around the Hastings area and have been for more than 40,000 years. The Birpai land was a rich luscious area of open forests and grasslands with pockets of thick eucalypt forests and rainforests that harboured an abundance of food and wildlife. Fire was a valuable tool in restraining the rampant rainforest with many rivers, creeks, lakes, lagoons and swamps to help control the spread of fire. They exercised traditional rights over the area including the lands and waterways of the Hastings. The Birpai people relied on these lands and waterways to provide them with much of their food and sustenance for life. They constructed temporary huts along the river and around the lakes in which they lived as they followed the seasonal food trail within their tribal boundaries. Numerous middens are still found in the area giving recognition to the gathering of the traditional owners and inhabitants. PMHC's Statement of Reconciliation and Commitment is built on the legacy of the traditional owners and the continuing contribution of the Birpai and other Aboriginal people to the local area.

Surveyor-General John Oxley changed traditional Birpai life with the mapping and naming of this area in 1818. In 1821 Port Macquarie was established as a place of secondary punishment under the Governorship of Lachlan Macquarie. In 1830 Port Macquarie was proclaimed open to free settlement.

The timber industry has driven the area's development from the convict timber cutters to the cedar cutters of the hinterland in the 1870's through to the supply of hardwood for use as railway sleepers and electricity poles. The North Coast Railway reached Wauchope in 1915.

The extensive local river systems provided highways for commerce. In the early part of the 1900's log dumps dotted the banks of the Hastings, Maria, Wilson and Camden Haven Rivers only to be rendered obsolete when road transportation began in earnest following World War II.

The LGA boasts a significant amount of heritage locations located in the coastal zone, particularly with Port Macquarie being settled in the early 19th century. The Municipality of Hastings Heritage Study was completed in July 1991 to identify heritage items related to European settlement and does not include issues related to Aboriginal or natural heritage. No comprehensive LGA-wide Aboriginal heritage study has ever been undertaken. It is recognised that the identification and assessment of Aboriginal heritage sites needs to be undertaken by a professional archaeologist and not left to "fortuitous" discovery.

The PMHC LEP lists known European heritage items in the PMHC LGA and limits development where these items are located. These locations are mapped in PMHC's GIS system.

11.3 COMMUNITY VALUES AND USES

Previous community consultation has been undertaken for CZMPs and EMPs. The values that were identified in these consultations *[as shown in Table 4]*.

The findings exemplify that the community values the unique natural beauty of the LGA, access and facilities for recreational activities and the rich biodiversity. It is intended that additional community and stakeholder engagement sessions will be undertaken in Stage 2 of the CMP process to further build on this information.

Plan Reference	Community Values
Hastings River EMP	• *Sustainably maintain the estuary's ecological quality* • *Protecting the marine environment* • *Maintain a viable mix of business, lifestyle and recreation* • *Maintain naturalness* • *Support lifestyles* • *Be responsible for future generations*
Camden Haven EMP	• *Visual aesthetics such as North Brother backdrop* • *Rural landscapes* • *Areas of open waterways* • *Recreational boating* • *Historical and heritage sites* • *Mooring facilities* • *Recreational fishing* • *Unique urban environment* • *Fisherman's Co-operative* • *Shoreline vegetation* • *Tourism*
Lake Cathie EMP	• *Recreational Values (Swimming, wading & pick-nicking)* • *Recreational fishing* • *Commercial fishing & prawning* • *Nature observation (canoeing, walking, birdwatching)* • *Tourism* • *Visual amenity*
Lake Cathie CZMP	• ***Natural environment:*** *Ocean, beach, estuary and lake, littoral rainforest, climate and natural beauty.* • ***Lifestyle:*** *Relaxed coastal environment, the quietness, the ambience, its peacefulness, living close to the water, the community, the village atmosphere, a place to raise children and the recreational opportunities* • ***Community Uses:*** *Swimming and surfing - family orientated swimming and wading downstream of the Ocean Drive Bridge which is the most intensively used area of the lake. Swimming at the beach and surfing. Middle Rock provides reasonable waves during east and southeast swells (Short 2007).* *Walking along the beach and foreshore reserves as well as bushwalking near Lake Cathie. Nature observation, including bird watching.* *Fishing – popular areas are at 'the drain' and either side of Ocean Drive Bridge.* *Prawning when the entrance is open, at which time good gutters form either side of the entrance for beach fishing (Short 2007).* *Boating upstream of the Ocean Drive Bridge - paddle craft and small powerboats in deeper areas.* *Beach driving - permitted north of Dirah Street and south of Middle Rock subject to a Council permit (Short 2007).*
Town Beach CZMP	• ***Environmental:*** *North-facing beach* *Protected during southerly winds and swell* *One of Port Macquarie's best beaches* *Bush setting and bird life* *Mosaic of landscapes* *Views from higher ground* *Natural amphitheatre from hills* *Access to natural areas* • ***Social:*** *Accessibility* *Safe swimming* *Patrolled beach* *Proximity to CBD* *Focal point for tourists and locals* *Embodies Port Macquarie image* *Good beach for bodyboarding and surfing* *Historical significance* *Sunbaking* *Fishing off break wall* *The name encapsulates the beach* *Surrounding paths are well uses* • ***Economic:*** *Important resource for tourism* *Family tourist town* *International tourists visit* *Visibility and accessibility* *Connectivity to CBD* *Central part of economic development strategy*

Table 4. *Community values and uses identified from CZMP's and EMP's.*

12. ECONOMIC CONTEXT

Approximately 29,000 people work within the PMH LGA with over 2,500 of those jobs supported by tourism. The largest employer by industry is the Health Care and Social Assistance sector (5,419) followed by the Retail Trade (3,295), Construction (2,995) and Education and Training (2,755) *[see Figure 30]*.

TOURISM

Tourists are generally drawn to the scenic beaches and accessible coastal walks with Port Macquarie the main destination. An increasing local population combined with abundant and frequent tourist visitors will inevitably put more pressure on the coastal environment. Many businesses rely on the continued use of the coastal zone for predominantly tourist activities such as tour boats, whale watching, stand-up paddle boarding, surfing lessons, cafés and restaurants, deep-sea fishing and scuba diving.

Promoting Port Macquarie-Hastings as a tourist destination is a significant contributor to the local economy, but in doing so it is important to maintain the naturalness and environmental attributes that keep visitors coming to the area.

Figure 32. *Port MAcquarie Hastings Coastal Walk*

Figure 30. *REMPLAN PMHC Industry Estimates. (REMPLAN, n.d.).*

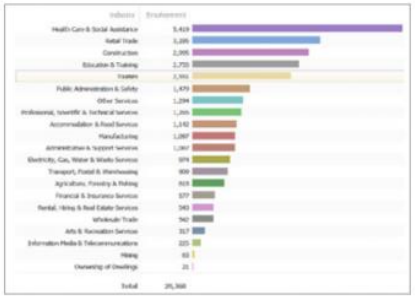
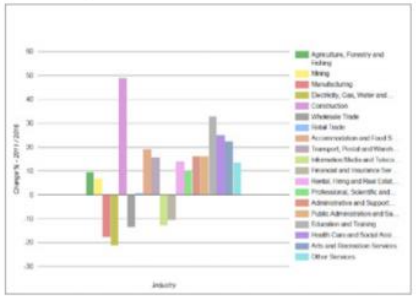


Figure 31. *REMPLAN PMHC Percentage Change in Jobs 2011 - 2016. (REMPLAN, n.d.).*



AGRICULTURE, FORESTRY AND FISHING SECTOR

The Agriculture, Forestry and Fishing sector makes up approximately 818 jobs in the LGA. Commercial fishing, prawning and oyster farming are still active throughout the LGA. Oyster leases are prevalent in the Hastings River extending to Munns Channel, Blackmans Point and Limeburners Creek, and in the Camden Haven River extending from Gogleys Lagoon at the entrance into Watsons Taylor and Queens Lake. Oyster production in the Hastings River peaked in 1987/88 producing 433.9 tonnes and in the Camden Haven River the peak was in 1977/78 producing 285.6 tonnes. Since then, there has been a steady decline with the Hastings River and Camden Haven River producing 176.5 tonnes and 285.6 tonnes respectively. In comparison to the surrounding estuaries of the Manning and the Macleay River, The Hastings River and the Camden Haven River appear to have remained commercially viable *[see Table 5]*. Oyster production in NSW has declined since the mid 1970's, which has been attributed to many factors such as oyster disease, the effects of Pacific Oyster introduction and the degradation of water quality in many coastal rivers, lakes and estuaries.

In 2018, Fishing, Hunting and Trapping and Aquaculture contributed $46.971 million to the total PMH LGA revenue *[see Table 6]*. (NSW DPI, 2016).

Estuary	Historic Peak (tonnes)	2014/2015 (tonnes)
Macleay River	*367.6 (1974/75)*	*19.8*
Hastings River	*433.9 (1987/88)*	*176.5*
Camden Haven	*229.5 (1977/78)*	*285.6*
Manning River	*428.4 (1960/61)*	*70.5*

Table 5. *Oyster Production in the Macleay, Hastings, Camden Haven and Manning Rivers from historic peaks to 2015/2015. (NSW DPI, 2016).*

	Port Macquarie - Hastings (A) (2018 Release 1)		Port Macquarie - Hastings (A) (2012 Release 2)	
Industry Sector	$M	%	$M	%
Fishing, Hunting & Trapping	$16.199	0.2%	$4.352	0.1%
Aquaculture	$30.772	0.3%	$32.886	0.5%
Sub-Total	$46.971	0.5%	$37.237	0.6%

Table 6. *2012 - 2018 Revenue for Fishing, Hunting & Trapping and Aquaculture. (REMPLAN, n.d.).*

13. LEGISLATIVE AND PLANNING CONTEXT

13.1 LAND-USE PLANNING INSTRUMENTS

LOCAL ENVIRONMENT PLAN 2011

The Port Macquarie-Hastings Local Environment Plan 2011 (LEP) contains provisions to protect and conserve the environment in the LGA. The LEP provides development restrictions and provisions in certain lands as defined in the LEP.

For the protection of PMHC's coastline, it has the following restrictions or provisions:

a. Development consent is required for works on land identified in the Acid Sulphate Soils Map. The types of allowable works vary depending depth and adjacency to higher classes. Any works on ASS require an Acid Sulphate Soils Management Plan in accordance with the Acid Sulphate Soils Manual.
b. Exempt or complying development cannot be carried out in environmentally sensitive areas including coastal waters of the State, a coastal lake, the Coastal Wetland and Littoral Rainforest Area (CWLRA), an aquatic reserve or marine park, land within a wetland of international significance, land within 100m of the previously mentioned, as well as areas of aboriginal and cultural significance and high biodiversity values. Development consent is required for any development above the mean high-water mark of tidal waters.
c. Land on which aboriginal or heritage items are located require an assessment in order to preserve the cultural significance.
d. Development consent is required for land defined in the Flood Planning Area and cannot be granted if detrimental increases are identified to other properties or environmental factors.
e. Development consent is required for any land mapped as having a coastal erosion risk and cannot be granted unless impacts from the hazards are not increased and the risk is managed appropriately.

DEVELOPMENT CONTROL PLAN 2013

At present, there are two development control plans in force: 2011 and 2013. The Port Macquarie-Hastings Development Control Plan 2011 (DCP 2011) applies to specific areas within the LGA while the Port Macquarie-Hastings Development Control Plan 2013 (DCP 2013) has conditions that apply to all land within the LGA as well as some area-specific parts. The DCP 2013 is the primary development control plan and is the key supporting document to the LEP and provides detailed guidance on design considerations and general standards.

The DCP makes provision for various aspects relating to protection of the coastal zone including:

- Protection Endangered Ecological Communities (EEC) close to waterways or wetlands
- Compliance with Council's Flood Policy
- Stormwater controls (Council's AUSPEC Design Specifications)
- Coastal Hazard Management for Lake Cathie

13.2 COASTAL WETLANDS AND LITTORAL RAINFORESTS

The Coastal Wetland and Littoral Rainforest Area (CWLRA) is land that displays the hydrological and floristic characteristics of coastal wetlands and littoral rainforest communities and lands adjoining those features (OEH, 2018).

Coastal wetland and littoral rainforest communities have high biodiversity values and are of regional and state significance. These communities are very sensitive to certain types of development and environmental threats.

COASTAL WETLANDS

Coastal Wetlands are identified in low-lying areas throughout the LGA. In the Hastings River catchment, they run along Koolonbung Creek, the floodplains along the Hastings River in close proximity to the airport, extending to the north along the banks of the Maria River, Wilsons River and Limeburners Creek area. Locations adjacent to some tributaries to the Hastings River such as King Creek, Sarahs Creek and Stoney Creek are mapped as Coastal Wetlands. There are also isolated patches mapped in the upper catchment near Rollands Plains and Upper Rollands Plains.

In the Lake Cathie/Bonny Hills area, Lake Cathie and Lake Innes both have Coastal Wetlands mapped on the outer boundaries of both lakes including some isolated patches west of the Pacific Highway. In the Camden Haven Coastal Wetlands extend along the Camden Haven River up to the township of Kendall. They border both Queens Lake, Watson Taylor Lake and areas of Gogleys Lagoon *[see Figure 33 below]*.

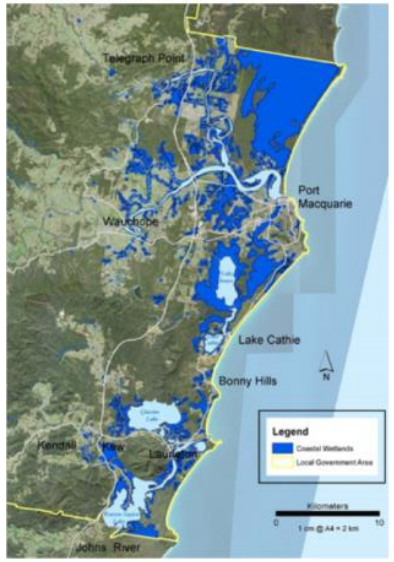


Figure 33. *Coastal Wetlands Areas*

Figure 34. *Littoral Rainforests Areas*

LITTORAL RAINFOREST

Some remnants of Littoral Rainforests are located along the coastline. Areas where they are located in PMH are the North Shore, Port Macquarie, Lake Cathie, Bonny Hills, North Haven and Dunbogan. All of these areas are prone to development pressures with greater emphasis on Port Macquarie and Lake Cathie/Bonny Hills localities *[see Figure 34 above]*.

POSSIBLE FUTURE ACTIONS

Complexity of development controls associated with development in the Coastal Wetland Littoral Rainforest Areas hinder Council's ability to undertake protection or environmental enhancement works, future actions will be to review the coastal SEPP mapping layers in PMHC and examine how to streamline approval pathways for environmental protection.

13.3 COASTAL VULNERABILITY AREAS

The Coastal Vulnerability Area (CVA) is land which is subject to current and future hazards (OEH, 2018). These hazards (defined in the CM Act) are:

- Beach erosion
- Shoreline recession
- Coastal lake or watercourse entrance instability
- Coastal inundation
- Coastal cliff or slope instability
- Tidal inundation
- Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters

Various controls are put in place to manage the risks and impacts of the abovementioned hazards. No state-wide mapping has yet been adopted for Coastal Vulnerability Areas as is defined in the CM SEPP.

The Coastal Erosion in New South Wales State-wide Exposure Assessment (OEH, 2017) identified a broad overview of coastal erosion potential impacts on assets along the NSW coastline. This assessment includes the PMHC LGA. The assessment is limited to beach erosion on open-coast beaches. It uses three methodologies:

1. **Proximity analysis (First Pass):** This identifies sandy shorelines and proximity buffer distances to potentially exposed assets.
2. **Regional Analysis (Second Pass):** This uses a sediment compartment-based approach and probabilistic framework to estimate the volume of potential coastal erosion. These hazard lines differ from local government hazard lines used in the Third Pass.
3. **Local government hazard lines (Third Pass):** This is the result of coastal hazard studies undertaken in an LGA using the Zone of Slope Adjustment as the hazard lines. This pass only considers hazard lines produced after 2008 due to SLR projection differences.

Council has focused its attention on areas that have had recorded events of significant coastal erosion, with and without storm events and which have sensitive infrastructure and assets at risk. The reason the investigations have been focused onto the areas is because these areas have shown to actively erode in normal coastal processes and even more so as the result of storm events. As such, PMHC has undertaken coastal hazard mapping for Town Beach and Lake Cathie (for their associated CZMPs).

This mapping shows hazard lines for various current (at the time of study) and future scenarios including sea-level rise *[see Figures 35 - 37]*

Further to the above-mentioned coastal hazard mapping two additional beaches have had further investigations completed due to specific project needs. These beaches include Rainbow Beach at Bonny Hills via a coastal hazard study (under a Part 3A approval) and the investigation of Flynns Beach during the Flynns Beach Seawall Detailed Design Report.

PMHC has incorporated the coastal hazard mapping for Lake Cathie into the LEP. The mapping completed for Town Beach, while still useful, is now outdated and therefore PMHC will not seek to map this in the LEP. Considering that the erosion issues at Town Beach are known and reasonably well defined, PMHC does not see the need to undertake further hazard studies on this area in the near future. Instead efforts may be directed towards other areas of coastline where hazards may exist, i.e. Lighthouse Beach, North Haven beach, Rainbow Beach (Bonny Hills), Shelly Beach, North Shore Beach (Corilla estate).

PMHC shares coastal sediment compartments *[Section 10.3]* with Kempsey Shire Council (KSC) and Mid Coast Council (MCC). *[Section 16 (1) (b) (i)]* of the Coastal Management Act 2016, states that if a shared coastal sediment compartment is within the CVA zone, the neighbouring Councils should consult with each other before adopting a CMP. Only two areas have been identified as having coastal hazards (Town Beach and Lake Cathie) and these areas are not in close proximity to the LGA boundaries. Therefore, PMHC considers that further consultation on this specific matter is not required. Nevertheless, PMHC will consult with KSC and MCC if any future identified issues or works are considered to potentially affect either Council.

PMHC also share and must consult with NPWS regarding mutual issues and associated management of 4WD access north to Queens Head.

Figure 36. *Lake Cathie Coastal Hazard Mapping (north) (Lake Cathie CZMP, Port Macquarie-Hastings Council, 2016)*

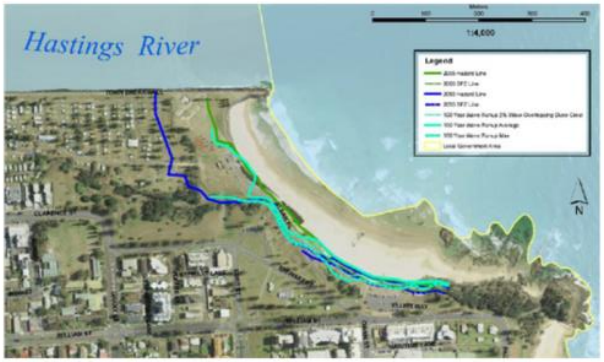


Figure 35. *Town Beach Coastal Hazard Mapping (Town Beach CZMP, Port Macquarie-Hastings Council, 2010)*

Figure 37. *Lake Cathie Coastal Hazard Mapping (south) (Lake Cathie CZMP, Port Macquarie-Hastings Council, 2016)*

BMT WBM was commissioned by Port Macquarie-Hastings Council (PHMC) in 2013 to undertake an estuary and coastline inundation mapping study to assist in the assessment of areas at risk from sea level rise.

The aim of the study is to determine the estuarine and coastal inundation extent for a range of design ocean events including:

- spring tide;
- king tide;
- 1 year Average Recurrence Interval (ARI);
- 50 year ARI, and;
- 100 year ARI.

The three epochs and associated mean sea levels (MSL) included in the study are: **Current** (MSL = 0.0 m AHD), **2050** (MSL = 0.4 m AHD), and **2100** (MSL = 0.9 m AHD).

These levels are based on the previous NSW Government planning benchmarks which are a projected rise in sea level (relative to the 1990 mean sea level) of 0.4 metres by 2050 and 0.9 metres by 2100 (DECCW, 2009). It is important to note that due to the inherent difficulty in forecasting actual rates of sea level rise (SLR) the mapping in this study shows the impact of 0, 0.4 and 0.9 m of SLR but does not specify the timing of these changes to mean sea level. The best available estimates of sea level rise projections indicate that these increases in mean sea level will occur by the year 2050 and 2100 as presented in the former NSW Planning Guidelines and adopted by Council (along with many other coastal Councils in NSW).

The study uses three numerical models of the major estuaries in the LGA including:

- Hastings;
- Lake Cathie/Lake Innes, and;
- Camden Haven.

High quality mapping of the inundation extents for the estuaries and coastal areas was undertaken using LiDAR ground elevation data collected for Council in October 2005 *[see Figure 38]*.

A discussion of changes to predicted tidal inundation extents due to sea level rise for each of the three (3) estuaries and the coastline is presented in the report. In particular an attempt was made to highlight key areas that are susceptible to tidal inundation which will be exacerbated by rising sea levels. It is important to note that the purpose of the study is to produce a "first-pass" assessment of areas that may be at risk from tidal inundation due to SLR. This "first-pass" assessment may be used by Council to undertake further studies in order to evaluate potential risks associated with future events. The areas identified below are based on interpretation of the mapped inundation extents provided in the report and are meant as a broad-scale (locality) assessment only.

Areas of specific interest were identified as:

Hastings River Catchment:

- North Shore
- Riverside
- Hibbard/Hastings River Drive
- Settlement Point
- CBD/Short Street
- The Hatch
- Blackmans Point

Lake Cathie/Innes Catchment:

- Kenwood Drive
- Lakeside Way

Camden Haven River Catchment:

- Dunbogan
- North Haven
- Laurieton

Bonny Hills:

- Duchess Creek

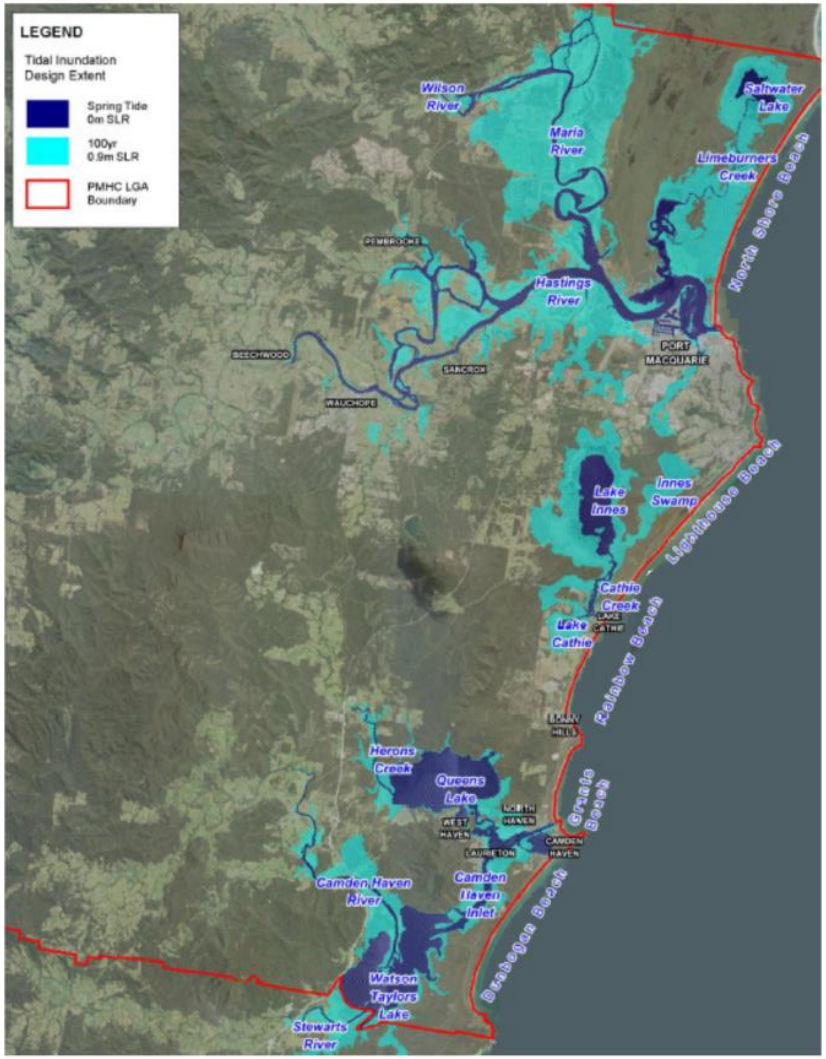


Figure 38. *PMHC LGA Sea Level Rise Mapping (BMT WBM, 2014)*

13.4 COASTAL ENVIRONMENT AREAS

Coastal Environment Areas (CEA) are made up of environmental features such as state waters, estuaries, coastal lakes and lagoons. It also includes land adjoining those features such as headlands and rock platforms. (OEH, 2018) *[see Figure 39]*.

Section 16(1) (b)(i) of the Coastal Management Act 2016 states that if two or more Councils share an estuary then consultation with each other is required before adopting a CMP. PMHC shares estuaries with KSC (Hastings River Estuary) and MCC (Camden Haven River Estuary). As such, Council will be working in consultation with these neighbouring LGA's before any works are undertaken.

The CM SEPP identifies sensitive coastal lakes where development constraints are needed to limit adverse impacts on water quality. The Port Macquarie Hastings LGA contains a sensitive coastal lake listed in the CM SEPP. This being Saltwater Lake in the Limeburners Creek Nature Reserve.

Figure 39. *Coastal Environment Area*

13.5 COASTAL USE AREAS

Coastal Use Areas (CUA) are lands adjacent to coastal waters, estuaries, costal lakes and lagoons, where impacts of development on the use and enjoyment of the beaches, foreshores, dunes, estuaries, coastal lakes and lagoons, and the ocean, need to be considered (OEH, 2018) *[see Figure 40]*.

The CM SEPP restricts development in these areas to ensure that adverse impacts on access, overshadowing, visual amenity, Aboriginal heritage and built environment heritage.

Management of CUAs involves ensuring access, use and amenity is maintained for the community. This includes ensuring that there is sufficient beach access, car parks, boat launching ramps, reserves, signage, etc. Fortunately, these themes are addressed through the Community Strategic Plan and the underlying Plans of Management or Masterplans associated with site specific areas. These plans allow for the community's input into the design of foreshore reserves and coastal recreational areas and will be considered during the design and development of the CMP.

Figure 40. *Coastal Environment Area*

13.6 COASTAL MANAGEMENT PLAN AREAS

A CMP applies to all, or part thereof, land within the coastal zone as defined by the Coastal Management Act 2016. A Council must decide whether to include all land mapped as the coastal management areas in the CMP.

The historical legislative framework has divided management of estuaries and open coasts as separate management areas. PMHC will maintain this approach when developing the CMP.

PMHC are proposing to develop one CMP comprised of the following four chapters:

1. Lake Cathie/Lake Innes & Bonny Hills Estuary & Coastline - incorporating the open coastline from the 4 x 4 access track adjacent to Dirah Street to the southern side of Grants Head (referred to in this document as the Lake Cathie/Bonny Hills chapter for simplicity).
2. Hastings River Estuary
3. Camden Haven River
4. Port Macquarie-Hastings Open Coastline (excluding the open coastline that is covered in the Lake Cathie/ Bonny Hills

Lake Cathie has experienced an ever-growing amount of community concern regarding the management of environmental issues and the opening of the lake. Given this increasing focus, along with the results of the Risk Assessment for Threats/Issues *[Table 16]* and the pending Stage 2 studies *[Table 20]*, Lake Cathie/Bonny Hills chapter of the CMP will be prioritised over other chapters

The spatial extent and management actions of the CMP will cover:

1. **Lake Cathie/Bonny Hills chapter**
   This chapter will cover the Lake Cathie/Lake Innes estuarine system as well as the open coastline from the 4 x 4 access track adjacent to Dirah Street to the southern side of Grants Head. This will ensure that the existing CZMP is included as it directly interacts with the lagoon entrance and its management in times of flood mitigation. It will also cover Bonny Hills.

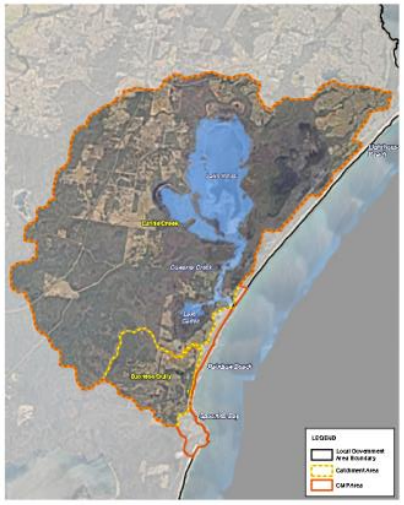


Figure 41: *Coastal Management Program Study Area - Lake Cathie / Bonny Hills*

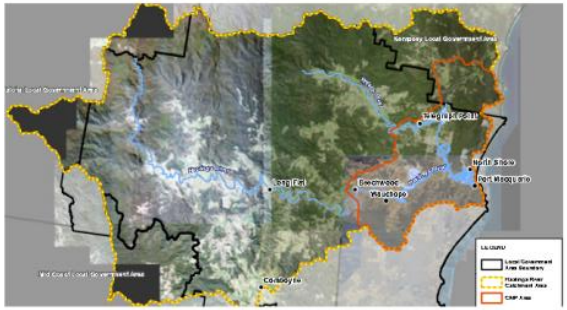


Figure 42: *Coastal Management Program Study Area - Hastings River Catchment*

2. **Hastings River Estuary chapter**
   This chapter will cover the Hastings River Estuary extending from the entrance at the Town Beach to the tidal limits of the Hastings River. Further investigations into the distance and amount of upper catchment extent will be explored during this chapter's development.

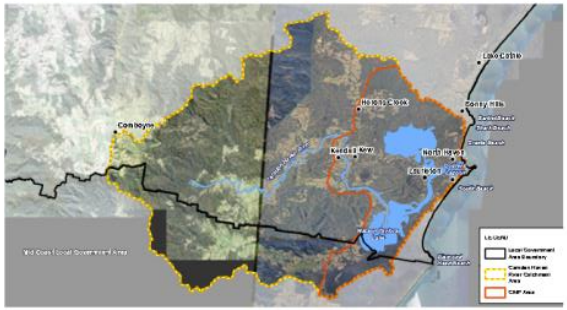


Figure 43: *Coastal Management Program Study Area - Camden Haven River*

3. **Camden Haven River chapter**
   This chapter will cover the Camden Haven River Estuary extending from the entrance between North Haven and Dunbogan to the tidal limits of the Camden Haven River. Further investigations into the distance and amount of upper catchment extent will be explored during this chapter's development.

Figure 44: *Coastal Management Program Study Area - Open Coastline*

4. **Port Macquarie-Hastings Open Coastline chapter**
   This chapter will cover all of the open coastline within the PMHC LGA with a focus on areas identified as being prone to coastal hazards. These areas include Town Beach, North Shore Beach, Flynns Beach, Shelly Beach, Lighthouse Beach and North Haven Beach. The open coastline from the 4 x 4 access track adjacent to Dirah Street (Lake Cathie) to the southern side of Grants Head is not included as it is covered in the Lake Cathie/Bonny Hills chapter.

14. BARRIERS AND OPPORTUNITIES

Funding, legislation, land ownership and management responsibilities are predominantly the main barriers for undertaking management actions. Broadly speaking, previous management actions undertaken under EMP's have not had a significant impact on estuary health due to the scale of the actions and the large amount of funding required. An exception to this is the ASS remediation works that were successfully carried out in the 2000's and early 2010's. Those actions identified in the EMP provided means to seek the employment of an ASS project officer, resulting in many benefits to waterway health and sustainable land management practices. This work which brought about large-scale benefits relied heavily upon dedicated PMHC staff members, significant funding and landowner buy-in. In order to continue large scale projects, such as the ASS program, large amounts of funding and dedicated resources will have to be a priority. These programs have proven to be and will continue to have the greatest effects in improving and maintaining estuarine health.

Working with landowners and various government stakeholders can be a potential barrier as well as an invaluable opportunity. At times, differing opinions, perspectives and desires can conflict. Financial burdens, ongoing maintenance requirements and legislative hurdles can place challenges in the way of successful programs. However, in reviewing existing management plans there is a good opportunity to renew relationships and continue to work towards better environmental outcomes.

For landholders, it has been over 15 years since they have been specifically consulted with and given the time that has lapsed, any previous arrangements may have ceased, been forgotten or have unknowingly been dismissed by new landholders through ownership transfers. PMHC views working with the community as an essential and valuable component of the CMP process.

For NSW government agencies they may have competing responsibilities and priorities they need to address and manage on the land and in the waterways, which may not align with Council and local community expectations.

The CM SEPP, among other legislation, imposes a requirement for development consent for all development (including the clearing of native vegetation) on land mapped within a CWLR Area. The CM SEPP also declares that development in a CWLR area is designated development for the purpose of the EP&A Act, which requires an Environmental Impact Statement and gives rise to merit appeal rights to people who object to the proposed development. Also where development is carried out with a 100 metre-proximity area of a CWLR area where development consent is required, additional considerations apply.

The CWLR area is also included in a biodiversity value map and as such automatically requires the preparation of a Biodiversity Development Assessment Report (BDAR) to be prepared with the designated development application in accordance with the Biodiversity Conservation Act (2016).

The consequence of land being mapped as within a CWLR Area is that it also must be mapped as Category 2 – Regulated Land (Sensitive regulated land) under Part 5A of the Local Land Services Act 2013, when in a rural zone. This makes it an offence to clear native vegetation on the land unless it is undertaken in accordance with the Land Management (Native Vegetation) Code 2018, or the works are authorised pursuant to another relevant approval.

Mapping inconsistencies have been identified within the LGA where CM SEPP mapping interacts with roads, carparks and other assets. For example there are a total of eight bridges in the area that have been included in the mapping, which results in the necessity of taking different environmental approvals for maintenance and upgrades.

PMHC staff have recently met with DPIE to discuss a possible amendment to the SEPP mapping and guiding policies. Consultation is ongoing at the time of writing this scoping study.

DPIE which includes NPWS, Fisheries, Crown Land, LLS and others, are key stakeholders in the management of the coastal area. These stakeholders have ownership and primary control over much of the coastal land, including National Parks and Nature Reserves, waterways, Crown Lands and the like. Council must work closely with these departments since nature knows no land tenure boundaries.

Although there are barriers and challenges to this work there are also immense opportunities. Working with government stakeholders in DPIE, environmental organisations, landowners and the Indigenous community provides Council with a rich tapestry of information and perspective from which to draw. This perspective and knowledge allow well rounded management decisions to achieve the triple bottom line of environment, economy and social needs. It ensures that decisions are made collectively rather than by an individual organisation. It allows the manifestation of partnerships and collaborative work relationships which achieve on-ground solutions to difficult problems. It may also assist in leveraging funds or resource sharing to assist in the financial burden and can result in a more rigorous review of an action, giving a better environmental outcome.

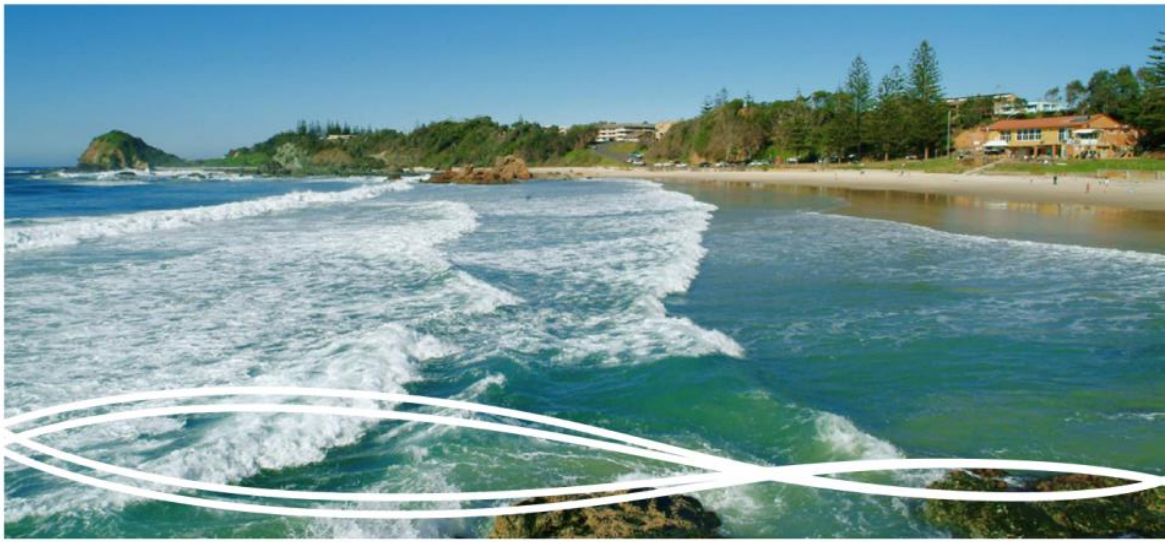


Figure 45: *Flynn's Beach, Port Macquarie*

15. SCOPE OF THE CMP

PMHC has already completed an extensive number of plans and studies in relation to coastal management. This includes two CZMP's (one of which has been gazetted), three, EMP's, vegetation mapping, sea-level rise mapping, and floodplain mapping.

The scope of the CMP should build upon existing knowledge of environmental, economic and social issues and the effectiveness of any management plans currently in place.

The Manual indicates that CMP's should consider the following factors when determining the scope:

- Local management issues, challenges and opportunities identified for each coastal management area, including the spatial extent
- Effectiveness of existing management approaches and land use planning instruments to address current and future challenges
- Responsibilities and capacities of Council, public authorities, communities and other stakeholders to address coastal management issues
- Future population growth and development pressures
- Risks and liabilities associated with coastal hazards and threats to coastal environments
- Vulnerability of coastal assets, environments and social and economic systems
- Potential opportunities to adapt to change and thereby enhance the resilience of natural features and coastal communities.

The purpose of a CMP, as defined by the CM Act is 'to set the long-term strategy for the co-ordinated management of land within the coastal zone with a focus on achieving the objects of the Act'. The Manual also imposes mandatory requirements as per the CM Act.

PMHC intends creating a CMP that is representative of community values and can sustainably manage issues affecting the present time and future.

Figure 46: *Town Beach, Port Macquarie*

16.1 COASTAL ZONE MANAGEMENT PLANS

16.1.1 TOWN BEACH CZMP

PMHC commissioned a preliminary appraisal of Town Beach coastal hazards in 2001. The preliminary appraisal suggested that changes to the offshore entrance bar have resulted in an increased penetration of north-easterly swell to Town Beach and a subsequent realignment of the beach to reflect this change in wave direction. The investigations and wave refraction modelling carried out show that, while there has been a change in offshore bathymetry, there is an increased wave energy reaching the northern end of the beach under most offshore swell wave directions and that it is this increase in wave energy that has resulted in the erosion. (SMEC, 2005).

Following the preliminary findings, PMHC engaged SMEC to undertake the Town Beach Hazard Definition Study in 2005. This was a detailed hazard definition study which included photogrammetric analysis, wave transformation modelling and storm bite determination. The study quantified the observed long-term beach recession at Town Beach and estimated the beach recession that would be caused by climate change induced sea-level rise.

The Town Beach CZMP was finalised in 2010 and built on the findings of the 2005 Hazard Definition Study. The Town Beach CZMP was developed to create a strategy to integrate effective management of long-term coastal processes with the further realisation of the recreational and economic potential of Town Beach and associated coastal reserves (Port Macquarie-Hastings Council, 2010) *[see Figure 47]*.

Figure 47: *Town Beach CZMP Study Area (Port Macquarie-Hastings Council, 2010).*

CZMP Key Issues

Key issues were identified in the CZMP following input from the community, Council and other government agency officers. These issues include:

- Ongoing management of coastal hazards, particularly coastal erosion and overtopping of the back beach area at the northern end of the beach;
- High levels of usage of the beach and adjacent reserves, often with competing interests in the use of the area;
- Pressure to improve lookouts, reserves and facilities; and
- Management and maintenance of beach access points, amenities and facilities.

The northern section of Town Beach has been subject to ongoing erosion since approximately the 1980s. Indications are that the construction of the northern break wall at the entrance to the Hastings River at Port Macquarie has altered the near shore wave climate along the beach. This lowered the offshore ocean bar, resulting in larger waves reaching the shore than would have done so previously. Consequently, sand is being eroded from the beach, causing recession of the back-beach escarpment and undermining part of the southern break wall *[as shown in Figure 49 over page]*. Analysis shows that the back-beach escarpment at the northern end of the beach is now approximately 30 metres landward of its 1980 position. In addition, the low back

Figure 48: *Town beach depicting break walls, back-beach escarpment and offshore ocean bar.*

beach escarpment is occasionally overtopped by storm wave run-up, inundating the reserve lands behind the beach *[refer to Figure 48]*.

The photogrammetric analysis (1971 to 2003) completed by SMEC in 2005 as a part of the Town Beach Hazard Definition Study identified that Town Beach has:

- Built up by approximately 15 to 25 metres at the southern end
- Remained reasonably constant where the kiosk is located
- Undergone approximately 15 to 20 metres of recession north of Gaol Rock
- Undergone approximately 30 metres of recession for approximately 50m south of the southern break wall.

The northern break wall was built in 1979 and the greatest period of recorded change in the beach was in the 10 years following. The northern section of the beach is presently not subject to active erosion as a result of rock protection works undertaken in the 2006, however continues to be affected by wave overtopping and tidal surges and remains to be an 'at risk' area

Modelling was done to assess the risk of inundation and hazards from wave run-up in a 1 in 100 year Average Recurrence Interval (ARI) storm event. This modelling indicated that:

- The kiosk at the time of modelling is landward of the average and 2% wave run-up levels but some inundation would be expected at maximum wave run-up levels.
- The car parking area at the southern section of the beach average would not be inundated.
- A section of road around the base of Gaol Point would be inundated at average wave run-up levels.
- The northern end of the beach and adjoining foreshore will be subject to wave overtopping and subsequent inundation.

Management Actions

Several management recommendations were included in the report. The highest priority actions were:

1. Control of erosion and coastal hazards at the northern section of beach
2. Redevelopment of the kiosk in the southern section
3. Actions to upgrade various amenities.

Works completed since the report was commissioned include:

1. Extension of the southern break wall approximately 100m further south to alleviate the erosion of the foreshore reserve.
2. Reconstruction of the northern dune in 2006 to protect the foreshore reserve from significant wave overtopping.
3. In partnership with Crown Land, PMHC have periodically accepted the dredged material from the Hastings River, which provides sand nourishment to the beach. This has historically occurred sporadically, and the sand has only been accepted on Town Beach when the beach needs nourishing.
4. The Town Beach Kiosk was upgraded in 2016 with the provision of new public toilets and upgraded sea rescue facilities.
5. A new Skate Park was constructed in 2012
6. A new Kiosk was built on the northern end of Town Beach in 2016. Both the kiosk and the skate park are within areas which are at significant risk of inundation in storm events.

In addition to the works completed an Emergency Action Plan was developed for the Town Beach area in response to coastal hazards. This plan focuses on the evacuation of at-risk areas in significant storm events and beach closure. While PMHC has closed the beach to the public in storm events, evacuation procedures have not yet proven to be necessary.

Figure 49: *Town beach depicting break walls, back-beach escarpment and offshore ocean bar.*

Other Management Actions

Coast/Estuary/Flood	Management Action Required	Status Comment
Coastal Management	*Maintain relatively natural pathway surfaces around southern headland (Flagstaff Hill)*	*Commenced - Footpath surfaces to be determined as part of detailed design for upgrades having regard for access requirements and asset durability.*
Coastal Management	*Design and install stormwater gross pollutant traps in car park at southern kiosk and car parks east and north of Gaol Point*	*Commenced - GPT installed adjacent to kiosk.*
	Prepare a 'Significant Bushland Overlay' for Council's GIS based on the mapping of priority conservation areas within the Vegetation Management Plan.	*Completed mapping. Refer to report.*
Gaol Point GPT subject to review.	*Upgrade parking facilities at Dunbogan Boat Launching Ramp*	*Detailed design for upgrade of Dunbogan Boatramp is currently being completed. The design includes some improvement of parking areas through current budget allocation is for boatramp widening and pontoon installation only. A timeline for parking improvements is not known at this time.*
Coastal Management	*Provide formalised stairway access from Gaol Point to the back beach area, on north and south faces of Gaol Point*	*Commenced - Stairs on southern face complete. Northern yet to be scheduled.*
Coastal Management	*Install additional seating, tables and lighting in the northern reserve, in the same general style as that in the southern reserve*	*Ongoing*
Coastal Management	*Upgrade pathways in Rotary Park and enhance landscaping to improve connectivity between the park, beach and adjacent accommodation*	*Ongoing*
Coastal Management	*Install shade structures in the back beach reserve at the southern end of Town Beach, to complement planting of shade trees*	*Commenced. Facilities installed in northern part of the reserve. Future works proposed for southern portion in future years.*
Coastal Management	*Continue to use local flowering small trees for shade and to provide local habitat for foraging native species*	*Commenced. Facilities installed in northern part of the reserve. Future works proposed for southern portion in future years.*
Coastal Management	*Maintain Southern Breakwall of the Hastings River entrance, to replace dislodged rock and protect the wall core and raise crest height to 4.6 mAHD*	*Ongoing*
Coastal Management	*Ongoing maintenance of Southern Breakwall*	*Ongoing*
Coastal Management	*Remove displaced rock from the surf zone to reduce safety hazards to swimmers and surfers*	*Ongoing*
Coastal Management	*Continue to remove weeds from coastal bluff grassland vegetation communities, replacing weeds with local coastal shrub and ground cover species*	*Ongoing*
Coastal Management	*Highlight pedestrian linkages from Town Green to Town Beach and beyond in tourist information and in sign posting/maps all key junctions along the walking paths. Develop major theme to integrate the walking track system. Sign posting to also be provided at Flagstaff Hill to highlight special visual features such as whale watching.*	*Commenced and ongoing - Port Macquarie Coastal Walk master planning phase complete, public consultation undertaken. Initial construction works completed on various stages. Grant funding received for initial construction stages. Project is being rolled out over numerous years.*
Coastal Management	*Review safety of all pathways, stairways, elevated walkways and lookout fencing around Flagstaff Hill.*	*Ongoing*
Coastal Management	*Ensure that any further development of facilities in the woodland areas at Flagstaff Hill and beyond does not detract from the natural landscape character of this area.*	*Ongoing*
Coastal Management	*Construct a rotunda adjacent to the children's playground area*	*Yet to be scheduled*
Coastal Management	*Prepare Traffic Management Plan that includes investigation of the closure of the southern end of Stewart Street and installation of traffic calming devices to minimise potential conflicts with pedestrians*	*Yet to be scheduled*
Coastal Management	*Implement Traffic Management Plan*	*Yet to be scheduled*
Coastal Management	*Improve lighting along all pathways, using efficient lighting fixtures*	*Yet to be scheduled*
Coastal Management	*Wherever possible, introduce shade trees into car parking areas*	*Yet to be scheduled*

Table 7. *Other management actions for Town Beach CZMP*

16.1.2 LAKE CATHIE CZMP

Lighthouse Beach (adjacent to Lake Cathie) is approximately 2 km long. The beach south of the estuary entrance is backed by residential development along Illaroo Road and by Johnathon Dixon Reserve which is seaward of development along Chepana Street (Port Macquarie-Hastings Council and SMEC, 2016).

The Lake Cathie CZMP was prepared in accordance with the former CP Act, NSW Coastal Policy, NSW Sea Level Rise Policy 2009 and the 2010 Guidelines for Preparing Coastal Zone Management Plans 2010 and was overseen by the CE&F sub-committee.

Goals

The Lake Cathie CZMP was proposed and written in order to achieve the following goals:

- Protect and restore natural areas through stormwater and foreshore management.
- Provide community access and opportunities to enjoy our natural environment through reserve improvements, continuing public access and beach nourishment.
- Plan and take action to minimise the impact of natural events and climate change through further investigations, contingency measures and construction of a revetment to protect private development and Illaroo Road.
- Manage development outcomes to minimise the impact on the natural environment through development controls.

General Issues Identified

A broad list of issues identified in consultation with community members, discussions with various NSW state agencies and a review of the literature and information at hand yielded the following list:

- Erosion and erosion control
- Safe beach access
- Maintaining recreational amenity
- Soil/sand stability at stormwater outlets
- Property values
- Increased tourism
- Revegetation/weeds

Detailed review of issues

Upon completion of the general list of issues Council began to have a more detailed review of the following two issues:

- Erosion and erosion control
- Soil/sand stability at stormwater outlets

These were addressed through the following studies.

Coastal Hazard Study - 2008

This first study undertaken was to work on ways to solve the erosion and erosion control issues. This was the priority since it dealt with the highest issues of risk, that being risk to life and property.

In order to understand these issues of erosion more comprehensively Council commissioned SMEC in 2008 to complete the Lake Cathie Coastal Hazard Study.

Coastline Management Study - Stage 1 - 2009

Following the 2008 Hazard Study, a two stage Management Study was undertaken. The Lake Cathie Coastline Management Study - Stage 1 was completed by SMEC in 2009 and focused on obtaining information from the community about their values and opinions on how the Lake Cathie coastline was used. Thirteen potential management option were assessed and after a period of public exhibition and consultation (where 344 submissions were received), four primary management options were endorsed for further investigation.

The shortlisted options from stage 1 were:

1. Planned Retreat (services relocation, development controls, voluntary purchase and property acquisition)
2. Beach Nourishment
3. 400m Revetment Wall for Illaroo Road
4. Groyne

Coastal Hazard Study - 2010

SMEC were engaged again in 2010 to revise the hazards to take into account the sea level rise planning benchmarks contained in the NSW Sea Level Rise Policy Statement 2009. The 2009 NSW Government Sea Level Rise Policy required that Council consider, as a minimum, 400mm sea level rise above 1990 mean sea levels by the year 2050 and 900mm rise by the year 2100. Following a review of the science behind the benchmarks, the NSW Chief Scientist and Engineer (2012) found that the science was 'adequate' in light of the evolving understanding of the associated issues. However, the Chief Scientist and Engineer also highlighted uncertainty associated with sea level rise projections and the possibility of undertaking more regionally specific calculations. Following these findings, the NSW government repealed the NSW Sea-level rise Policy Statement 2009 and its associated benchmarks, instead recommending that individual Councils could adopt a range of locally relevant projections commensurate with competent scientific opinion, and that these could be used for risk assessment under local planning instruments with suitable development controls.

It should be noted that although the NSW Government has repealed the Sea Level Rise Policy (benchmarks), PMHC feels this is the best available information and all work has been undertaken on this basis.

Figure 50: *Illaroo Road Rock Revetment Wall Detailed Design, Aurecon 2015*

Coastline Management Study - Stage 2 - 2012

The Stage 2 Management Study (2012) assessed the four management options in detail. PMHC held public consultation and exhibited the report in mid-2012. Following large public support received via submissions (over 4500 submissions were received), PMHC resolved to proceed with the preparation of the Lake Cathie Coastal Zone Management Plan incorporating a revetment and beach nourishment as the management option for Illaroo Road.

Illaroo Road Rock Revetment Wall - Detailed Design - 2013

As a result of the adoption of a revetment wall in 2012 under the Stage 2 Management Study and the resolution to proceed with a CZMP Council engaged Aurecon to investigate and design revetment wall for Illaroo Road *[see Figure 50]*.

The detailed design for a rock armoured revetment was completed in 2015. The rock revetment wall included pedestrian footpaths, beach access points, and additional car parking. The wall was estimated to cost $8.1M in 2015, however this estimate was heavily dependent on the availability of hard, durable rock from nearby quarries.

Lake Cathie Coastal Zone Management Plan - 2013

Council prepared Coastal Zone Management Plan (CZMP) for Lake Cathie due to the Lake Cathie Beach being designated a coastal erosion hotspot. The purpose of a CZMP is to describe proposed actions to be implemented to address priority management issues including:

- Managing risks to public safety and built assets,
- Pressure on coastal ecosystems, and
- Community uses of the coastal zone.

Council has previously undertaken the abovementioned studies in preparation for the CZMP. On the basis of considerable public support for a revetment with sand nourishment to mitigate coastal erosion risks at Illaroo Road, Council adopted the Coastal Zone Management Study (Stage 2) in July 2012. This is the preferred management option referred to in the current CZMP and forms the focus of this document.

The CZMP was adopted by Council in 2013 on the basis that funding for the total cost of the revetment wall construction would be provided by both the NSW and Commonwealth Governments.

Certification of the CZMP by the NSW State Government was requested in March 2014. In March 2015 the Minister for Planning requested a number of actions be undertaken before the CZMP would be certified.

Of particular note, Council was requested to:

- include updated costs for the construction of the revetment wall which was based on Aurecon's detailed design,
- incorporate the results of a Cost Benefit Analysis (CBA) that was being prepared by OEH on Council's behalf, and
- consider reviewing the management of stormwater to minimise the direct outflow of stormwater onto the beach.

Hazard Study Review - 2014

The Lake Cathie Coastal Zone Management Plan included actions for further investigation. One such action related to geotechnical investigation targeting indurated sands "coffee rock" within the study area. The main issue being the uncertainty relating to the influence of regional coffee rock formations on long term shoreline recession and storm erosion demand at the study site.

This review included:

- A geotechnical investigation of the indurated sand (coffee rock) strength and extent.
- Producing a conceptual sediment transport model for the site.
- Undertaking photogrammetric analysis of the exposed coffee rock over time.

Results of the review showed that there was no justification to change the previously adopted hazard lines from the 2008 and 2010 SMEC reports.

Lake Cathie Coastal Zone Management Plan - 2016

Council revised the CZMP to incorporate the actions requested by the minister. The plan was adopted by Council in April 2016 and ministerial certification was subsequently requested.

Ministerial certification of the Lake Cathie Coastal Zone Management Plan 2016 was provided in November 2016 and was Gazetted in January 2017.

The certification again came with a list of actions which were required to implement the plan. The letter advised that the next critical step was the development of a workable funding model based on a distributional analysis that accords with the provisions of the new Coastal Management Manual.

The CZMP is the final document of the coastal zone management process and as such is a summarising document containing important information gathered from the three previous studies.

Implementation of CZMP Actions as at March 2020

a. **440m Revetment Wall for Illaroo Road**
As mentioned above, at the direction of the Minister, OEH (now DPIE) engaged Balmoral Group in 2015 to undertake a Cost-Benefit Analysis (CBA) of management options along with a socio-economic profile of Lake Cathie. The analysis concluded that beach nourishment had the greatest net social benefit for the community, closely followed by the option of building a revetment wall.

Following the direction from the Minister in 2016 Council engaged Marsden Jacob & Associated to prepare a funding model which would rely on the results of the 2015 Balmoral Group CBA. However, upon review of the Balmoral modelling a number of fundamental issues with the modelling were uncovered. Accordingly, a new CBA and Funding Model needed to be completed.

The revised CBA & funding model:

- synthesized and accurately reported cost components based on the results of the Cost Benefit Analysis and associated engineering studies.
- identified and evaluated the strengths and limitations of alternative funding models. The assessment focuses on current opportunities and alternative management options and strategies that could result in a budget neutral outcome for the Council or identify long-term alternative sustainable funding.
- described the public and private beneficiaries and the extent of the benefits to each beneficiary associated with the preferred option.
- identified funding options and models that could support the development of the revetment and that are founded on the Council's statutory ability to levy fees and charges under relevant state government legislation.
- recommend a preferred funding model. In developing this model, we note that we would need to consider the capacity of beneficiaries to pay apportioned costs.

At this time, a preferred funding model has been recommended, but further consultation with residents is required before an assessment can be made on their willingness and capacity to pay for coastal protection measures (i.e. the revetment wall). Community engagement is planned to be undertaken in order to inform the directly impacted residents and community at large of the outcome. This project has not been finalised or adopted by Council at the time of writing this Scoping Study.

b. **Short-term beach management**
Short-term beach management includes monitoring the beach for erosion following storm events, continuing interim development controls, continuing beach nourishment with sand from dredging activities in Lake Cathie, foreshore management and construction of Illaroo Road stormwater realignment.

c. **Illaroo Road Stormwater realignment**
Council successfully sought grant funding to undertake construction works to redirect stormwater away from two outlets that currently discharge water directly onto the beach at Illaroo Road. The project aims to capture this stormwater and discharge the water into a single outlet in Bundella Avenue.
The stormwater realignment is currently on-hold due to dumped asbestos (building waste) and Aboriginal archaeological findings at the site which are undergoing further investigation.

d. **Emergency Action Plan**
A plan has been developed under this plan which identifies actions to manage risks to public safety in the event of a coastal erosion emergency. It has not been necessary to implement any of these response actions to date.

Figure 51: *Lake Cathie CZMP Study Area (Port Macquarie-Hastings Council and SMEC, 2016)*

Other Management Actions

Key Issues	Management Action Required	Status Comment
Stormwater Management	*Redirect Illaroo Rd stormwater to minimise the direct outflow of stormwater onto the beach. Illaroo Road only included as a contingency pending confirmation of the timing of the construction of the Revetment.*	*Commenced - Detailed design plans completed. Grant application for construction has been submitted. Awaiting outcome.*
Stormwater Management	*Continue to upgrade the stormwater outlets to the beach e.g: placement* ***of rock at outlets to reduce beach scour.***	*Commenced & ongoing - numerous beach outlets upgraded within past 10 years. Grant funding application successful for Middle Rock & Chepana Street outlet works. Construction works were completed on 2x outlets in 2019.*
Ongoing Beach Nourishment	*Any sand dredged/ excavated from the Lake Cathie entrance to be placed on the beach adjacent to Illaroo Road.*	*Ongoing*
Foreshore Management	*Batter back any storm erosion escarpment that forms at Foreshore Reserve (or in other locations) to ensure public safety and maintain park amenity.*	*Ongoing*
Public Access	*Continue to monitor and rehabilitate informal beach access tracks*	*Ongoing*
Public Access	*Reduce erosion escarpments at the base of beach accessways and carry out any necessary repairs following storm erosion*	*Ongoing*
Foreshore Management	*Continue to control/ remove bitou bush along with regeneration/ revegetation with locally indigenous vegetation species.*	*Ongoing, subject to funding availability.*
Reserve Improvements	*Prepare masterplan for foreshore reserves (Aqua Reserve, Foreshore Reserve and Johnathon Dixon Reserve), incorporating the following improvements: - additional lighting at Johnathon Dixon Reserve and in the vicinity of the Foreshore Reserve barbeque facilities - upgrade Johnathon Dixon Reserve to relieve pressure on Foreshore Reserve by providing shade, shelter and play areas. Upgrades should allow for revetment end effects.*	*Completed for Aqua Reserve and Foreshore Reserve. Foreshore reserve masterplan developed and adopted by Council. A masterplan for Jonathon Dixon Reserve is yet to be prepared. Ongoing implementation will be undertaken over coming years.*
Development Controls	*Review area subject to controls following construction of the revetment and when the hazard lines are reviewed. Note that the 50 year impact line would move over time due to shoreline recession (and possibly affect additional properties, e.g. along Chepana Street).*	*Yet to be scheduled*
Revetment	*Call tenders and construct revetment.*	*Yet to be scheduled*
Revetment	*Finalise private/ public cost-sharing arrangements including private payment plans.*	*Ongoing - consultant engaged and project is underway. Council is working closely with DPIE to finalise project.*
Revetment	*Carry out post-storm assessments to identify revetment maintenance requirements and actions to address exacerbated erosion in front of, and at the ends of, the revetment.*	*Yet to be scheduled*
Contingency Measures	*Develop a Servicing Strategy in consultation with other service providers in the event that access and services to Illaroo Road properties are threatened by coastal erosion, prior to construction of a revetment.*	*Yet to be scheduled*
Contingency Measures	*Designate Aqua Crescent/ Bundella Avenue and Illaroo as a one-way loop in a Local Area Traffic Management Plan in the event that damage to the road reserve occurs as a result of erosion events and the road pavement width needs to be reduced to maintain safe access, prior to the construction of a revetment.*	*Yet to be scheduled*

Table 8. *Other management actions for Lake Cathie CZMP*

16.2 ESTUARY MANAGEMENT PLANS

The NSW Government introduced the Estuary Management Policy in 1992 which was consistent with the former Catchment Management Act 1989. The Estuary Management Policy was introduced in order to achieve an integrated, balanced, responsible and ecologically sustainable use of estuaries. Preparation of Estuary Management Plans was in accordance with the NSW Estuary Manual which saw the establishment of coast and estuary management committees.

16.2.1 HASTINGS ESTUARY MANAGEMENT PLAN

The Hastings EMP was prepared for PMHC and overseen by the Hastings Council Estuary Management Committee (now Port Macquarie-Hastings Council Coast, Estuary and Floodplain Advisory Sub-Committee) in 2001 by Umwelt (Australia) Pty Limited. The EMP was developed in accordance with the NSW Estuary Management Manual 1992.

The Hastings EMP was created to provide integrated management of the estuarine system by obtaining information about system processes and current conditions and designing management actions to address any issues identified.

The Hastings Estuary Management Plan covered the following areas:

- The waterways of the Hastings estuary and its tributaries (e.g. the Maria River, Limeburners Creek and Kooloonbung Creek), up to the limit of tidal influence.
- The foreshore and other lands adjacent to the estuary, including all wetlands and floodplain areas that are functionally related to the estuary; and
- The catchment areas of the estuarine waterways, in relation to the impacts of catchment processes on the estuarine environment. The interaction of the catchment and estuary as parts of a single system is a fundamental concept for sustainable estuary management.

Key Issues

Key issues that affected the Hastings Estuary were identified as:

- Estuary form and processes
- Acid sulphate soils
- Bank erosion
- Riparian vegetation and conservation values
- Water quality
- Scenic value
- Aquatic primary production
- Floodplain production
- Dredging
- Population growth and age structure
- Tourist and recreational use
- Community views about the value of the estuary

Management Actions

Numerous actions were adopted under this plan with many being completed. Some notable actions include:

- The appointment of an Acid Sulphate Soils Officer
- Development of a Hydrodynamic Model
- Rocks Ferry upgrade
- Completion of the Partridge Creek Management Strategy and subsequent remediation of the Partridge Creek Acid Sulphate Soil hotspot.

Other Management Actions

Key Issues	Management Action Required	Status
Habitat rehabilitation & Riparian Zone Management	*Enhance foreshore habitat of Kooloonbung Creek between Gordon and William streets*	*Commenced - planning and environmental approvals obtained and certain works completed*
Habitat rehabilitation & Riparian Zone Management	*Strategic planning to protect high value conservation areas*	*Mapping completed as part of Biodiversity Strategy. Protection of high value conversation undertaken as part of any individual rezoning process.*
Salvinia control in Upper Maria River	*Eradicate Salvinia from upper Maria River and Connection Creek and undertaken annual inspections of target farm dams*	*Ongoing*
Control Upper estuary vine weeds	*Control invasive vines weeds in the upper Hastings estuary*	*Ongoing*
Fish Stock Monitoring	*Seek opportunities to develop fish stock monitoring.*	*Ongoing*
Significance/Protected Area Mapping	*Continue working on Biodiversity Strategy to highlight key environmental assets (including wetlands and riparian) necessary for protection.*	*Ongoing*
Estuary Sedimentation	*Determine significant sediment sources and educate where appropriate.*	*Ongoing*
Acid Sulphate soils	*Initiate regulatory and enforcement action to unlawful ASS management activities*	*Ongoing*
Sustainable Urban Growth and waterway use	*Provide opportunities for direct community participation in review of the plan*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Council and DUAP to Monitor and enforce compliance with SEPP 14 & SEPP 26*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Council to Ensure compliance with development consent conditions for habitat conservation*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Maintain existing rock wall protection*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Prepare plans for strategic retreat of ancillary buildings and infrastructure*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Council to Monitor and enforce compliance with tree preservation policy*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Review management plans for foreshore reserves*	*Ongoing*
Sustainable Urban Growth and waterway use	*Monitoring and enforcement of soil and water management and habitat protection provisions of development consent*	*Ongoing*
Sustainable Urban Growth and waterway use	*Audit Planning decisions to ensure consistent response to issues affecting the health of the estuary*	*Ongoing*
Sustainable Urban Growth and waterway use	*Stormwater management for Kooloonbung Creek*	*Ongoing*
Habitat rehabilitation & Riparian Zone Management	*Support Landcare groups or landowners to carry out riparian zone rehabilitation*	*Ongoing*
Sedimentary Processes and Dredging Management	*Council, DLWC, NSW Fisheries and EPA use regulatory powers strategically to enhance environmental outcomes*	*Ongoing*
Sustainable Urban Growth and waterway use	*Establish and maintain tourism databases*	*Ongoing*
	Implement urban stormwater measures, Wauchope and lower priority areas of Port Macquarie	*Ongoing*
	Continue to negotiate landholder agreements for drain operation, maintenance, restoration of high conservation land	*Ongoing*
Sedimentary Processes and Dredging Management	*Prepare statutory documentation for urgent navigation dredging (REF) and confirm funding options*	*Ongoing - as part of specific proposals*
Sustainable Urban Growth and waterway use	*Scenic Amenity and conservation plan*	*Ongoing - component of landuse and open space planning*
Manage Interactions of Recreational Users	*Maintain and enforce no wash zones in narrow channel areas (Maria River and Limeburners Creek)*	*Ongoing - RMS*
Acid Sulphate soils	*Collate information on performance indicators such as fish kills, water quality etc*	*Ongoing - SoE process*
Sustainable Urban Growth and waterway use	*Establish monitoring programs for core indicators of estuary health*	*Ongoing - SoE process*
Habitat rehabilitation & Riparian Zone Management	*Establish assessment and monitoring protocol for riparian vegetation to be reported in SoE*	*Ongoing - SoE process*
Sustainable Urban Growth and waterway use	*Report on core suite of sustainability indicators*	*Ongoing - SoE process*

Sustainable Urban Growth and waterway use	Maintain Integrate socio-economic databases with environmental databases	Ongoing - SoE process
Sustainable Urban Growth and waterway use	Maintain 3 yearly ecological and sediment monitoring of Kooloonbung Creek	Ongoing - SoE process
Acid Sulphate soils	Initiate ecological monitoring program	Ongoing - SoE process
Sedimentary Processes and Dredging Management	Extend river Styles assessment to the estuary	Ongoing - SoE process
Habitat rehabilitation & Riparian Zone Management	Conduct community surveys on usage/ satisfaction with foreshore park facilities	Ongoing - through existing community engagement processes
Sustainable Urban Growth and waterway use	Provide direct and well publicised Council contact on environmental matters via estuary education	Ongoing (NRO) position
Sustainable Urban Growth and waterway use	Maximise opportunities for sustainable reuse of sewage effluent	Ongoing and fully funded through the delivery of recycled waste water (purple pipe) for new developments such as Area 13.
Sustainable Urban Growth and waterway use	Continue to promote and fund Urban Landcare	Ongoing and funded through Environmental Levy
Sedimentary Processes and Dredging Management	Establish an ongoing program of channel survey to monitor rates of shoaling at key locations, bed form and refine maintenance dredging program	Ongoing Dept of Lands
Habitat rehabilitation & Riparian Zone Management	Focus riparian vegetation protection measures in Maria River and Limeburners Creek	Ongoing requires landholder willingness
Sustainable Urban Growth and waterway use	Septic safe program - Onsite sewerage management plan	Ongoing through provision of rural village sewer programme and OSMS inspections
Sustainable Urban Growth and waterway use	Involve local aboriginal community in ongoing estuary management activities	Ongoing through representation on the Committee and other estuary related matters
	Ongoing monitoring and reporting of sustainability indicators for the estuary	Ongoing through the Regional State of the Environment reporting
Habitat rehabilitation & Riparian Zone Management	Establish voluntary conservation agreements with landholders	Ongoing where suitable
Manage Interactions of Recreational Users	Provide baseline data on recreational fishing effort and catches	Fisheries advice required
	Provide additional boat ramp to Wauchope area	Complete - Additional boat ramp was not identified as a priority in the Mid North Coast Regional Boating Plan as adopted by the RMS in 2015. A floating pontoon has being installed at Rocks Ferry Reserve to improve facilities for recreational boaters in this area.
Manage Interactions of Recreational Users	Provide clear information and Guidance to visitors and residents on issues such as recreational boating, swimming areas, water conservation etc	Yet to commence
Manage Interactions of Recreational Users	Implement ongoing projects under HIMS-T system	Yet to commence
Habitat rehabilitation & Riparian Zone Management	Fund Blackmans Point Landcare to continue installation of log walls	Yet to commence

Table 9. *Other management actions for Town Beach CZMP*

16.2.2 CAMDEN HAVEN ESTUARY MANAGEMENT PLAN

The Camden Haven EMP was developed in 2002 for PMHC, overseen by Camden Haven Estuary Committee (now merged into the CE&F committee).

The plan involved significant community consultation and stakeholder engagement throughout the process.

Key Issues

Key issues that affected the Camden Haven Estuary were identified as:

- Development and Human Impacts - growing pressures from urban growth adjacent to the estuary. Clearing and drainage of land has resulted in oxidation of acid sulphate soils.
- Water Quality - stormwater and acid runoff can deteriorate water quality even during minor rainfall and flood events. The poor flushed parts of the estuary such as Mirror Bay and Gogleys Lagoon are most susceptible to these impacts.
- Bank Erosion - continued erosion of shoreline, in particular along Stingray Creek at Henry Kendall Reserve
- Estuary Sedimentation - infilling of the estuary, particularly at locations where navigation is important such as the Camden Haven River entrance to Watsons Taylor Lake
- Fishery - Decline in fish stocks and effects to oyster farming
- Preservation of Wetlands, Mangroves, Saltmarsh and Seagrass
- Maintenance of the aesthetic attributes - the close proximity of tall mountains (the 'Three Brothers') to the estuary is a unique feature.

Management Actions

The plan incorporated both long-term and short-term strategies for managing the estuary. Long term strategies focused on regional issues such as reversing larger scale human impacts whilst short term strategies related to work or measures that could be implemented as soon as funding became available. Several strategies were created ranging from Priority 1 Actions (initiated over the next 2 years) to Priority 3 Actions (initiated over the next 5-10 years).

These actions included

- Implementing water quality monitoring programs.
- Community education relating to estuarine processes and responsible stormwater runoff management.
- Design and construction of pollution control devices.
- Development controls.
- Bank stabilisation for erosion control
- Further studies/reviews relating to vegetation mapping, priority conservation areas, acid generation, biological assessment of seagrass beds, significant wetlands and reported reduction in fish stocks.
- Estuarine/lakeside linkages project aimed at reducing feral pests and invasive weeds.

Other Management Actions

Key Issues	Management Action Required	Status
WATER QUALITY	Develop Stormwater Catchment Action Plans for all urban and rural sub-catchments draining directly to the estuary (in accordance with the Hastings Stormwater Management Plan).	Commenced - 1 sub catchment completed
WATER QUALITY	Maintain existing foreshore vegetation around Queens Lake	Completed - weed and vertebrate pest control works undertaken under the Lakeside Linkages Project which ran from 2017-2019. Works were undertaken in partnership with Queens Lake Landcare Group.
ENVIRONMENTAL MANAGEMENT	Prepare a 'Significant Bushland Overlay' for Council's GIS based on the mapping of priority conservation areas within the Vegetation Management Plan.	Completed mapping.
RECREATION	Upgrade parking facilities at Dunbogan Boat Launching Ramp	Detailed design for upgrade of Dunbogan Boatramp is currently being completed. The design includes some improvement of parking areas through current budget allocation is for boatramp widening and pontoon installation only. A timeline for parking improvements is not known at this time.
RECREATION	Upgrade the boat launching ramp within Henry Kendall Reserve.	Upgrade of this facility is not prioritised in Draft Camden Haven River Recreation Boating Study. Instead, upgrading of Bruce Porter Reserve and Dunbogan Reserve boating facilities have been nominated. Upgrading of these facilities is yet to be scheduled.
WATER QUALITY	Determine and adopt target values for water quality parameters for different reaches of the estuary consistent with the Interim Environmental Objectives of the NSW Water Reforms.	2nd round of Ecohealth Montoring is currently being finalised and has been developed. Further specific targets to be developed by UNE
RECREATION	Support local Landcare Groups to retain or reinstate riparian vegetation along river and creek corridors to provide a 30 metre wide strip along each bank.	Ongoing
WATER QUALITY	Identify and map derelict oyster leases and those that are not in production	Ongoing
WATER QUALITY	Identify, prioritise, design and construct stormwater management mechanisms (eg., Gross Pollutant Traps and constructed wetlands) at key locations within the drainage system so that better control of catchment runoff to the estuary can be effected.	Ongoing - as stormwater upgrade works proceed
WATER QUALITY	Undertake specific actions to prevent future threats to estuary water quality	Ongoing - managed through the rezoing and development assessment processes
WATER QUALITY	Establish an estuary wide water quality monitoring program	Ongoing - SoE process
WATER QUALITY	Undertake water quality monitoring program	Ongoing - SoE process
WATER QUALITY	Monitor seagrass growth throughout the estuary	Ongoing - SoE process
WATER QUALITY	Establish a stormwater quality monitoring program.	Ongoing - SoE process
WATER QUALITY	Pursue gains for the environment through negotiated conditions on any new developments.	Ongoing and supported through DA process.
BANK EROSION	Identify areas where stock access should be restricted on individual properties to either: a. prohibit livestock access to creeks by fencing, with watering afforded by pumping to off-channel farm dams; or to, b. control livestock access so that watering only occurs at selected and rotated watering points.	
BANK EROSION	Develop vegetated buffer strips along major creek lines such as Stingray Creek, Stewarts River and the upper reaches of the Camden Haven River.	Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
RECREATION	Throughout the rural hinterland (ie., Kew, Kendall, eron's Creek Catchment) encourage conservation of valued terrestrial vegetation through voluntary conservation agreements and retain existing riparian vegetation. Target areas should include: · land adjoining the eastern perimeter of Queens Lake · extensive forested areas and existing riparian vegetation around Heron's creek · large tract of undisturbed old growth forest adjacent to Dooragan National Park	Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
ENVIRONMENTAL MANAGEMENT	Encourage the establishment of native vegetation on private property by providing tube stock to foreshore property owners.	Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
WATER QUALITY	Enforce erosion and sediment controls for development and activities which have the potential to impact on the estuary.	Ongoing through the DA process
FISHERY	Promote use of existing boat effluent pump out facilities.	Ongoing through Waterways
RECREATION	Re-establish vegetation along the cleared parts of the Queens Lake foreshore	Ongoing. Part of the Camden Haven Estuarine Lake Linkages project
WATER QUALITY	Develop a community education program for responsible stormwater runoff management within the urban areas adjacent to the estuary.	Yet to commence
ENVIRONMENTAL MANAGEMENT	Justify and recommend that wetland areas identified as regionally significant be rezoned to "Environmental Protection" under Hastings LEP 2000, or be incorporated within SEPP 14.	Ongoing through individual rezoning application phase.
ENVIRONMENTAL MANAGEMENT	Justify and support the rezoning to "Environmental Protection" of the following within land that drains to the estuary: a. Priority 1 and 2 status vegetation identified and mapped in the draft Hastings Vegetation Management Plan that fall within a 500 metre wide band that is parallel to and extends around the perimeter of the estuary shoreline; b. Native vegetation that exists within a 250 metre wide band along either side of the banks of all estuary tributaries where that vegetation is considered to be of value.	Ongoing through individual rezoning application phase.
	Emergency Management Measures	Commenced - Camden Haven Flood Plan Complete - New Hastings LGA SES Flood Plan completed in 2015.
	Improved Flood Access	Stages 1A, 1B & 1C of the Dunbogan Flood Access Road upgrade are complete.
	Small Levee in Lakewood Village	Project is considered a low priority. Numerous unsuccessful grant applications have impacted the delivery of this project. Due to the low cost/benefit ratio this project is unlikely to be completed without grant funding.
	Voluntary House Raising	Yet to commence - Audit undertake in 2007 showed project of high cost and mixed interest from owners. Pilot scheme was suggested to gauge likely issues. The pilot has not commenced at this time.

Table 10. *Other management actions for Camden Haven Estuary*

16.2.3 LAKE CATHIE/LAKE INNES ESTUARY MANAGEMENT PLAN

The Lake Cathie/Lake Innes EMP was created in 1994 in collaboration with NSW Public Works (now Public Works Advisory) and the National Parks and Wildlife Service (NPWS).

Key Issues

Issues that were identified were discussed with the Lake Cathie-Bonny Hills Estuary Management Committee along with the community and environmental groups to determine and prioritise management actions.

The key issues identified are listed below:

- Entrance opening - increased salinity when lake is closed, waterbirds nesting and seasonal feeding, organic staining of waters when lake is closed, recreational activities, fish and prawn migration, deoxygenation of waters and pollution build up.
- Shoaling in the lower estuary - the construction of the Ocean Drive and Kenwood Drive bridge have changed the shoaling patters and tidal and flood flows and sand infeed from the ocean entrance
- Closing of Lake Innes - based on Lake Innes historically being freshwater system and may impact fisheries, salt marsh populations, flood and tidal hydrodynamics, water quality, biology and lake opening/closing frequencies.
- Water quality - surrounding residential development results in increased stormwater runoff impacting on gross pollutants, nutrients, bacteria and particulate matter.
- Flooding - several properties are flood prone particularly in relation to the lake opening frequency
- Waterway uses - recreational, commercial, access
- Sedimentation - limited volumes for fine suspended sediments (clays and silts) enter the estuarine system with surrounding wetlands acting as barriers

Management Actions

EMP management actions included:

- Implement combined entrance opening strategy and modified entrance opening procedure
- Potential reversion of Lake Innes into a freshwater system by installing a levee
- Establish run-off quality guidelines
- Adoption of flood policy changes
- Water quality monitoring and establish nutrient budgets
- Facility and access upgrades
- Dredging of lower estuary

Further studies have been completed to understand the complex processes in the estuarine system, some of which are listed below:

- Nutrients in the Lake Cathie / Lake Innes Lagoonal System, Port Macquarie (Southern Cross University, 1994)
- Cathie Creek Maintenance Dredging Environmental Review, (Webb, McKeown & Associates, November 1994)
- Lake Cathie/Lake Innes Water Quality Study, (Department of Public Works and Services, Manly Hydraulic Laboratory, November 1995)
- Lake Cathie/Lake Innes Entrance Opening Strategy Environmental Review, (Webb, McKeown & Associates, May 1995)
- Lake Cathie/Lake Innes Waterway Users Study, (Webb, McKeown & Associates, July 1998)
- Lake Innes Nature Reserve Plan of Management, (NPWS, November 1999)
- A Tale of Two Lakes - Managing Lake Innes and Lake Cathie for Improved Ecological and Community Outcomes - Issues and Options, (Umwelt, February 2004)
- Maintenance Dredging of Lake Cathie Review of Environmental Factors, (GHD, September 2004)
- Port Macquarie-Hastings Council Dredging Strategy, (Port Macquarie-Hastings Council, September 2007)
- Lake Cathie Lake Innes Estuary - Hydrodynamic Model Development & Investigation (BMT WBM, May 2011)
- Lake Cathie and Lake Innes Acid Sulfate Soil Risk Assessment, (Soil Conservation Services, July 2019)

Water quality monitoring

PMHC undertakes water quality monitoring at Lake Cathie typically monthly and primarily from the Ocean Drive Bridge. As of June 2019, PMHC is also undertaking monitoring at three separate locations in the estuarine system. Water quality is broadly considered within acceptable limits although there have been some recent occurrences of high salinity. Water level data is recorded by the NSW Government from automatic recording equipment, managed by Manly Hydraulics Laboratory.

Connection of Lake Innes to Lake Cathie

Lake Cathie and Lake Innes are a connected system however this has not always been so. Before 1933, Lake Innes was a stand-alone freshwater lake. A channel was dug between both lakes in an attempt to drain Lake Innes to create farmland, this resulted in Lake Innes being converted to an estuarine system with permanent connection to Lake Cathie.

Opening of Lake Cathie

The Intermittently Closed and Open Lake or Lagoon (ICOLL), from which the town of Lake Cathie takes its name, is part of a wider system that includes Cathie Creek and Lake Innes to the north.

PMHC (and its earlier counterpart i.e. Hastings Shire Council) has been artificially opening Lake Cathie since the 1960s. This is typically done by excavating a small starter channel through the beach dune when water levels exceed 1.6m AHD, however this level has formerly been 1.5m AHD and 1.8m AHD.

PMHC in consultation with the community established the Lake Cathie Opening Strategy in 1995. The strategy was reviewed in 2001, 2004/2005 and 2011. Artificial openings, to alleviate flooding have occurred on average once every 12 months. The Strategy aimed to minimise adverse effects on the ecology of the area, minimise build-up of sand in the lake entrance, and reduce impacts of flooding, while providing residents and visitors with opportunities for recreational activities. The former Opening Strategy flowchart is shown in *[Figure 52 over page]*.

A hydrodynamic model was developed by BMT WBM in 2011 to assist in management of the Lake Cathie ICOLL. This report did not recommend any changes be made to the opening strategy.

Lake Cathie continues to be a contentious area in regard to its existing and ongoing management from the perspective of the community and environmental groups. The health of the estuary is questioned constantly with community members quite often requesting that PMHC open the lake regardless of whether opening triggers have been met or not. Extensive consultation and education work have been undertaken in the last two years however there appears to be an ever-growing demand for a change in management strategy. Considering this community interest and the length of time since the latest review, (2011) a review of the existing Opening Strategy will be prioritised in the Lake Cathie/Bonny Hills chapter.

Further impetus to update the Opening Strategy comes from recent Crown Land advice where it was determined that as the environmental approval (Review of Environmental Factors - REF) was greater than 5 years old, a new REF would be required before lake openings could be undertaken. As Council does not own the land (i.e. the lower estuary, downstream of Ocean Drive bridge is Crown Land) works cannot be undertaken until a licence is issued, this will not be issued by Crown Land unless it is supported by an up to date REF.

Lake System Acid Sulphate Soils

The latest artificial opening of Lake Cathie occurred in mid-July 2018 as water levels reached the upper threshold of 1.6m AHD under the opening strategy. The draining of the lake system followed a similar pattern to other opening events whereby the initial discharge of lake water scours the beach berm down to meet the prevailing low tide mark. However ongoing drought conditions on the east coast of Australia during 2019 resulted in the lowest annual rainfall total for Port Macquarie ever recorded. After the lake entrance closed the water levels continued to decline and expose extensive foreshore areas comprising Acid Sulfate Soils. Ongoing evaporation, dry and hot conditions and bushfires resulted in the lake water levels dropping further causing high water temperatures, low dissolved oxygen, hypersalinity and fish kills.

In order to better understand the ASS risk within the lake system, Soil Conservation Services (SCS) were engaged to undertake a risk assessment. This report confirmed that a significant ASS storage and high risk contamination exists and needs further investigation. Accordingly, it was agreed between managing stakeholders that additional ASS studies were required. Council set aside $147,500 to fund this work in 2019 and applied for grant funding to cover the additional $147,500. The application is on a reserve list and may be activated upon the completion of this scoping study.

Other Management Actions

Key Issues	Management Action Required	Status
Lower Lake Cathie Creek (North)	*linking pathways*	*Commenced*
Lower Lake Cathie Creek (North)	***additional seating***	*Commenced*
Shoaling in the lower estuary	*Monitor shoaling and initiate entrance closure if required*	*Ongoing*
Water Quality	*Continue and expand WQ monitoring*	*Ongoing*
Lower Lake Cathie Creek (North)	*water quality monitoring*	*Ongoing*
Lake Innes and Lake Cathie	*vehicle and bike barriers*	*Ongoing*
Water Quality	*Construct water quality control structures*	*Ongoing - as stormwater upgrade works proceed*
Shoaling in the lower estuary	*Undertake EIS and dredge lower estuary*	*Ongoing - REF completed in 2017 to supplement SOEE Completed in 2013. These approvals cover repeated dredging works and allow placement of sand spoil at Illaroo Road or on Foreshore Reserve. Recent dredging works were completed with 1:1 funding received from NSW govt.*
Water Quality	*Investigate pollution impacts and establish nutrient budgets*	*Ongoing - incorporated in Ecohealth Programme*
Sedimentation	*Construct sediment control structures*	*Ongoing as necessary*
Lake Cathie Entrance Opening	*Implement combined entrance opening strategy (when to open)*	*Ongoing*
Upper Cathie Creek	*creek pathway*	*National Parks and Wildlife Service advice required*
Lake Innes and Lake Cathie	*linking pathways*	*National Parks and Wildlife Service advice required*
Water Quality	*Undertake community education program*	*No longer considered necessary*
Flooding	*Prepare Floodplain management Plan*	*No longer considered necessary*

Table 11 *Other management actions for Lake Cathie/Lake Innes Estuary*

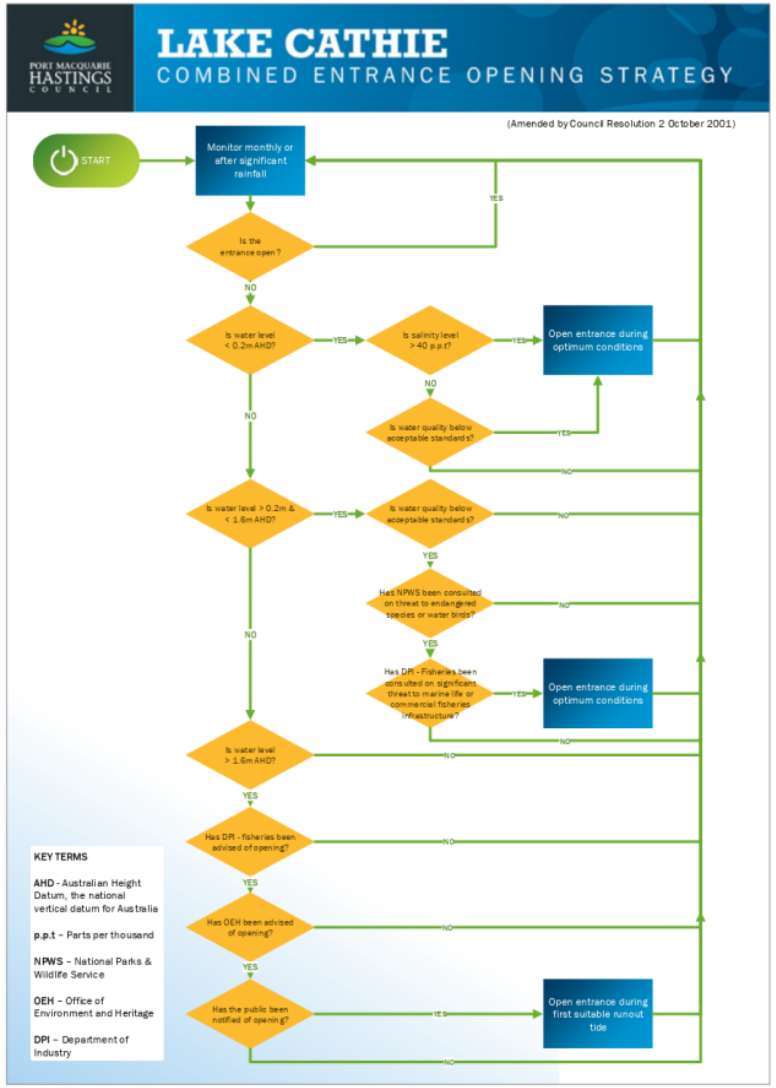


Figure 52: *Former Lake Cathie Opening Strategy Flowchart*

16.2.4 SALTWATER CREEK MANAGEMENT PLAN

Saltwater Creek is a small creek that flows through the northern section of Bonny Hills and drains a catchment of 2.5km2. The creek flows intermittently into the ocean at Rainbow beach immediately north of the Bonny Hills Surf Life Saving Club.

The Management Plan was developed in 2005 to identify issues associated with Saltwater Creek and its catchment, and proposes a strategy and action plan to address these issues.

The impetus of the plan came from the local community and the former Hastings Coast and Estuaries Committee who highlighted the deteriorating visual and environmental aspects of the creek and its surrounds.

Saltwater Creek had not received formal management or maintenance for some years prior to this management plan. One of the reasons for this has been multiple ownerships (i.e. private landowners, Crown Lands and PMHC).

Key Issues

Key issues explored and addressed by the plan are:

- Aesthetics
- Flooding
- Creek Water Quality
- Stormwater Quality
- Maintenance of Stormwater Infrastructure and derelict structures
- Sedimentation
- Debris Build up and rubbish dumping
- Erosion
- Vegetation Management

Management Actions

The management plan identified issues and prioritised them according to their environmental impacts and importance placed by community. A range of strategies and actions were then recommended to manage specific issues.

Management actions contained in the plan will be reviewed and if appropriate, included in the CMP.

16.2.5 OTHER PLANS AND REPORTS

There are many other documents that fall within all coastal management areas and are managed by different Council sections, other government agencies and some in partnership with community groups. Some of these documents are listed below:

- Hastings Regional Crown Reserve - Precinct A - Plan of Management, December 2014
- Westport Park - Plan of Management, January 2012
- Bonny Hills Reserves Master Plan 2012
- Lake Cathie Foreshore Master Plan 2018
- Bruce Porter Reserve Master Plan 2011
- (Draft) Flynns Beach Master Plan 2019
- Town Beach Master Plan 2013
- Coastal Walk Master Plan 2017
- Port Macquarie Foreshore Walkway Master Plan (Concept) 2019

Figure 53. *Town Beach, Port Macquarie*

17.1 KEY ISSUES AND THREATS

Key issues/threats to Coastal Management Areas have been previously determined through the EMPs and CZMPs. These threats have been reviewed and most are considered to still be relevant *[see Table 12 below]*.

Threats/Issues	Coastal Wetlands and Littoral Rainforest Area (CWLRA)	Coastal Vulnerability Area (CVA)	Coastal Environmental Area (CEA)	Coastal Use Area (CUA)
Access and Amenities Impacts	Y	Y	Y	Y
Acid Sulphate Soils	Y		Y	Y
Coastal Erosion	Y	Y	Y	Y
Development and Land-use Planning Impacts	Y		Y	Y
Fish/Prawn/Oyster Stock Changes	Y		Y	Y
Flooding	Y	Y	Y	Y
Invasive Weeds	Y		Y	Y
Land Ownership/Management/Responsibilities Uncertainties	Y		Y	Y
Navigation Obstructions	Y		Y	Y
Ocean Bath/Tidal Pool		Y	Y	Y
Recreational Users Impacts	Y		Y	Y
Seagrass Changes	Y		Y	Y
Riparian Zone Impacts	Y		Y	Y
River Bank Erosion	Y		Y	Y
Sea-level Rise/Tidal Inundation	Y	Y	Y	Y
Sedimentation/Shoaling	Y		Y	Y
Urban and Rural Stormwater Runoff	Y		Y	Y
Vertebrate pests	Y		Y	Y
Water Quality Changes	Y	Y	Y	Y
Coastal Lake or Watercourse Entrance Instability	Y	Y	Y	Y
ICOLL Entrance Opening	Y	Y	Y	Y
Coastal Cliff Instability	Y	Y	Y	Y

Table 12 *Other management actions for Lake Cathie/Lake Innes Estuary*

17.2 FIRST-PASS RISK ASSESSMENT

A first-pass risk assessment was undertaken based on the issues identified in *[Section 16]*. This risk assessment was done in order to prioritise issues to determine when and where action needs to be taken.

The risk assessment methodology was sourced from the Manual Part B: Stage 1. *[Table 13]* shows the consequence scale and *[Table 14]* shows the likelihood scale and *[Table 15]* shows the risk assessment matrix. The success criteria in the consequence scale was chosen based on what was most applicable to each issue.

Each issue was assessed based on the likelihood of it occurring and the consequence of it occurring. This assessment was done for each catchment as issues vary in significance across the LGA *[see Table 16]*.

Issues identified as high risk and above are considered to be priority risks and should be considered in Stage 2 of the CMP. Low or moderate risks will still be considered, however timeframes for completion may be longer than high priority issues. *[Table 17]* shows the priority risks (threats/issues), current management practices, any knowledge gaps and any investigations required in Stage 2.

Rating	Success criteria				
	Public safety	**Local economy and growth**	**Community and lifestyle**	**Environment and sustainability**	**Public administration**
Catastrophic	Large numbers of serious injuries or loss of lives	Regional decline leading to widespread business failure, loss of employment and hardship	Region would be seen as very unattractive, moribund and unable to support its community	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	Public Administration would fall into decay and cease to be effective
Major	Isolated instances of serious injuries or loss of lives	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community	Severe loss of environmental amenity and danger of continuing environmental damage	Public administration would struggle to remain effective and be seen as in danger of failing completely
Moderate	Small numbers of injuries	Significant general reduction in economic performance relative to current forecasts	General appreciable decline in services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	Public administration would be under severe pressure on several fronts
Minor	Serious near misses or minor injuries	Individually significant but isolated areas of reduction in economic performance relative to current forecasts	Isolated but noticeable examples of decline in services	Minor instances of environmental damage that could be reversed	Isolated instances of public administration being under severe pressure
Insignificant	Appearance of a threat but no actual harm	Minor shortfall relative to current forecasts	There would be minor areas in which the region was unable to maintain its current services	No environmental damage	There would be minor instances of public administration being under more than usual stress but it could be managed

Table 13: *Consequence scale. Sourced from NSW Coastal Management Manual Part B: Stage 1 (OEH, 2018) and adapted from Climate Change Risk Management: A guide for business and government (AGO, 2006).*

Likelihood level	Likelihood of impacts
Rare	Never reported for this situation, but still plausible within the timeframe (< 5%).
Unlikely	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe (5-30%).
Possible	There is clear evidence to suggest this is possible in this situation within the timeframe (30-50%).
Likely	Expected to occur in this situation within the timeframe. There is a history of frequent occurrence (50-90%).
Almost certain	Very likely. A very large certainty that this will occur in this situation within the timeframe; a history of regular occurrence (>90%)

Table 14: *Likelihood scale. Sourced from NSW Coastal Management Manual Part B: Stage 1 (OEH, 2018) and adapted from NSW Marine Estate TARA (MEMA, 2017).*

	CONSEQENCE				
Likelihood	*Insignificant*	*Minor*	*Moderate*	*Major*	*Catastrophic*
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	High	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Table 15: *Risk assessment matrix. Sourced from Sourced from NSW Coastal Management Manual Part B: Stage 1 (OEH, 2018) and adapted from Climate Change Risk Management: A guide for business and government (AGO, 2006).*

Threat/Issue	CMP AREA											
	Hastings			Lake Cathie/Lake Innes/Bonny Hills (incl surrounding Coastline)			Camden Haven			Open Coastline (Excl LC/LI/BH)		
	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Access and Amenity Impacts	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High	Likely	Major	High
Acid Sulphate Soils	Likely	Major	High	Almost Certain	Major	Extreme	Likely	Major	High	N/A	N/A	N/A
Coastal Erosion	N/A	N/A	N/A	Almost Certain	Major	Extreme	N/A	N/A	N/A	Almost Certain	Moderate	High
Development and Land-use Planning Impacts	Likely	Major	High	Possible	Minor	Medium	Possible	Minor	Medium	Possible	Minor	Medium
Fish/Prawn/Oyster Stock Changes	Possible	Major	High	Likely	Major	High	Possible	Major	High	Possible	Moderate	High
Flooding	Possible	Major	High	Possible	Moderate	High	Possible	Major	High	N/A	N/A	N/A
Invasive Weeds	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High
Land Ownership/Management/ Responsibilities Uncertainties	Likely	Moderate	High	Likely	Major	High	Likely	Moderate	High	Likely	Moderate	High
Navigation Obstructions	Possible	Minor	Medium	Unlikely	Minor	Low	Possible	Minor	Medium	Possible	Minor	Medium
Ocean Bath/Tidal Pool	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Possible	Major	High
Recreational Users Impacts	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High
Seagrass Changes	Possible	Moderate	High	Unlikely	Minor	Low	Possible	Moderate	High	N/A	N/A	N/A
Riparian Zone Impacts	Likely	Moderate	High	Unlikely	Moderate	Medium	Likely	Moderate	High	N/A	N/A	N/A
River Bank Erosion	Likely	Moderate	High	Unlikely	Minor	Low	Likely	Moderate	High	N/A	N/A	N/A
Sea-level Rise/Tidal Inundation	Almost Certain	Major	Extreme	Almost Certain	Moderate	High	Almost Certain	Major	Extreme	Almost Certain	Moderate	High
Sedimentation/Shoaling	Possible	Minor	Medium	Likely	Moderate	High	Possible	Minor	Medium	N/A	N/A	N/A
Urban and Rural Stormwater Runoff	Possible	Moderate	High	Possible	Moderate	High	Possible	Moderate	High	N/A	N/A	N/A
Vertebrate Pests	Likely	Moderate	High	Likely	Moderate	High	Likely	Moderate	High	Likely	Minor	Medium
Water Quality Changes	Possible	Moderate	High	Possible	Moderate	High	Possible	Moderate	High	Possible	Moderate	High
Coastal Lake or Watercourse Entrance Instability	Unlikely	Moderate	Medium	Possible	Major	High	Unlikely	Moderate	Medium	N/A	N/A	N/A
ICOLL Entrance Opening	N/A	N/A	N/A	Almost Certain	Major	Extreme	N/A	N/A	N/A	N/A	N/A	N/A
Coastal Cliff Instability	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Likely	Minor	Medium

Table 16: *Risk Assessment for Threats/Issues, compiled using the MEMA TARA model 2017*

Priority Threat/Issue	CMP Area	Current Management	Knowledge gaps	Required Investigations in Stage 2	Responsibility
Access and Amenities Reduced or Impacted	*All*	• *Upgrading foreshore accessways and walkways* • *Westport Park Foreshore upgrade works* • *Town Green & Kooloonbung Creek upgrades (ongoing)* • *Coastal Walk upgrade* • *Beach to Bago & Creek to Creek works (ongoing)* • *Lake Cathie foreshore masterplan*	• *Footpaths inundated at Lake Cathie when lake full, need survey heights AHD of public and private assets around lake foreshore at risk to 2.6m AHD* • *Small section of Tallong Drive impacted when lake full.*	1. *Undertake detailed survey of impacted infrastructure (footpaths, open space, sewer and stormwater infrastructure etc) around Lake Cathie to investigate risk to public and private assets to lake water level of 1.6m AHD.* 2. *Investigate options to raise small section of Tallong Drive near intersection with Grenuglie Street.*	*PMHC*
Acid Sulphate Soils	*All*	• *EMP Remediation works undertaken in 2001-2011 throughout Hastings and Camden Haven catchments including weir installation and landowner agreements* • *ASS Study completed in 2019 for Lake Cathie/Lake Innes indicating the ASS is potentially catastrophic.*	• *Weir operation, channel function and other ASS structure condition is currently unknown.* • *Generation of ASS in dried out lake foreshores when lake is enduring dry periods and the implications of changed climate extremes on these processes.* • *Quantify risk and interaction of ASS generation from entrance opening strategy*	1. *Undertake ASS Infrastructure Condition Audit* 2. *Implement actions of ASS Study for Lake Cathie/ Lake Innes comprising:* 3. *ASS Digestion Model* 4. *Review 2013 Reversion Strategy* 5. *Undertake ongoing water sampling within system* 6. *Prepare concept ASS Containment Design* 7. *Review Saltmarsh Community condition within Lake Innes* 8. *Review of entrance opening strategy to mitigate the impact of ASS.*	*PMHC* *NPWS* *DPIE*
Coastal Erosion	*Lake Cathie / Lake Innes / Bonny Hills, Open Coastline*	• *Gazetted CZMP for Lake Cathie* • *CZMP for Town Beach completed however not certified* • *Flynns Beach Seawall investigation complete* • *Coastal Hazard Assessment complete* • *Ongoing reactive beach nourishment and protection works as required* • *Funding investigations for Illaroo Road Revetment Wall ongoing* • *Illaroo Road Stormwater Redirection project ongoing*	• *Coastal Hazard studies have only been done for Lake Cathie and Town Beach. Other beaches have been identified as potential areas of interest: Rainbow Beach, Shelly Beach, Corilla Estate (North Shore), North Haven Beach, Lighthouse Beach.* • *State Government coastal erosion dataset.*	1. *Request access to NSW hazard mapping to inform whether further investigation is required for areas of open coastline outside of Town Beach, Lake Cathie & Flynns Beach.*	*PMHC* *Crown Lands*
Development & Land-use Planning Impacts		• *Existing land zonings prone to multiple threats (flooding, bushfire, coastal erosion, tidal inundation etc)* • *Urban sprawl into productive farmland and encroachment into sensitive environmental areas*	• *No policy on how to manage existing developments where subject to significant risks* • *Review long term planning documents to limit urban sprawl and instead consolidate existing suitable developed areas*	1. *Develop a climate change policy* 2. *Review DCP to improve capacity to achieve urban infill* 3. *Biodiversity strategy* 4. *Koala Plan of Management*	*PMHC*
Fish /Prawn/ Oyster Stock Changes	*All*	• *DPI Fisheries responsible*	• *PMHC has little knowledge of Fish/Oyster/Prawn stock changes*	1. *Request access to DPI Fisheries catch records to determine whether further investigation is required.*	*DPI Fisheries*
Flooding	*All*	• *Flood Studies are complete for the Hastings River, Hibbard Precinct, Camden Haven River and Wrights Creek.* • *Floodplain Risk Management Studies (FRMS) and Floodplain Risk Management Plans (FRMP) are complete for the Hastings and Camden Haven Rivers.*	• *Camden Haven FRMP is outdated and key action items have been completed. Update required.* • *No FRMS or FRMP for Wrights Creek, Hibbard Precinct.* • *No FRMS for Lake Cathie/Lake Innes system.* • *Lake Cathie flood study update is required.*	1. *Nil as these studies come under the Floodplain Management Program.*	*PMHC*

Invasive weeds	*All*	• *Invasive weeds are managed in accordance with Biosecurity Act 2015 and controls are effective.*	• *Consultation with LLS ongoing*	1. *No action in Stage 2. Continue to liaise with LLS to implement controls.*	*PMHC* *LLS* *DPI*
Recreational Users Impacts	*All*	• *Management of foreshore lands and access to beaches and rivers is ongoing as per various EMP actions.*	• *Audit access, condition and any pressures.*	1. *Review audit processes.*	*PMHC* *Crown Lands* *TfNSW*
Seagrass Changes	*Hastings, Camden Haven*	• *PMHC has seagrass mapping incorporated into GIS software.* • *No other management*	• *Seagrass extent is poorly understood, as is the extent of impact on other aspects of the aquatic environment.*	1. *Lobby Fisheries to update seagrass mapping in the PHMC LGA*	
Land Ownership/ Management/ Responsibilities Uncertainties	*All*	• *Management responsibilities are presently uncertain as a result of recent changes to multiple pieces of legislation.* • *Previous EMP's are no longer recognised.* • *The platform from which councils ordinarily seek funding has changed.* • *Crown Land licensing arrangements have changed.* • *Community expectation is that someone will manage lands and without direct involvement by state government agencies the perception is that PMHC should manage in their absence.*	• *Management Responsibility is unclear between PMHC, Crown Lands and other government agencies. Lake Cathie is the most at-risk location as a result of this issue.*	1. *Management Agreements to be considered and roles clearly defined.*	*PMHC* *Crown Lands* *NPWS* *DPIE* *DPI Fisheries* *LLS* *DPI*
Ocean Bath/ Tidal Pool	*Open Coastline*	• *New tidal pool/ ocean bath is desired by community.* • *Federal funding provided for investigations.* • *The ocean bath located at North Haven requires ongoing maintenance.*	• *The interactions of these proposals with coastal processes is unknown*	1. *No action in Stage 2. To be considered in CMP once feasibility studies are completed.*	*PMHC*
Riparian Zone Impacts	*Hastings, Camden Haven*	• *Riparian management is responsibility of many stakeholders, including private land holders.* • *PMHCs recent Lakeside Corridor project resulted in the management of riparian weeds, pests and bush regeneration works jointly funded by PMHC, LLS and OEH Estuary program.*		1. *No action in Stage 2.*	*PMHC* *Private landholders* *Community groups* *LLS*
River Bank Erosion	*Hastings, Camden Haven*	• *Riverbank erosion has historically been undertaken by PMHC at various locations.* • *PMHC strategically maintains existing foreshore/riparian vegetation via weed control and native plantings as per EMP actions.* • *PMHC maintains existing rock wall protection as per EMP actions.*	• *Current waterway bank erosion condition and the status of priority sites for restoration to reduce sedimentation and water quality impacts.*	1. *No action in Stage 2.*	*PMHC* *Crown Lands* *TfNSW*
Sea-level Rise / Tidal Inundation	*All*	• *LGA wide SLR inundation mapping complete for 0.4m (2050 Horizon) and 0.9m (2100 Horizon) SLR scenarios* • *Lake Cathie CZMP has coastal hazard mapping accounting for future SLR scenarios for 2050 and 2100*	• *The effect of SLR and tidal inundation on Coastal Management Areas, vegetation communities and other assets is relatively unknown.* • *The impact on infrastructure and assets is relatively unknown.* • *No current policy platform to implement changes to planning policy regarding SLR. SLR is incorporated into current PMHC Flood Policy, however not all implications (i.e. Tidal Impacts) are adequately captured this way.*	1. *Assess impact of SLR and tidal inundation on other mapped assets and Coastal Management Areas.* 2. *Initiate steps to complete LGA wide SLR and Tidal Inundation policy (possibly via climate change policy).*	*PMHC*

Coastal Lake or Watercourse Entrance Instability	*Lake Cathie/ Lake Innes,*	• *Lake mouth subject to impacts from storms, climate change and flooding*	• *Entrance instability could occur as a result of storms overtopping berm* • *Climate change may change berm dynamics and behaviour* • *Foreshore reserve susceptible to erosion from tidal flows and ocean swells.*	1. *Assess impacts of SLR on entrance opening and berm.* 2. *Consider management options to minimise erosion of Foreshore Reserve*	*PMHC DPIE Crown Land*
Vertebrate pests	*Hastings, Lake Cathie/ Bonny Hills/ Lake Innes, Camden Haven*	• *Ad-hoc culling operations of feral deer, (Largely ineffective) in accordance with the Hastings Wild Deer Management Strategy (LLS).* • *Previously had a vertebrate pests officer employed however this has ceased*	• *The full extent of feral deer population in the LGA is unknown and needs to be established.*	1. *No action in Stage 2. Continue to liaise with LLS to implement controls.*	*PMHC LLS DPI*
Sedimentation / Shoaling	*Hastings River, Camden Haven River, Lake Cathie/ Bonny Hills/ Lake Innes*	• *Changes in sand shoals is an issue of concern for the Lake Cathie community.* • *Dredging strategy and EMPs maintain navigatable waterways from the Pacific Highway to the entrance for commercial slipway (Birdon) and charter operators.* • *Dredging of channel near Lady Nelson Wharf undertaken on a periodic basis to ensure navigation for commercial fishers can occur and access to fisherman's wharf and marina is maintained.*	• *Scientific investigation into sediment transportation and changes in sand shoaling has not been undertaken within lake system* • *Ensure dredging of main channel to access Marina and Fishermen's Wharf is maintained, needs to be included in any update to the Dredging Strategy.*	1. *Update Dredging Strategy* 2. *Investigate sand shoaling within Lake Cathie/Lake Innes*	*PMHC Crown Lands*
Urban and Rural Stormwater Runoff	*All*	• *AUSPEC D7 specifies water quality controls to achieve principle objectives* • *Site specific stormwater management plans .e.g. for large developments* • *Gross Pollutant Traps (GPT) are installed throughout the LGA* • *Operational maintenance plans:* • *Open drains* • *GPTs* • *Tidal flaps / flood mitigation channels/ devices* • *Canals* • *Ecohealth reports 2011/2017 highlighting subcatchments with high nutrient/turbidity impacting waterways.* • *OEH Estuary Health Risk dataset and modelling maps*	• *Compliance with stormwater management plans and AUSPEC is considered to be minimal which has believed to impacting on water quality, i.e. Older developed areas constructed pre 1990's have minimal water quality provisions.* • *Maintenance procedures for existing water quality devices not specific / tailored to each device and/or contributing catchment.* • *AUSPEC D7 has been developed based on industry best practice and not to site specific needs.* • *Floodplain mitigation devices . effects of acid sulphate soils.* • *Investigate root cause of elevated nutrients in subcatchments identified in the Ecohealth reports.*	1. *Review compliance with stormwater management plans and AUSPEC.* 2. *Investigate WSUD surrounding Lake Cathie.* 3. *Investigate and determine maintenance plans specific to each GPT and catchment (expected loadings, historic maintenance cleanout reports)* 4. *Investigate root cause of poor water quality sources identified in Ecohealth reports.* 5. *Water quality sampling at GPT and Bio-retention device outlets.* 6. *Investigate specific coastal estuary needs, current health as recommended health, adopting the MEMA (Marine Estate Management Authority) method to tailor the requirements of AUSPEC D7 to specific estuarine needs, and not the current broad Industry practise needs e.g. higher sediment loads to particular estuaries may require improved sediment and erosion controls due to geological reasons or compliance issues etc.*	*PMHC*
Water Quality Changes	*All*	• *Stormwater management as outlined earlier* • *Echohealth reporting is performed for PMHC by the University of New England (UNE) throughout the LGA* • *PMHC's laboratory does some water quality testing at facilities and in some estuaries, e.g. Lake Cathie, Duchess Creek & Kooloonbung Creek.*	• *Lack of consistent analysis and reporting to the community and stakeholders on what the monitoring means.* • *Lack of LGA wide water quality strategy defining the objectives and values of waterways that the monitoring strategy seeks to report on.*	1. *No action in Stage 2. Arrange funding for Ecohealth monitoring* 2. *Prepare LGA wide water quality monitoring to ensure additional rounds of Ecohealth monitoring continues and reporting strategy.* 3. *Audit all water quality monitoring currently undertaken, then formulate a revised approach to ensure efforts undertaken are for a clear purpose.*	*PMHC DPIE DPI Fisheries NSW Health*
	ICOLL Entrance Opening	*Lake Cathie/ Lake Innes,*	• *Lake entrance strategy requires review*	• *Integration of previous studies (i.e. Hydrodynamic Model) into new opening strategy.* • *Insufficient ASS knowledge of lake system* • *Insufficient knowledge of Kenwood Drive and Lakeside Woods estate flooding* • *Gaps in knowledge of critical infrastructure at risk when lake is full.* • *Impacts of current entrance management on exposed ASS, lake foreshore ecology, marine organisms, birds, frogs etc.*	1. *Undertake review of assets impacted by flooding (open reserves, footpaths, sewer infrastructure, roads, stormwater infrastructure etc)* 2. *Consider Flood Study to inform whether lake openings required to alleviate Kenwood Drive flooding impacts.*	*PMHC Crown Lands DPIE DPI Fisheries NPWS*
	Coastal Cliff Instability	*Open Coastline & Lake Cathie/ Bonny Hills/ Lake Innes*	• *Audit of structures located on coastal headlands and cliffs* • *Undertake geotechnical assessment to determine erosivity of coastal headlands where assets are located.*	• *Gaps in knowledge of susceptibility of coastal headlands to erosion.*	1. *High level geotechnical assessment could inform management strategies for existing and proposed assets located on coastal headlands.*	*PMHC*

Table 17: *Priority Threats/Issues, current management, knowledge gaps and required investigations.*

17.3 FORWARD WORKS PROGRAM

OVERVIEW

As outlined in the Coastal Management Manual, preparation of the CMP is to be completed following a staged process *[illustrated in Figure 1]*. Guidance for this process along with key requirements are outlined in Part A and Part B of the Manual. The subsequent stages in this process after this Stage 1 Scoping Study are:

- Stage 2: Determine risks, vulnerabilities and opportunities (through further detailed studies).
- Stage 3: Identify and evaluate options (through risk assessment and cost, benefit analysis).
- Stage 4: Prepare, exhibit, finalise, certify and adopt a CMP (leading to implementation).
- Stage 5: Implement, monitor, evaluate and report (to feedback to the cycle).

This section provides:

- CMP Implementation obligations for Councils and public authorities.
- A summary of the requirements, process and expected outcomes for Stages 2 to 4 outlined from the Manual (Part B).

A section with considerations, analysis of options and recommendations related to governance of the CMP project going forward.

STAGE 2: DETERMINE RISKS, VULNERABILITIES AND OPPORTUNITIES

Stage 2 of the CMP process involves undertaking detailed studies that will help PMHC to identify, analyse and evaluate risks, vulnerabilities and opportunities in the study area. The studies conducted during Stage 2 are to provide information to support decision-making in the later stages of the CMP planning process.

A summary of the Coastal Management Manual identifies Stage 2 as including the following:

- Engaging with the community and stakeholders.
- Refining the understanding of key management issues.
- Identifying areas exposed to coastal hazards and threats to coastal values.
- Analysing and evaluating current and future risks (detailed risk assessment).
- Identifying scenarios for social and economic change and related opportunities for coastal communities.
- Preparing a planning proposal to amend maps of coastal management areas, to commence the Gateway process.
- Identifying timing and priorities for responses, thresholds and lead times.

STAGE 3: IDENTIFY AND EVALUATE OPTIONS

Stage 3 of the CMP process requires PMHC to identify and evaluate possible management options in order to select preferred coastal management actions to address the issues identified as affecting the CMP study area. The aim of Stage 3 is to develop strategies and management actions that reduce exposure to coastal hazards, address coastal management issues and take advantage of opportunities, consistent with provisions in Section 14 and 15 of the Coastal Management Act 2016.

A summary of the Coastal Management Manual identifies Stage 3 as including the following:

- Identifying and collating information on management options.
- Evaluating management actions, considering:
- Feasibility (is it an effective and sustainable way to treat the risks?).
- Viability (economic assessment).
- Acceptability to stakeholders.
- Engaging public authorities about implications for their assets and responsibilities.
- Evaluating mapping options and implications if a planning proposal is being prepared.
- Identifying pathways and timing of actions.
- Preparing a business plan for implementation.

STAGE 4: PREPARE, EXHIBIT, FINALISE, CERTIFY AND ADOPT A CMP.

Stage 4 of the CMP process involves a draft coastal management program being prepared, exhibited and then submitted to the Minister for certification.

It is a mandatory requirement of the Coastal Management Manual that a draft CMP be exhibited for a period of at least 28 calendar days. It is also a requirement under Section 16 of the CM Act that consultation is carried out during the preparation of the draft CMP.

Once the Minister certifies the CMP, PMHC must publish it in the Gazette. The CMP takes effect on the date on which it is published in the Gazette (or on a later date if specified in the CMP)

STAGE 5: IMPLEMENT, MONITOR, EVALUATE AND REPORT.

Stage 5 gives guidance to councils on how to implement and give effect to their CMP and the associated ongoing monitoring and reporting of the implementation of a CMP to meet the requirements of the Coastal Management Act 2016.

The Coastal Management Manual provides council with guidance on the following:

- Implementing actions in the published Coastal Management Program through the Integrated Planning and Reporting (IP&R) framework and Land Use Planning System.
- Implementing actions in partnership with adjoining councils and public authorities where relevant.
- Implementing an effective Monitoring, Evaluation and Reporting (MER) program.
- Monitoring indicators, trigger points and thresholds.
- Amending, reviewing and updating the CMP.
- Reporting to stakeholders and the community on progress and outcomes through the IP&R framework.

CMP STRUCTURE AND PROJECT GOVERNANCE

The NSW Coastal Management Framework provides flexibility around the scope, structure and governance arrangements of a CMP.

A CMP provides a unique opportunity for Council, state government agencies and their

communities to achieve a strategic and coordinated approach to manage coastal risks and improve coastal habitats and environments, for both environmental and social (community) benefit within the PMH LGA.

PMHC will manage the CMP development, implementation and reporting processes. This includes the preparation, development and review of, and the contents of, the plans, strategies, programs and reports to which Part 2 of Chapter 13 of the Local Government Act 1993 applies, and the preparation of planning proposals (if required) and development control plans under the Environmental Planning and Assessment Act 1979.

Potential governance and management arrangement for the CMP are outlined in *[Table 18]*.

Entity	Responsibility
Port Macquarie-Hastings Council	*Lead agency, coordination and implementation.*
State Agencies: - *Department of Planning Industry and Environment* - *Department of Industry - Crown Lands and Water* - *Department of Primary Industries - Fisheries* - *National Parks and Wildlife Services* - *NSW Environment Protection Authority* - *Roads and Maritime Services* - *Transport for NSW*	*Sign off on CMP, collaboration, action(s) and implementation (as defined).*
Coast, Estuary & Floodplain Advisory Sub-Committee - *Port Macquarie-Hastings Council* - *State Agencies* - *Industry Representatives* - *Community Representatives*	*Council adopted Sub-Committee, to assist Council in undertaking management and planning. To assist reviewing studies, plans and policies and to provide and receive feedback from the community.*

Table 18: *Potential CMP Governance and Management*

CMP CHAPTERS AND TIMELINES

CMP Stage	Lake Cathie/ Bonny Hills	Hastings	Camden Haven	Open coastline
2	*2020-2021*	*2021-2022*	*2022-2023*	*2022-2023*
3	*2021-2022*	*2022-2023*	*2023-2023*	*2023-2023*
4	*2021-2022*	*2022-2023*	*2023-2024*	*2023-2024*
5	*2023*	*2024*	*2025*	*2025*

Table 19: *Order of CMP Chapters and approximate timelines*

Lake Cathie/ Bonny Hills	Priority	Details	Cost
Stage 2	*Extreme*	*Digestion model of the Acid Sulphate Soil (ASS) study.*	*$185,000*
Stage 2	*Extreme*	*Review of the Lake Innes Environmental Assessment (2013) (Lake Innes reversion study).*	*$50,000*
Stage 2	*Extreme*	*Ecological condition assessment of the saltmarsh community within Lake Innes.*	*$10,000*
Stage 2	*Extreme*	*Review of possible ASS containment works.*	*$50,000*

Table 20: *Initial Stage 2 studies for Lake Cathie/Bonny Hills*

17.4 PRELIMINARY BUSINESS CASE

OVERVIEW

A preliminary business case is provided herein to outline the benefits of and recommendation for, progressing with a CMP for the four main areas in the LGA: The Hastings River, Lake Cathie/Bonny Hills (including adjoining open coastline), Camden Haven River as well as the coastline from Point Plomer to Diamond Head (excluding coastline around Lake Cathie township).

Reforms to the NSW coastal management legislative and regulatory framework present a unique opportunity to build on the existing coastal management work considering lessons learnt, and improved engagement and collaboration with relevant stakeholders and agencies, preparing a holistic, inclusive CMP.

This business case demonstrates the benefit of preparing a CMP to the economic, social and ecological values of the Port Macquarie-Hastings region. The business case aims to demonstrate the need to take a long-term, risk based approach to coastal management, which can be facilitated through the preparation of a CMP. There is a wealth of existing information and suitable management actions in former EMP's and CZMP's, and the CMP will provide an opportunity to build on these past studies and planning.

Considerations and context for collaboration and cost sharing arrangements are also provided. A preliminary business case is a requirement of the Stage 1 CMP Scoping Study.

Under the Coastal Management Act, Council may prepare a Coastal Management Program that covers its entire coastal zone. The current timeframe for transitioning older style plans to CMPs is the 31st December 2021. Additionally, the grants funding package which accompanied the coastal management reforms in NSW will only extend to the 2020-21 financial year. State government funding under the Coast & Estuary Grants program is not confirmed nor guaranteed after this time.

ECONOMIC, ENVIRONMENTAL AND SOCIAL BASIS

The Port Macquarie-Hastings area is a wonderfully biodiverse region and its natural environment is highly valued by the community. The biological and natural assets contribute to the cultural, lifestyle, aesthetic and recreational identity of the area.

The natural environment is also locally enriched by a long history and ongoing connection of Aboriginal people with the coast, post-European settlement heritage and a wide range of passive and recreational activities.

The waterways and coastline in the study area are highly utilised by the public for swimming, fishing, surfing and a variety of other recreational activities. The area also supports valuable aquaculture and commercial fishing industries.

As such the coastline supports many significant and important environmental, economic, sociocultural values and community benefits. These values and benefits are threatened by increasing pressures including coastal hazards, climate change, sea level rise, population and tourism growth and coastal development.

A CMP will provide a comprehensive strategic vision and action plan that is locally contextualised and enabled through a government supported process, for managing the priority issues affecting the study area.

PROGRAM RISKS AND RESPONSIBILITIES

Some key risks and challenges associated with the development of a CMP are:

Resourcing

- Ongoing allocation of resources. The preparation of a CMP could potentially result in conflict within Council and with other contributing stakeholders, in terms of competing needs for scarce resources (including but not limited to funding and staff).

Responsibility

- Co-ordination, ongoing involvement and meaningful commitment of multiple agencies during both the development and implementation of the CMP.

Funding

- Grant funding is only available for existing CZMP's, developing a CMP or for action items contained within CMP's. For existing CZMP's only 1:1 funding is available, For development of CMPs' only 1:1 funding is available. For adopted items on CMP's 2:1 funding is available.
- Council has limited funding, therefore its ability to development and implement actions for management of the coastline and estuaries is limited.
- Coastal & Estuary grant funding applications are not always successful.
- Coastal and Estuary grant program funding is not guaranteed after 20-21 FY.
- For projects with significant costs they need to be accompanied by a CBA (it should be noted that the role CBAs play and how they are used is currently under review by the NSW Government).

Expectations

- Expectations of key stakeholders (agencies, authorities and community) not aligning with priorities. Preparation of the CMP is likely to create (or exacerbate) community expectations for the implementation of actions for coastal management. An inherent risk exists if the CMP process fails to deliver the actions, or if these actions fail to achieve the vision and objectives of the CMP.
- Negative community opinion of "yet another plan".
- Outcomes of coastal hazard assessment not being palatable to some members of the community (insurance and a perceived decline in property values).
- Expectation that the NSW Government will not change the program again and result the CMP process being redundant.

EXISTING MANAGEMENT ARRANGEMENTS

The estuaries have been the subject of previous management investigations and as such, each had an EMP prepared under the former NSW planning frameworks. The existing plans vary in age and in the extent to which management actions have been implemented. Similarly, certain areas of the coastline (Town Beach, Lake Cathie) were the subject of previous investigations with Lake Cathie still having an active CZMP. However this plan will lapse in December 2021 unless the actions from this plan are incorporated in a new CMP.

COMMUNITY AND STAKEHOLDER ENGAGEMENT STRATEGY

Impacts of COVID-19 on this Strategy: At the time of developing this Strategy, governmental guidance and policies regarding the COVID-19 pandemic are likely to present significant challenges and limitations with regards to in-person community and stakeholder engagement tasks. The situation is complex and dynamic, and timing and duration of state and federal government policies cannot be reasonably predicted over the life of the project (at least at this stage). Therefore, the Strategy will need to consider the possibility that social distancing restrictions may affect the engagement activities throughout the project. If this comes to bear, then the engagement strategy may need to be updated and reviewed at the beginning of each CMP Stage in order to adequately align with the current circumstances and government advice.

The likely impact will be the replacement of "in-person" engagement tasks with online and remote engagement methods. Some advice and guidance regarding such methods has been provided by IAP2 and the World Health Organisation (WHO). At the time of developing this strategy, some relevant resources include:

- World Health Organisation (WHO) advice on How to manage COVID-19 risk when organising meetings & events (WHO, 2020a)
- WHO technical guidance on Getting your workplace ready for COVID-19 (WHO, 2020b)
- WHO Report: COVID-19: How to include marginalized and vulnerable people in risk communication and community engagement (WHO, 2020c)
- IAP2: 5 Keys to Digital Engagement (IAP2, 2020)
- Based on this, some remote engagement methods that may be suited to this strategy include:
  - The use of "Virtual Town Hall Meetings" through live streaming. This can include broadcasting important events and public consultations, showcasing experts, panels, and live interactive Q&A sessions with stakeholders.
  - The use of pre-recorded video "webinars" which can communicate project objectives, methods and/or outcomes. These can be integrated into the Have Your Say project web page.
  - Interactive online data sharing methods, including use of web-based mapping portals for "drop-pinning" areas of importance and "photo-sharing". Many of these can be accessed through Engagement & Public Participation Software such as "Bang the Table" that can be easily integrated into the Have Your Say project web page.
  - The increased use of online community surveys.

The appropriateness of these engagement methods should be assessed at the commencement of each CMP Stage, based on state and federal government advice and policy.

There are a broad spectrum of stakeholders involved in the CMP process given the complex and diverse nature of coastal management. These stakeholders range from State Government agencies to community groups. Table 11 below identifies known stakeholders. It is intended that the number of stakeholders will increase as well as the detail around their interests as the CMP process progresses. The exact timeframe of stakeholder has not yet been determined however it is likely to comprise of information sessions, surveys and meetings.

PMHC's community and stakeholder Engagement plan involves consulting with both internal Council staff and key external stakeholders including the general community, and the Coast, Estuary & Floodplain Advisory Sub-Committee. For this Stage 1 scoping study, relevant community interests and aspirations were drawn from previous community engagement and in addition to this, PMHC is conducting a live Q&A session on the 26th May 2020 with expert NSW Government speakers to communicate to the community why PMHC is developing a CMP and how it will be utilized to manage our coastline and estuarine systems.

PMHC understands that extensive engagement is required in order to capture the vast array of values held by people across the LGA and to incorporate the knowledge from cross-disciplinary interactions.

Throughout the following stages of the CMP the engagement plan will evolve along with the objectives according to the CMP Framework.

Stakeholders	Internal / External	Role description (including role, responsibilities and authorities)	Engagement (participation level)	Engagement actions required	Engagement actions timeframe
Coast Estuary and Floodplain Advisory (CE&F) Sub-Committee	*Internal and External*	*Review of the Scoping Study. Members consisting of Councillors, Waterways User Reps, Community Reps, Development Industry Rep, Oyster Industry Rep, Council staff, Lands Department, DPI - fisheries, NPWS, OEH, TINSW - Maritime division, SES.*	*Inform and Consult*	*Committee meeting - presentation of final draft Scoping Study*	*Upon receiving the final draft from DPIE.*
Department of Planning, Industry & Environment (DPIE)	*External*	*Advice and review of the Scoping Study*	*Consult*	*Review of draft Scoping Study.*	
Council staff	*Internal*	*Natural Resources, Development and Strategic Planners, Recreation & Buildings, Community Place*	*Inform, consult & collaborate*	*Review of draft Scoping Study*	*Throughout development of CMP. Community Place team to assist with community and industry engagement*
Other Councils (KSC and MCC)	*External*	*Consult if affected land falls in other LGAs. Shared Estuaries or Coastal Sediment Compartments*	*Inform, consult and collaborate*	*Meetings, emails, phone calls*	*Throughout development of CMP*
Council and Councillors	*Internal*	*Approval required for adoption*	*Inform*	*Council meeting Councillor briefing*	*Council meeting for approval of CMP stages & reports. Briefing for further stages of CMP.*
Community	*External*	*Consultation and Engagement*	*Inform, consult and involve*	*Information sessions, mail outs, surveys*	*Throughout the entire process*
Industry	*External*	*Consultation and Engagement*	*Inform, consult and involve*	*Information sessions, mail outs, surveys*	*Throughout the entire process*
NSW Coastal Council	*External*	*Potential advice*	*Consult*	*Review of draft CMP*	*If required throughout process*

Table 21: *Program stakeholders and responsibilities*

Figure 54. *Nobby's Point, Port Macquarie*

APPENDIX A - WEATHER STATISTICS

A.1 HILL STREET, PORT MACQUARIE

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C) for years 1907 to 2003	25.7	25.9	25.1	23.2	20.7	18.5	17.9	18.8	20.4	21.8	23.2	24.7	22.2	97	1907	2003
Highest temperature (Degrees C) for years 1910 to 2003	41.2	33.5	35	33.3	30.1	26.7	28	29.4	34.4	38.3	42.3	41	42.3	58	1910	2003
Date of Highest temperature for years 1910 to 2003	6-Jan-94	20-Feb-98	13-Mar-13	8-Apr-66	2-May-91	16-Jun-02	18-Jul-74	27-Aug-70	27-Sep-65	22-Oct-88	19-Nov-68	2-Dec-79	19-Nov-68	N/A	1910	2003
Lowest maximum temperature (Degrees C) for years 1910 to 2003	18	19.4	17.9	16.1	13.9	10.3	10.1	11.5	13.9	14.4	16.7	18	10.1	58	1910	2003
Date of Lowest maximum temperature for years 1910 to 2003	1-Jan-18	15-Feb-18	2-Mar-87	22-Apr-17	25-May-16	9-Jun-13	14-Jul-20	14-Aug-76	1-Sep-12	23-Oct-18	10-Nov-93	21-Dec-75	14-Jul-20	N/A	1910	2003
Decile 1 maximum temperature (Degrees C) for years 1910 to 2003	23.5	23.9	22.8	20.8	18.2	16.1	15.6	16.7	17.8	19.2	20.6	22.2		58	1910	2003
Decile 9 maximum temperature (Degrees C) for years 1910 to 2003	27.8	28	27.2	25.7	23.3	21.1	20.5	21.7	23.5	24.5	26	27.2		58	1910	2003
Mean number of days >= 30 Degrees C for years 1910 to 2003	0.6	0.2	0.2	0.1	0	0	0	0	0.1	0.4	0.6	0.7	2.9	58	1910	2003
Mean number of days >= 35 Degrees C for years 1910 to 2003	0.1	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.4	58	1910	2003
Mean number of days >= 40 Degrees C for years 1910 to 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	58	1910	2003
Mean minimum temperature (Degrees C) for years 1907 to 2003	18.3	18.4	17.1	14.1	10.9	8.5	7.2	7.7	9.9	12.8	15.2	17.1	13.1	97	1907	2003
Lowest temperature (Degrees C) for years 1910 to 2003	10	11.7	8.2	7.2	1.4	0	-0.6	0.6	2.2	3.6	5.1	9.8	-0.6	58	1910	2003
Date of Lowest temperature for years 1910 to 2003	25-Jan-61	10-Feb-96	14-Mar-13	17-Apr-61	31-May-11	6-Jun-20	13-Jul-18	18-Aug-70	9-Sep-19	11-Oct-10	6-Nov-13	28-Dec-93	13-Jul-18	N/A	1910	2003
Highest minimum temperature (Degrees C) for years 1910 to 2003	23.7	24.5	23	21.5	20.5	16.7	19.1	16.7	18.5	21.7	22.5	23.1	24.5	58	1910	2003
Date of Highest minimum temperature for years 1910 to 2003	27-Jan-87	17-Feb-81	3-Mar-81	11-Apr-74	5-May-96	14-Jun-67	1-Jul-20	25-Aug-69	13-Sep-73	30-Oct-88	26-Nov-67	31-Dec-95	17-Feb-81	N/A	1910	2003
Decile 1 minimum temperature (Degrees C) for years 1910 to 2003	15.8	16.1	14.4	11.2	7.2	5	3.9	4.6	6.7	9.4	11.7	14		58	1910	2003
Decile 9 minimum temperature (Degrees C) for years 1910 to 2003	21.2	21.4	20	17.9	15.1	12.7	11.2	11.6	14.4	16.8	18.7	20.3		58	1910	2003
Mean number of days <= 2 Degrees C for years 1910 to 2003	0	0	0	0	0	0.3	0.5	0.2	0	0	0	0	1	58	1910	2003
Mean number of days <= 0 Degrees C for years 1910 to 2003	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1	58	1910	2003
Mean rainfall (mm) for years 1840 to 2010	152.3	178.1	175.2	167.3	144.3	133.2	97.6	81.3	81.4	94	104.1	126.5	1515.2	140	1840	2010
Highest rainfall (mm) for years 1840 to 2010	1387.6	844.5	678	619.2	916.4	651.5	774.2	775.5	355.8	419.5	462	636.7	3204.4	150	1840	2010
Date of Highest rainfall for years 1840 to 2010	1848	1929	1974	1963	1852	1930	1950	1899	1954	1914	1887	1873	1950	N/A	1840	2010
Lowest rainfall (mm) for years 1840 to 2010	5.7	1.8	9.8	7.2	6.9	3.3	0.5	0	0	9.4	1.6	8.1	734	150	1840	2010
Date of Lowest rainfall for years 1840 to 2010	1882	1939	1965	1996	2004	1904	1910	1991	2003	1843	1926	1847	1915	N/A	1840	2010
Decile 1 monthly rainfall (mm) for years 1840 to 2010	35.3	51.3	60.2	40	22.6	16.5	10.7	8.1	14.1	23.1	28.3	29.6	1034.7	149	1840	2010
Decile 5 (median) monthly rainfall (mm) for years 1840 to 2010	112.4	158.8	156.6	131	112.8	104.6	73.3	53.1	63.7	72.6	87.8	109.9	1424.5	149	1840	2010
Decile 9 monthly rainfall (mm) for years 1840 to 2010	259.2	324.9	306.7	346.5	284.3	285.2	207.6	189.5	186.2	191.8	195.2	235	2116.5	149	1840	2010
Highest daily rainfall (mm) for years 1841 to 2010	274.6	212.2	259.6	298.2	180.1	189.2	140.7	142.2	149.4	150.6	273.3	205.2	298.2	142	1841	2010
Date of Highest daily rainfall for years 1841 to 2010	8-Jan-62	6-Feb-02	12-Mar-74	28-Apr-63	1-May-55	19-Jun-30	20-Jul-50	31-Aug-35	23-Sep-1881	18-Oct-14	09-Nov-1887	05-Dec-1873	28-Apr-63	N/A	1841	2010
Mean number of days of rain for years 1840 to 2010	12.4	13.2	14.1	12.6	11.3	10	9.1	8.5	8.8	10.5	11	11.2	132.7	149	1840	2010
Mean number of days of rain >= 1 mm for years 1841 to 2010	8.6	9.4	10.4	9	7.9	7.1	6.1	5.6	6	7.2	7.4	7.9	92.6	142	1841	2010
Mean number of days of rain >= 10 mm for years 1841 to 2010	3.3	3.7	4	3.7	3.1	3	2.2	1.7	1.8	2.2	2.6	2.8	34.1	142	1841	2010
Mean number of days of rain >= 25 mm for years 1841 to 2010	1.3	1.7	1.6	1.6	1.3	1.3	0.9	0.7	0.7	0.7	0.8	1.2	13.8	142	1841	2010
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2020	24.2	21.4	18.2	15.2	11.5	9.8	11	14.6	18.5	20.8	22.3	23.8	17.6	30	1990	2020
Mean number of clear days for years 1957 to 2003	7.9	5.9	8.3	9.4	9.8	10.7	13.2	14.5	12.9	10	7.8	8.5	118.9	47	1957	2003
Mean number of cloudy days for years 1957 to 2003	11.2	11.5	10.8	9.3	10.1	9.6	7.6	6.9	6.1	9.4	10.6	10.6	113.7	47	1957	2003
Mean 9am temperature (Degrees C) for years 1907 to 2003	23.1	22.8	21.8	19	15.6	12.8	11.7	13.3	16.5	19.2	20.8	22.4	18.2	86	1907	2003
Mean 9am wet bulb temperature (Degrees C) for years 1907 to 2003	20.5	20.6	19.6	16.8	13.7	11.1	9.8	10.9	13.5	16.1	17.9	19.5	15.8	85	1907	2003
Mean 9am dew point temperature (Degrees C) for years 1957 to 2003	18.8	19.1	17.9	15.2	11.8	9.2	7.3	8	10.2	13.1	15.4	17.4	13.6	46	1957	2003
Mean 9am relative humidity (%) for years 1907 to 2003	78	81	81	79	80	80	77	73	70	71	74	76	77	85	1907	2003
Mean 9am cloud cover (okas) for years 1907 to 2003	4.2	4.4	4.1	3.7	3.6	3.6	3.1	2.8	2.9	3.6	4	4	3.7	78	1907	2003
Mean 9am wind speed (km/h) for years 1957 to 2003	14.4	13.7	13.3	13.4	13.3	13.8	13.5	13.5	14.5	15.2	15.1	14.3	14	46	1957	2003
Mean 3pm temperature (Degrees C) for years 1909 to 2003	24.4	24.6	23.9	22	19.7	17.6	17	17.7	19.1	20.3	21.8	23.2	20.9	84	1909	2003
Mean 3pm wet bulb temperature (Degrees C) for years 1909 to 2003	21.4	21.6	20.8	18.5	16.1	14.1	13.2	13.7	15.4	17.1	18.7	20.3	17.6	83	1909	2003
Mean 3pm dew point temperature (Degrees C) for years 1957 to 2003	19.4	19.6	18.5	16	12.9	10.3	8.7	9.3	11.7	14.3	16.2	18.1	14.6	46	1957	2003
Mean 3pm relative humidity (%) for years 1909 to 2003	75	75	74	70	68	66	63	62	66	71	73	75	70	83	1909	2003
Mean 3pm cloud cover (oktas) for years 1921 to 2003	4.2	4.4	4.2	4.1	4	3.9	3.4	3.3	3.4	3.9	4.2	4.3	3.9	75	1921	2003
Mean 3pm wind speed (km/h) for years 1957 to 2003	21.4	20.7	19.6	18.5	16.8	17.3	18.1	20.1	22.7	22.8	22.5	21	20.1	46	1957	2003

Table 22: *Monthly Climate Statistics - Hill Street, Port Macquarie - 1841 to 2010 Bureau of Meteorology (BOM)*

A.2 PORT MACQUARIE AIRPORT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C) for years 1995 to 2020	28	27.7	26.5	24.4	21.7	19.5	19	20.3	22.7	24.1	25.4	26.9	23.8	25	1995	2020
Highest temperature (Degrees C) for years 1995 to 2020	41.9	46.6	34.5	33.5	30.1	26.8	27.1	34.6	38.2	39.4	38.6	43.3	46.6	25	1995	2020
Date of Highest temperature for years 1995 to 2020	18-Jan-17	12-Feb-17	9-Mar-04	9-Apr-19	4-May-07	16-Jun-02	31-Jul-17	24-Aug-09	24-Sep-17	20-Oct-12	29-Nov-06	24-Dec-05	12-Feb-17	N/A	1995	2020
Lowest maximum temperature (Degrees C) for years 1995 to 2020	19.5	20.1	19.8	15.6	14	11.3	12.4	12.4	14.7	14.4	16.6	19.1	11.3	25	1995	2020
Date of Lowest maximum temperature for years 1995 to 2020	15-Jan-16	16-Feb-96	30-Mar-02	22-Apr-08	30-May-11	30-Jun-98	18-Jul-04	11-Aug-03	5-Sep-95	2-Oct-11	23-Nov-96	1-Dec-11	30-Jun-98	N/A	1995	2020
Decile 1 maximum temperature (Degrees C) for years 1995 to 2020	24.6	24.8	23.8	21.5	19	16.9	16.3	17.3	19	20.1	21.3	23.5		24	1995	2020
Decile 9 maximum temperature (Degrees C) for years 1995 to 2020	31.3	30.3	29.1	27	24.5	22.1	21.7	23.8	27	28.2	29.5	30.5		24	1995	2020
Mean number of days >= 30 Degrees C for years 1995 to 2020	6.4	4.5	1.9	0.2	0	0	0	0.1	1	1.5	2.5	4	22.1	25	1995	2020
Mean number of days >= 35 Degrees C for years 1995 to 2020	0.5	0.4	0	0	0	0	0	0	0.2	0.2	0.4	0.3	2	25	1995	2020
Mean number of days >= 40 Degrees C for years 1995 to 2020	0.1	0.1	0	0	0	0	0	0	0	0	0	0.1	0.3	25	1995	2020
Mean minimum temperature (Degrees C) for years 1995 to 2020	18.5	18.4	17.1	13.9	10.3	8.3	6.3	6.6	9.3	12.1	15.1	16.9	12.7	25	1995	2020
Lowest temperature (Degrees C) for years 1995 to 2020	9.5	10.6	7.9	5	-3.5	-2.9	-3	-2.4	0.6	2	4.2	7.5	-3.5	25	1995	2020
Date of Lowest temperature for years 1995 to 2020	1-Jan-05	10-Feb-96	31-Mar-19	7-Apr-06	31-May-19	16-Jun-06	1-Jul-04	21-Aug-18	15-Sep-17	17-Oct-10	10-Nov-19	3-Dec-19	31-May-19	N/A	1995	2020
Highest minimum temperature (Degrees C) for years 1995 to 2020	24.2	23.8	22.4	21.3	19.8	16.6	16	16	18.6	20.8	22.5	23.8	24.2	25	1995	2020
Date of Highest minimum temperature for years 1995 to 2020	24-Jan-20	4-Feb-17	26-Mar-19	13-Apr-98	5-May-96	8-Jun-02	14-Jul-10	27-Aug-99	29-Sep-04	29-Oct-03	7-Nov-18	31-Dec-05	24-Jan-20	N/A	1995	2020
Decile 1 minimum temperature (Degrees C) for years 1995 to 2020	14.9	15.3	14.1	10.8	5.9	3.4	1.9	2.2	4.9	7.7	11.3	12.8		25	1995	2020
Decile 9 minimum temperature (Degrees C) for years 1995 to 2020	22	21	20	17	14.6	12.5	11	11.3	13.9	16.3	19	20.4		25	1995	2020
Mean number of days <= 2 Degrees C for years 1995 to 2020	0	0	0	0	0.5	1.4	3.7	2.9	0.4	0	0	0	8.9	25	1995	2020
Mean number of days <= 0 Degrees C for years 1995 to 2020	0	0	0	0	0.3	0.4	0.7	0.8	0	0	0	0	2.2	25	1995	2020
Mean rainfall (mm) for years 1995 to 2020	142.7	167.6	179.1	134.2	106.7	138.1	61.6	61.7	59.2	75.4	144.7	109.1	1371.3	22	1995	2020
Highest rainfall (mm) for years 1995 to 2020	418.8	424	533.6	431.4	328	342.4	227.4	234.6	233.6	275.1	330.4	261.6	2009.4	25	1995	2020
Date of Highest rainfall for years 1995 to 2020	2015	2020	2017	2009	1996	2009	2006	2007	1998	2004	2007	2017	2011	N/A	1995	2020
Lowest rainfall (mm) for years 1995 to 2020	8.4	48.2	27.8	7.6	4.6	1.2	0	3	1	14.6	9.8	20.4	514	25	1995	2020
Date of Lowest rainfall for years 1995 to 2020	2019	2019	2016	2006	2006	2001	1995	2018	2003	2001	2019	2013	2019	N/A	1995	2020
Decile 1 monthly rainfall (mm) for years 1995 to 2020	35.2	62	62.3	29.7	9.6	23.1	11.5	4.2	7	31.4	57.7	51.8	1070.9	25	1995	2020
Decile 5 (median) monthly rainfall (mm) for years 1995 to 2020	114	145.7	156.2	103.3	64.7	138	64.8	33.4	41.6	59	132.6	95.8	1355.2	25	1995	2020
Decile 9 monthly rainfall (mm) for years 1995 to 2020	272.7	335	289.6	287.3	246	269.8	107.4	181.4	126.1	130.5	263.5	176.2	1739.1	25	1995	2020
Highest daily rainfall (mm) for years 1995 to 2020	165.8	165	166.2	119	154.8	95	110	109	92	80	175	202	202	24	1995	2020
Date of Highest daily rainfall for years 1995 to 2020	27-Jan-15	25-Feb-04	16-Mar-17	21-Apr-09	24-May-13	18-Jun-09	28-Jul-96	21-Aug-07	12-Sep-98	19-Oct-04	9-Nov-04	27-Dec-17	27-Dec-17	N/A	1995	2020
Mean number of days of rain for years 1995 to 2020	11.7	13.6	15.2	13.6	12.6	12.4	10	7.9	9	10.4	13.5	12.3	142.2	25	1995	2020
Mean number of days of rain >= 1 mm for years 1995 to 2020	8.6	10.6	11.5	9.2	7.7	7.8	6.2	5.3	5.6	7.6	10.2	9	99.3	24	1995	2020
Mean number of days of rain >= 10 mm for years 1995 to 2020	3.7	4	5	3.8	2.8	3.8	1.9	1.8	1.6	2.5	3.7	3.2	37.8	24	1995	2020
Mean number of days of rain >= 25 mm for years 1995 to 2020	1.5	2.1	2.4	1.6	1.1	1.8	0.3	0.6	0.5	0.7	1.6	1.2	15.4	24	1995	2020
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2020	23.8	21	18	15	11.6	9.9	11	14.5	18.3	20.6	22	23.3	17.4	30	1990	2020
Mean 9am temperature (Degrees C) for years 1995 to 2010	23.3	22.6	20.8	19.5	16.1	13.3	12.3	14	17.7	20.1	20.7	22.6	18.6	15	1995	2010
Mean 9am wet bulb temperature (Degrees C) for years 1995 to 2010	20.4	20.4	18.9	16.9	13.7	11.4	10.1	11.1	14	16	17.7	19.3	15.8	15	1995	2010
Mean 9am dew point temperature (Degrees C) for years 1995 to 2010	18.7	19.1	17.7	14.9	11.6	9.3	7.6	7.8	10.5	12.5	15.4	17.1	13.5	15	1995	2010
Mean 9am relative humidity (%) for years 1995 to 2010	76	82	83	76	76	78	75	68	64	64	73	72	74	15	1995	2010
Mean 9am wind speed (km/h) for years 1995 to 2010	13	12.3	11.5	12.3	12.5	11.5	11.9	12.6	13.6	14.7	14	13.6	12.8	15	1995	2010
Mean 3pm temperature (Degrees C) for years 1995 to 2010	26.1	26	24.9	22.5	20.1	18.2	17.5	18.7	20.5	21.9	23.1	24.9	22	15	1995	2010
Mean 3pm wet bulb temperature (Degrees C) for years 1995 to 2010	21.4	21.5	20.4	18.1	15.6	13.9	12.7	13.3	15.4	16.9	18.7	20.2	17.3	15	1995	2010
Mean 3pm dew point temperature (Degrees C) for years 1995 to 2010	18.7	18.9	17.6	14.9	11.8	9.7	7.6	7.8	10.8	13	15.6	17.2	13.6	15	1995	2010
Mean 3pm relative humidity (%) for years 1995 to 2010	65	66	65	64	61	60	55	52	56	59	65	64	61	15	1995	2010
Mean 3pm wind speed (km/h) for years 1995 to 2010	22.4	21.6	20.1	17.3	15.3	14.9	16	19	21	22.2	22.5	22.3	19.6	15	1995	2010

Table 23: *Monthly Climate Statistics - Port Macquarie Airport - 1995 to 2019 Bureau of Meteorology (BOM)*

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PORT MACQUARIE-HASTINGS COUNCIL

Item: **09**

Subject: **ACTIVE COAST, ESTUARY & FLOODPLAIN PROJECTS STATUS UPDATE**

Presented by: **Development and Environment, Melissa Watkins**

RECOMMENDATION

That the Committee note the status of the active Coast, Estuary & Floodplain projects.

Discussion

This report provides an update on active PMHC Coast, Estuary and Floodplain projects. Where applicable, each project has been listed with the current project cost and corresponding grant amount provided by DPIE.

As the Sub-Committee is aware, PMHC has a Floodplain Risk Management Plan for the Hastings River and the Camden Haven River and an active Coastal Zone Management Plan for the Lake Cathie coastline. As such, PMHC and relevant stakeholders have been working progressively to undertake the actions proposed in these plans.

For floodplain related matters, as has been noted in previous Sub-Committee meetings, many of the actions of the Camden Haven River Floodplain Risk Management Plan have been completed as this plan dates from 2001. Since the adoption of the Hastings River Floodplain Risk Management Plan in 2014, multiple actions have either commenced or have been completed. The status of the remaining action items from these plans have been shown in the attached document (**Attachment 2**). Items which have had a change in status since the last meeting have been highlighted for ease of reference.

For estuary related matters, due to the changes to the Coastal Management legislation, the remaining items from Councils Estuary Management Plans are now no longer capable of being grant funded, and thus are not currently being delivered. As such, these items will need to be reviewed as part of the future CMP. Regardless, it is noted that most of the actions in each EMP had been completed as these plans had been in place for many years. Accordingly, the attached document does not show any of the previous estuary management plans as there has been no change to these items since the last full Committee meeting in January.

For coastal related matters, multiple key actions from the Lake Cathie Coastal Zone Management Plan have commenced. These include a number of actions relating to stormwater outlet reconstruction, stormwater network redirection detailed design and a CBA & funding model for the construction of the revetment along Illaroo Road. The status of the action items from these plans have been shown in the attached document (**Attachment 2**). Items which have had a change in status since the last meeting have been highlighted for ease of reference.

PORT MACQUARIE HASTINGS COUNCIL

FLOODPLAIN MANAGEMENT

1. North Brother Local Catchments Flood Study - ***Current status - Ongoing***

Financial Breakdown

Items	Cost
Estimated total project cost	$153,820
DPIE grant funding component	$102,546.67
Council funding spent (to date)	$14,847.33
DPIE grant funding spent (to date)	$29,694.67
Actual total project cost to date	$44,542

Milestones completed to date

- Successful grant application under 2016-17 Floodplain Management funding round.
- Project is underway with the flood study component (Stage 1) adopted by Council at the July 2019 Council meeting.
- The Floodplain Risk Management Study - options assessment phase (stage 2) is now underway.
-

Refer to separate report for further details.

2. Dunbogan Flood Access Road – Construction - ***Current status - Ongoing***

Financial Breakdown

Items	Cost
Estimated total project cost	$1,166,801.40
DPIE grant funding component	$777,867.60
Council funding	$488,000
Actual total project cost to date	$1,265,867.60

Milestones completed to date

- Successful grant application under 2018-19 Floodplain Management funding round.
-
- EIRE construction have completed the majority of road construction works to upgrade the final stage of the Dunbogan Flood Access Road project.
-
- Finishing works are still required and will be completed by EIRE over coming weeks.
-
- Year 1 of bushland management works at the offset site (near Bayside Circuit, Laurieton) are complete with a significant reduction in the weed load achieved. Year 2 of bushland management works should commence in June 2020.

COASTAL MANAGEMENT

PORT MACQUARIE HASTINGS COUNCIL

1. *Illaroo Road Stormwater Redirection – Construction -* ***Current Status - Ongoing***

Financial Breakdown

Items	Cost
Estimated total project cost	$865,803.93
DPIE grant funding component	$432,901.97
Council funded	$432,901.97
Actual total project cost to date	$nil (however contract has been awarded for archaeology work worth $24,450 (ex GST)

Milestones

- Successful grant application under 2017-18 Coastal Management funding round. Council applied for grant funding in early 2018 and were notified of successful grant application in late October.

- Draft Aboriginal Archaeology Assessment Report has been received. Aboriginal archaeology deposits have been confirmed at the site and further investigation works will be required.

Identified issues to date

- The discovery of dumped asbestos and aboriginal archaeological deposits at the proposed outlet location has complicated matters and has delayed the project significantly requiring further assessment to be undertaken.
-

2. *Lake Cathie CZMP – Funding Model -* ***Current Status - Complete***

Financial Breakdown

Items	Cost
Estimated project cost	$87,500
DPIE grant funding component	$68,700
Council funded	$18,800
Actual total project cost to date	$87,500

Milestones

- Successful grant application under 2016-17 Coastal Management funding round.
-
- Project is now complete with Marsden Jacob Pty Ltd submitting final reports in late April.
-

Future works

Council staff are still working through options regarding community consultation. Given the contentions nature of the project and the sensitive information contained within the reports, a specialised, targeted and possibly staged approach to consultation will be required.

PORT MACQUARIE HASTINGS COUNCIL

ESTUARY MANAGEMENT

1. *Lake Innes Acid Sulphate Soil Management Options Study* - ***Current Status - On hold***

This study has been initiated after consultation with key stakeholders, including NPWS, DPIE, Fisheries & Crown Lands. The project consists of specialist studies that quantify the Acid Sulphate Soil (ASS) risk to the lake system. The findings from these studies will then be used to inform the review of the 2013 Lake Innes Reversion Study in order to determine if the currently listed management actions are applicable or if new management actions are appropriate in lieu of the new information and the second outcome will be to provide Council with a list of management options to address the ASS risk in the immediate future to deal with emergency containment works.

Financial Breakdown

Items	Cost
Estimated total project cost	$293,000
Requested DPIE grant funding	$147,500
Council funded	$145,500
Actual total project cost to date	$nil

Milestones

- Council recently made an application to DPIE under the 2019-20 Coast and Estuary Management funding round to undertake this project.
- Notification was recently received that the application was placed on a reserve List and that the funding would be available once the CMP Scoping Study was completed. If the Scoping Study was not completed by August, then the grant money would not be forthcoming and a new grant application would need to be made.

A Council report has been prepared which will be reported to the May Council meeting. The report requests that Council fully funds the study (i.e. Council pays the full $293,000) in order to avoid further delays.

The urgency of not delaying the project any longer is because the report is critical background information that will assist in informing Stage 2 of the CMP process for Lake Innes/Lake Cathie. Without this work, an informed decision on the management of the lake system cannot be reached.

The outcome from the Council report will be provided as an update at the meeting.

2. *Bushfire Affected Coastal Waterways* - ***Current Status - About to Commence***

Financial Breakdown

Items	Cost
Estimated total project cost	$290,000
DPIE grant funding component	$265,000

Council funded	$25,000
Actual total project cost to date	$Nil

Milestones

- Successful grant application under the one-off Coastal & Estuary Bushfire Affected Waterways funding round.
-
- Notification of our success in receiving grant funding has only just been provided to Council so no works or contractors have been engaged yet.

Future works

The works are to be concentrated on the burnt areas of koala habitat at both Lake Cathie/Lake Innes and Watson Taylor Lake. A map of the areas is included in this report as **Attachment 3**.

The project will be divided into two stages.

- Stage one will focus on data collection and investigation along with comparison against historical trends and
- Stage two will be primarily on-ground implementation and remediation including weed management, replanting, temporary containment works and soil and erosion controls coupled with ongoing monitoring to provide evidence of success or opportunities for improvement. Stage 2 improvements will provide both immediate and long term outcomes.

Attachments

1⇩. Bushfire Affected Coastal Waterways Program Funding Agreement
2⇩. Coast and Floodplain Management Plan - Action Status
3⇩. Burnt Koala Habitat Lake Innes/Lake Cathie and Watson Taylor Lake

Planning, Industry & Environment

Our Ref. DOC20/337985

Craig Swift-McNair
General Manager
Port Macquarie-Hastings Council
PO Box 84
PORT MACQUARIE NSW 2444

Dear Mr Swift-McNair

Subject: Offer of financial assistance under the Bushfire Affected Coastal Waterways Program 2019-20

I refer to Port Macquarie-Hastings Council's application to the Bushfire Affected Coastal Waterways Program for the following project:

Sensitive receptors - catchment management
Maximum funding amount: $265,000
Grant reference no. 2019-20-BACW-0012

I am pleased to advise that Council's application to the program has been successful. The offer is subject to Council undertaking to meet the balance of funds for the project, as outlined in the application, and agreeing to the terms set out in the attached *Funding Agreement for Financial Assistance* (the Agreement).

Council may accept this offer by signing both copies of the enclosed Agreement and returning one copy by email to the email address noted at the bottom of the Agreement by **15 June 2020**. Please note that if the signed Agreement is not returned by this date, the offer of funding will automatically lapse. Please pay attention to specific conditions under clause 19.

I would like to draw Council's attention to condition 3.1 of the Agreement, which outlines the requirement to submit a Work Plan. To assist Council in preparing this, I have arranged for an electronic link to the template to be emailed to Blayne West. The Work Plan should be prepared in consultation with Council's Department of Planning, Industry and Environment contact, John Schmidt, and be submitted electronically no later than **4 October 2020**.

If Council has any questions in relation to this grant offer, please call me on 02 9895 6494 or email at coastalestuary.floodgrants@environment.nsw.gov.au

Yours sincerely

04/05/2020
Alexandra Gardiner
Acting Manager Contestable Grants - Coast, Estuary and Flood
Grants Branch, Environment, Energy and Science

Contact officer: John Schmidt
02 6561 4975

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Action Number	Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
5	Camden Haven	Floodplain Management		Emergency Management Measures		Complete.
6	Camden Haven	Floodplain Management		Improved Flood Access		Commenced & ongoing. Stage 1A (final stage to supplement Stages 1B & 1C) is now completed. Minor inishing construction works will be undertaken within coming weeks, along with Year 2 of Bushland Management Works at the offset site in Bayside Circuit.
8	Camden Haven	Floodplain Management		Small Levee in Lakewood Village		Project is considered a low priority. Numerous unsuccessful grant applications have impacted the delivery of this project. Due to the low cost/benefit ratio this project is unlikely to be completed.
7	Camden Haven	Floodplain Management		Voluntary House Raising		Yet to commence - Audit undertake in 2007 showed project of high cost and mixed interest from owners. Pilot scheme was suggested to gauge likely issues. The pilot has not been commenced at this time.
7	Hastings	Floodplain Management		Commission a Climate Change Assessment Study to investigate and quantify the implications of climate change on existing design flood predictions to Year 2100	1. Prepare Brief defining climate change scenarios to be investigated 2. Engage consultant to undertake associated modelling 3. Undertake Investigations and compare results to Design Levels adopted in Hastings FRMS (2011) 4. Adopt revised Design Flood Levels (as appropriate) 5. Determine and map Updated Flood Planning Area (as required)	Complete. Completed during 2018-19 FY
8	Hastings	Floodplain Management		Commission a Hibbard Precinct Floodway Refinement Study to investigate potential options for the management of the designated floodway between Fernbank Creek and Hibbard, including potential options to modify the current floodway to accommodate existing development, while at the same time maintaining flow conveyance	1. Undertake "local scale" investigation to identify potential alternative floodway alignments through Hibbard Precinct 2. Consult with stakeholders including landowners to identify feasible floodway alternatives 3. Identify potential properties for buy back over time (potential may exist for voluntary purchase depending on funding availability). Funding opportunities to be determined in association with OEH. 4. Determine recommended alternate / refined floodway corridor 5. Identify potential properties for voluntary purchase 6. Develop Implementation Plan	Commenced. Flood Study phase is complete, however due to complexities in the adoption of the Hastings River Climate Change study the Hibbard Flooway Study was significantly delayed and funding arrangements and grant funding requirements could not be met. Hence, the Floodplain Risk Management Study & Plan phase of the previous contract was not delivered. These stages will require a further grant funding application. Accordingly, the Floodplain Risk Management Study & Plan phase is yet to commence.
11	Hastings	Floodplain Management		Develop flood interpretation software package which incorporates flood warning data for use as a flood management tool	1. Identify flood interpretation software; e.g., waterRIDE or other software 2. Engage consultant to develop flood forecasting tool 3. Develop Flood Forecasting Tool 4. SES have obtained relevant software licenses and are currently working on producing inundation mapping and incident management plans for critical areas. A MOU is in place with MIDROC to provide a technical officer as part of the Incident management Team. 5. Undertake training of SES personnel in the use of the Flood Forecasting Tool	Commenced - SES have obtained relevant software licenses and are currently working on producing inundation mapping and incident management plans for critical areas. A MOU is in place with MIDROC to provide a technical officer as part of the Incident management Team.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Action Number	Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
2	Hastings	Floodplain Management		Construct Settlement Point Flood Protection Levee	1. Review results of Supplementary Study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for Settlement Point. Establish projected timescale for levee that acknowledges community based safety requirements. 2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life. 3. Prepare REF/EIA for Settlement Point Levee. Develop preliminary concept design that recognises staggered impacts of climate change. 4. Apply for funding under the floodplain management grants program 5. Develop formal concept design incorporating additional stakeholder / community consultation 6. Undertake Detail Design 7. Undertake staged construction as per climate change impact risk	Yet to be scheduled - Project was reviewed in line with other priority projects and is now considered a low priority as a result. Mapping of the recently completed flood studies (Hastings River Climate Change Modelling, Hibbard Precinct Floodway Investigation., Wrights Creek Flood Study) is now the main focus area. Mapping works are now underway.
4	Hastings	Floodplain Management		Update Port Macquarie-Hastings LEP 2011 to reflect latest standard clauses for the management of flood prone land	1. Develop recommended changes in wording for flood related clauses within Port Macquarie - Hastings LEP 2011 2. Submit recommended clause changes to Council's Planning Department for consideration 3. Workshop with Council's Dept of Planning (as required) 4. Submit final recommended clause changes to Council for acceptance 5. Following Council acceptance, forward to NSW Dept of Planning & Infrastructure for adoption and incorporation into LEP 2011 6. Public notification of changes & incorporation of community feedback.	Commenced - now that the Hastings River Climate Change Flood Study & Wrights Creek Flood Study Projects are completed, Council staff will work towards producing revised flood mapping.
10	Hastings	Floodplain Management		Investigate options for properties / dwellings that fall within the floodway corridors for house raising	1. Identify relevant floodway areas: - Oaks Crescent - Blackmans Point - Fernbank Creek - sections along Hastings River Drive in Hibbard 2. Engage consultant to investigate feasibility and cost for house raising works 3. Consult with residents and landowners to gauge their support for house raising 4. OEH guidelines confirm that grant funding for house raising is not available where the development falls within a floodway. However it is dependent on the individual circumstances of the site and each proposal would be assessed on a case by case basis.	Yet to be scheduled
19	Hastings	Floodplain Management		Develop and initiate flood education and awareness program for vulnerable groups and flood affected communities	1. Vulnerable Groups to include: - Heritage Christian School at Hibbard - Wauchope High School - St Josephs Primary School and Regional High School 2. Priority flood affected communities to target: - Settlement Point - Hibbard - Fernbank - Blackmans Point	Yet to be scheduled - 2016-17 Grant funding application not successful - not proposed to submit grant funding application in 2017/18 due to volume of other flood projects underway.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Action Number	Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
9	Hastings	Floodplain Management		Commission a Climate Change Adaptation Study for the lower Hastings River Estuary that sets a strategy for protecting (or otherwise) existing infrastructure that will be exposed to more frequent fluvial and tidal flooding as climate change impacts manifest	1. Review results of Supplementary Climate Change Modelling Investigation (Item 7) and prepare Brief defining climate change adaptation investigation requirements 2. Engage consultant 3. Undertake Investigations and Develop Adaptation Strategy	Yet to be scheduled
12	Hastings	Floodplain Management		Install additional rainfall and streamflow gauges, particularly at Dennis Bridge and Telegraph Point and identify any additional sites required	1. Engage with BoM/MHL to identify process for installation of streamflow gauges 2. Procure gauge and commission installation	Commenced - First round of additional gauges installed with the installation of a new gauge at Mundays Lane. River Level & Rainfall Gauge installed at this location by MHL. Additional gauges may be installed in future years pending grant funding and other competing priorities.
1	Hastings	Floodplain Management		Construct North Shore Flood Protection Levee	1. Review results of Supplementary Study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for North Shore. Establish projected timescale for levee that acknowledges community based safety requirements. 2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life. 3. Prepare REF/EIA for North Shore Levee. Develop preliminary concept design that recognises staggered impacts of climate change. 4. Apply for funding under the floodplain management grants program 5. Develop formal concept design incorporating additional stakeholder / community consultation 6. Undertake Detail Design 7. Undertake staged construction as per climate change impact risk	Yet to be scheduled. Due to the inconclusive response from residents construction of a ring levee at North Shore may depend on community acceptance or a future change in flood policy.
13	Hastings	Floodplain Management		Raise Settlement Point Road between the ferry wharf and Park Street	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works	Yet to be scheduled - Project was reviewed in line with other priority projects, and is now considered a low priority as a result.
14	Hastings	Floodplain Management		Raise Hastings River Drive from west of Boundary Road to Tuffins Lane	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works	Yet to be scheduled - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Hughes Place to Boundary Street and Boundary Street from HRD Intersection to Airport.
15	Hastings	Floodplain Management		Raise Hastings River Drive between Fernbank Creek bridge and the existing Pacific Highway	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design	Yet to be scheduled - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
16	Hastings	Floodplain Management		Raise Fernbank Creek Road	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works	Yet to be scheduled - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
18	Hastings	Floodplain Management		Raise short section of Shoreline Drive (near Riverside Drive intersection) (interim emergency response measure)	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works	Yet to be scheduled - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

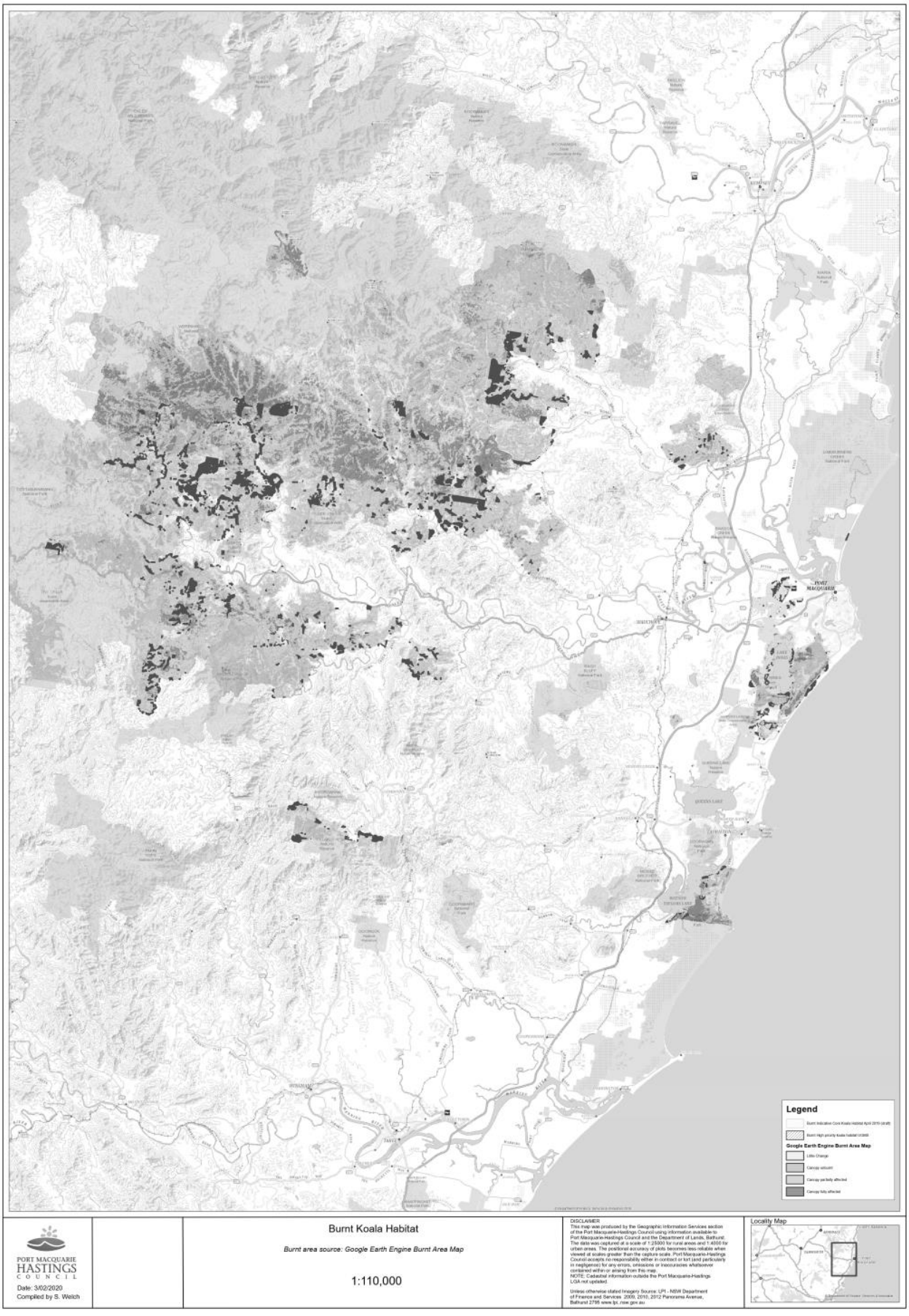
Specific Plan Action Number	Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
17	Hastings	Floodplain Management		Raise Shoreline Drive and North Shore Drive (subject to construction of North Shore and Settlement Point Levees)	1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design with consideration of existing stormwater drainage issues 4. Undertake construction works	Yet to be scheduled - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport..
3.2	Lake Cathie	Coastal Management	Stormwater Management	Redirect Illaroo Rd stormwater to minimise the direct outflow of stormwater onto the beach. Illaroo Road only included as a contingency pending confirmation of the timing of the construction of the Revetment.		Commenced & ongoing - Detailed design plans completed. Grant application successful. Dumped asbestos has been uncovered as had Aboriginal archaeology. Aboriginal archaeology investigation is now underway. This investigation needs to be completed before the asbestos can be remediated and the stormwater constructed.
3.1	Lake Cathie	Coastal Management	Stormwater Management	Continue to upgrade the stormwater outlets to the beach e.g: placement of rock at outlets to reduce beach scour.		Commenced - numerous beach outlets upgraded within past 10 years. Grant funding application successful for Middle Rock & Chepana Street outlet works. Construction works completed for 2x outlets during 2018-19 FY.
5	Lake Cathie	Coastal Management	Ongoing Beach Nourishment	Any sand dredged/ excavated from the Lake Cathie entrance to be placed on the beach adjacent to Illaroo Road.		Ongoing
7.4	Lake Cathie	Coastal Management	Foreshore Management	Batter back any storm erosion escarpment that forms at Foreshore Reserve (or in other locations) to ensure public safety and maintain park amenity.		Ongoing
9.2	Lake Cathie	Coastal Management	Public Access	Continue to monitor and rehabilitate informal beach access tracks		Ongoing
9.3	Lake Cathie	Coastal Management	Public Access	Reduce erosion escarpments at the base of beach accessways and carry out any necessary repairs following storm erosion		Ongoing
7.1	Lake Cathie	Coastal Management	Foreshore Management	Continue to control/ remove bitou bush along with regeneration/ revegetation with locally indigenous vegetation species.		Ongoing, subject to funding availability.
8.1	Lake Cathie	Coastal Management	Reserve Improvements	Prepare masterplan for foreshore reserves (Aqua Reserve, Foreshore Reserve and Johnathon Dixon Reserve), incorporating the following improvements: - additional lighting at Johnathon Dixon Reserve and in the vicinity of the Foreshore Reserve barbeque facilities - upgrade Johnathon Dixon Reserve to relieve pressure on Foreshore Reserve by providing shade, shelter and play areas. Upgrades should allow for revetment end effects.		Completed. Foreshore reserve masterplan developed and adopted by Council. Ongoing implementation will be undertaken over coming years.
2.2	Lake Cathie	Coastal Management	Development Controls	Review area subject to controls following construction of the revetment and when the hazard lines are reviewed. Note that the 50 year impact line would move over time due to shoreline recession (and possibly affect additional properties, e.g. along Chepana Street).		Yet to be scheduled
3.5	Lake Cathie	Coastal Management	Revetment	Call tenders and construct revetment.		Yet to be scheduled
3.6	Lake Cathie	Coastal Management	Revetment	Finalise private/ public cost-sharing arrangements including private payment plans.		Ongoing - Consultant has completed CBA & Funding Model. Community engagement yet to be undertaken.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Action Number	Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
3.7	Lake Cathie	Coastal Management	Revetment	Carry out post-storm assessments to identify revetment maintenance requirements and actions to address exacerbated erosion in front of, and at the ends of, the revetment.		Yet to be scheduled
4.1	Lake Cathie	Coastal Management	Contingency Measures	Develop a Servicing Strategy in consultation with other service providers in the event that access and services to Illaroo Road properties are threatened by coastal erosion, prior to construction of a revetment.		Yet to be scheduled
4.2	Lake Cathie	Coastal Management	Contingency Measures	Designate Aqua Crescent/ Bundella Avenue and Illaroo as a one-way loop in a Local Area Traffic Management Plan in the event that damage to the road reserve occurs as a result of erosion events and the road pavement width needs to be reduced to maintain safe access, prior to the construction of a revetment.		Yet to be scheduled

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD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Burnt Koala Habitat
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PORT MACQUARIE HASTINGS COUNCIL
Date: 3/02/2020
Compiled by S. Welch
DISCLAIMER
Locality Map

Item: 10

Subject: LAKE INNES / LAKE CATHIE ESTUARINE SYSTEM - UPDATE

Presented by: Development and Environment, Melissa Watkins

RECOMMENDATION

That the Committee note the report.

Discussion

Several Lake Innes/Lake Cathie projects are underway. Many of these projects are still under discussion at the time of writing this report.

Accordingly, in order to provide committee members with the most up to date information regarding various Lake Innes/Lake Cathie projects Council staff will provide a presentation at the meeting.

Topics that will be presented will include:

- Lake Opening (low level)
- Lake Opening (high level)
- Lake Innes Acid Sulphate Soil Investigation
- Lake Cathie/Lake Innes & Bonny Hills (including Open Coastline) CMP chapter
- Illaroo Road Revetment Wall Funding Model & CBA
- Illaroo Road Stormwater Redirection, Asbestos Removal & Aboriginal Archaeology
- Lake Cathie Opening Strategy
- Lake Cathie Flood Mitigation REF

Attachments

1⇩. Lake Cathie Opening REF - Flood Mitigation
2⇩. Lake Cathie and Lake Innes Acid Sulphate and Soil Risk Assessment

PORT MACQUARIE HASTINGS COUNCIL

DE299

PORT MACQUARIE-HASTINGS COUNCIL

PO Box 84, Port Macquarie NSW 2444 DX 7415
PMO Office: 6581 8111 **Laurieton Office**: 6559 9958 **Wauchope Office**: 6589 6500

PORT MACQUARIE HASTINGS

REVIEW OF ENVIRONMENTAL FACTORS

NOTE: This REF is for projects that have minor and predictable impacts and require a Part 5 assessment. See (guideline) for information on completing this REF. Steps 1-12 are described in that document. See (guideline) for further information on Part 5 assessments and assessments under Parts 3A and 4 of the EP&A Act.

Project Name	Lake Cathie Opening - Flood Mitigation	**Project Number**	NR_P001_LC
Project Location	Lake Cathie	**Assessment Date**	09/04/2020

CONSTRUCTION WORK MUST NOT COMMENCE UNLESS:

- The person completing the REF has signed the completed document, verifying that each of the steps has been satisfied and no further assessment or investigation is required, AND
- The Determining Officer has signed this Checklist to verify that the assessment has been adequately completed, the conclusion as to the likely environmental impact of the project is reasonable and the project can proceed subject to relevant control measures and conditions in any approvals, licences or permits, AND
- The required approvals, licences and permits have been obtained as outlined in TABLE 2 and TABLE 3, AND
- All relevant construction personnel are aware of:
  - Their responsibilities detailed in the REF
  - The project's Environmental Impacts in TABLE 4
  - The project's specific Control Measures in TABLE 4
  - The project's environmentally Sensitive Areas in TABLE 3
  - The conditions in any approvals, licences or permits in TABLE 2
  - The project details and likely impact of the project on the community in TABLE 1

NOTE: If any environmental issues are identified or if any environmental control measures are required, refer to TABLE 4 from this completed EIA Checklist. The following is to occur:
- Where a construction drawing is prepared as part of the construction work pack, the environmental control measures should be listed in the schedule on that drawing, and for more complicated projects,
- The environmental control measures should be included in a project specific environmental management plan.

NOTE: If any approvals, licences or permits are required as outlined in TABLE 2 or TABLE 3 then copies of these MUST be included in the construction work pack that is submitted to the Construction Manager for the project.

NOTE: Projects may require a more detailed assessment of particular issues (eg a specialist ecology report). In these cases, this document should accompany this report and the findings be considered in the assessment and identification of control measures.

NOTE: Some minor projects are exempt development. There is a separate checklist to be completed if you think your project is exempt. Where the project meets the exempt criteria and the exempt criteria checklist has been completed, a REF is not required.

NOTE: Projects requiring a Part 4 planning approval must be referred to the relevant consent authority.

NOTE: This checklist also includes an Environmental Protection and Biodiversity Conservation Act 1999 checklist.

DE299

TABLE 1 – PROJECT DETAILS

STEPS 1-2

NOTE Prior to completing this REF a site inspection is to be undertaken by the officer completing the assessment.

Date:	22/04/2020	Officer: Blayne West/Tim Haydon

Site Inspection.	☑ Yes

Item	Project justification	
1.1	Description of those activities of the project which are being assessed under Part 5 of the EP&A Act: Outline specific clauses in legislation (ie infrastructure SEPP) which allow the proposal to be considered as development permitted without consent. (include ancillary activities such as future maintenance, street lighting, access tracks, fences, tree trimming, etc. and include all mitigation measures)	**Background** Lake Cathie is small coastal hamlet on the New South Wales (NSW) mid-north coast, approximately 20 kilometres (km) to the south of Port Macquarie. The town has been established adjacent to a coastal lake. This coastal lake naturally alternates between being open and closed to the Ocean due to the natural establishment of a sand berm at the interface of the lake with the Pacific Ocean. Coastal lakes and lagoons that exhibit this behaviour are known as Intermittently Closed and Open Lakes and Lagoons (ICOLLs). About 70 of the coastal lakes and lagoons in NSW are 'ICOLLs' (https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw). The Department of Primary Industries (Fisheries) web-page https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw) outlines specific information related to ICOLLs, which has been referenced below to provide background information for the current situation at Lake Cathie. Note that italicised text is a direct quotation from the website, outlining the guiding principles to ICOLL management as directed by the NSW DPI (Fisheries). **ICOLL Formation and Natural Behaviour** *ICOLLs are separated from the ocean by a sand beach barrier or berm. This entrance barrier forms and breaks down depending on the movement and redistribution of sand and sediments by waves, tides, flood flows and winds.* *ICOLLs open and close to the ocean naturally in a constant but irregular cycle. When there is sufficient water flowing into the lake or lagoon from the catchment area (usually following heavy rainfall), water levels in the ICOLL will rise.* *Eventually the water in the ICOLL will spill over the entrance sand berm and drain to the ocean. The force of the backed up water then quickly scours an entrance channel through the beach and reopens the ICOLL to the ocean. When ICOLLs are open they become tidal with seawater moving into and out of the estuary with the daily tidal cycle.* *ICOLLs close when the ocean waves and tides push sand from offshore into the entrance, which gradually closes the entrance channel. Without further large freshwater flows into the estuary from the catchment, the ICOLL will remain closed to the sea. When ICOLLs are closed they do not exchange water with the ocean and water levels within them fluctuate depending on rainfall, catchment inflows and evaporation.* *During wetter times many ICOLLs remain constantly open to the ocean. In times of drought and reduced rainfall ICOLL entrances close more frequently and stay closed for longer periods of time. It is common for many ICOLLs to remain closed for several years at a time. As well as rainfall, specific local conditions such as catchment size and headlands near the entrance determine if an ICOLL is mostly open or mostly closed. However historical records show that about 70% of the ICOLLs in NSW are closed for the majority of the time.* **Circumstances for artificially opening ICOLLS** *Many ICOLLs have been, and continue to be, manually or artificially opened to the ocean by various authorities. Heavy equipment, such as excavators, are used to artificially open ICOLLs by digging a channel through the sand berm between the ICOLL edge to the ocean.* *The main reason for artificially opening an ICOLL entrance is to mitigate and reduce the impacts of flooding. When water levels rise in a closed ICOLL following rainfall this can lead to flooding*

		of urban and rural development adjacent to the lake or lagoon foreshore, including private properties, business premises, roads, parklands, sewerage systems and farmland. *Artificial breaching of the entrance barrier is undertaken to 'drain' the ICOLL to the ocean and lower water levels to relieve existing flooding of foreshore development and infrastructure or avoid the likely threat of flooding which would occur before the ICOLL entrance opens naturally. The trigger for artificially opening many ICOLLs (rather than let nature takes it course) is often a consequence of past developments being allowed to be located in low lying areas too close to the edge of the lake or lagoon.* Port Macquarie Hastings Council (PMHC) have an opening strategy for Lake Cathie. The Opening Strategy is provided in *Appendix A* and discussed further in *Section 1.2*. **Responsibility for ICOLL Entrance Management** *Responsibility for undertaking artificial openings of ICOLL entrances usually lies with the local Council under their duty of care to the local community.* *Management of ICOLL entrances is sometimes a controversial issue in local communities with competing interests wanting entrances opened more often or less often for different reasons. On occasion, local community members have even attempted or succeeded in artificially opening ICOLLs without obtaining approval or using appropriate methods which has led to unwanted consequences, including fish kills. Such activities are also illegal and offenders can face fines or prosecution for their actions.* *It should be remembered that flooding and drying are natural components of the hydrological and ecological processes operating within ICOLLs. Coastal lakes and the life they support have evolved in response to these forces and to maintain a 'healthy' lake ideally it should be left to operate as close to natural as possible.* *ICOLLs are very complex environments and the impact of artificially opening entrances on fish species and fish habitats is not well understood. It is important to recognise that ICOLLs have always been dynamic coastal environments. They are significantly different from bays, harbours or inlets which are permanently open to the sea. NSW already has many permanently open estuaries which can be enjoyed by those people who prefer this type of waterway.* **Future Permanent Management Considerations** Ultimately, PMHC are attempting to adhere to the following advice provided by the DPI (Fisheries): *In the long-term, local councils and government agencies should aim to reduce the need for artificial manipulation of the entrance by taking active measures to remove, relocate or otherwise manage items of low-lying infrastructure that currently necessitate breaches below the natural breakout range, and adopting catchment management practices that:* • *reduce the inputs of nutrients and pollutants from point and diffuse sources,* • *prevent transfer of flood prone and riparian land on the margins of ICOLLs into private ownership,* • *prevent the future development or subdivision of flood-prone and riparian lands by adopting appropriate zonings and buffers in planning instruments,* • *implement community awareness campaigns to gain broad based understanding and support for the environmentally responsible management of ICOLLs* **History of Artificial Openings at Lake Cathie** Webb, McKeown and Assoc. (1995) stated that there has been artificial openings of the estuary entrance since at least the early 1960's, by excavating a channel through the beach dune when the Lake water levels reached approximately 1.5mAHD. **Location of the Proposed Activity** The proposed activity will be undertaken on the back beach and sand berm currently present at the confluence of Lake Cathie and the Pacific Ocean. *Figure 1* provides the regional context of the location, and *Figure 2* demonstrates the extents of the proposed activity. The area shown in *Figure 2* encompasses what will herein be referred to as the 'Study Area' required to allow access, establishment of site and the excavation and stockpiling works.

Figure 1- Site Locality

Figure 2 - Proposed Activity Extent ('Study Area')

Description of Proposed Activity

The proposed activity includes:

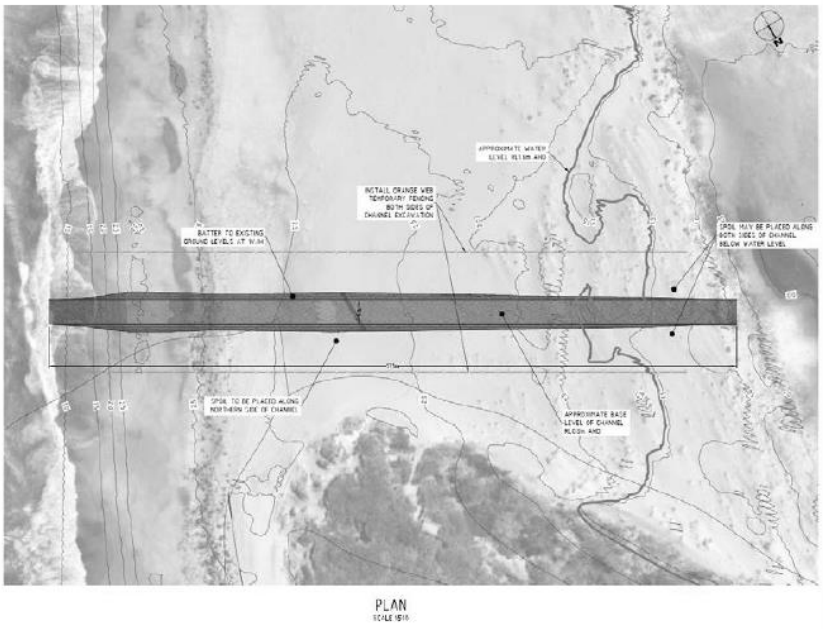
- floating of earthmoving equipment to site via public road network
- establishing containment fencing of the proposed excavation area
- access to the works area via the beach access at northern end of Illaroo Road
- earthmoving equipment tracking along sand berm to the proposed excavation area
- excavation of an approximately 135m long, 6m wide trapezoidal channel (1V:1H batter slopes) in the sand berm to allow accumulated water to the west of the berm to be released to the ocean, thus preventing accumulated water to interact with PMHC sewerage infrastructure and thus contaminate the water within the Lake network;
- the base level of the drain will be approximately RL0.8mAHD
- excavation will proceed from west to east initially, up to beach berm crest. From the beach berm crest, works are to excavate form the back of the beach to the crest to release the water;
- excavated spoil will be placed on the northern side of the channel; except below lake water level where spoil may be placed on both sides of the channel.
- upon the opening of the channel, tracking the earthmoving equipment back to the float
- removing the containment fencing.

Preliminary plans outlining the works are provided in *Appendix B*, with key features demonstrated in *Figures 3* to *5* below.

The proposed access location that has been used in the past is demonstrated in Photograph 1 below.

Photograph 1 - Past opening event, demonstrating access point on Northern end of Illaroo Road.

The proposed activity is limited in extent to the area shown in *Figure 2*, however will cause changes to water levels and hydrodynamics in the upstream watercourse and lake network. The impacts of this decrease in water level/change to hydrodynamics is discussed and assessed throughout this report and is considered to replicate an opening that would occur under natural conditions.



PLAN

Figure 3- Proposed Channel Excavation

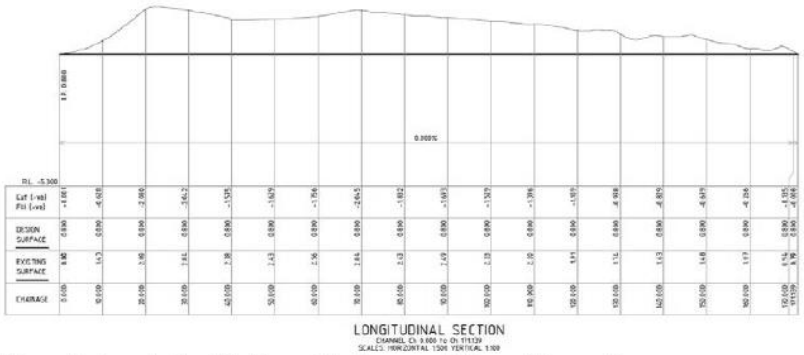


Figure 4 - Longitudinal Section of the Proposed Channel Excavation

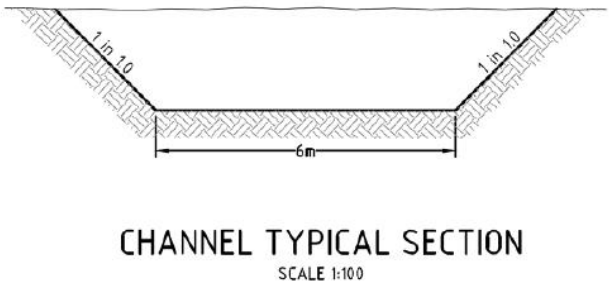


Figure 5 - Typical Cross Section of the Proposed Channel

Equipment

The proposed activity will be undertaken by earthmoving equipment (including one or more excavators and possibly in conjunction with a bulldozer) with the capacity to construct the channel to the required dimensions within 1-2 days. The activity will include the operator of the earthmoving equipment, and possibly a site supervisor or spotter. The earthmoving equipment will be floated to site. Operators and ground staff will access the site via the public road network and park in the existing sealed carparks in the vicinity of the Lake. Access to the beach will be provided by an existing cleared area used for vehicle access at the northern end of Illaroo Road. Examples of equipment used on other artificial ICOLL openings are provided in *Figure 6*.

Figure 6 - Photographs of similar opening activities under taken on ICOLLs
(Sourced on 20/04/2020 - https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw)

Excavated Material Management

Approximately 1670 cubic metres (m^3) will require excavation, based on survey of the sand berm from November 2019. Sand will be deposited adjacent to the channel, on the northern side of the excavation. As the excavated material will not be removed from the berm, and will not be leaving the site, it is not a waste material requiring specific management measures. The material would be classified as virgin excavated natural material (VENM) and can remain on-site.

Justification for the proposed Activity

The primary purpose of the opening the lake during flood events is to prevent the inundation of private and public infrastructure. Of greatest concern is the flooding of PMHC sewerage infrastructure, and the consequent potential pollution impacts within the watercourse. The inundation of sewerage infrastructure also may overload the Bonny Hills Sewage Treatment Plant (STP), with lake water entering the sewerage infrastructure and being conveyed to the STP, causing increases to effluent to be treated and pressure on the system.

The alternative of allowing the inundation of the PMHC sewerage system would have significant negative environmental impacts including:

- Negative, long term impacts to water quality through the introduction of faecal coliforms and other contaminants from the sewage;
- Deleterious impacts to aquatic ecology, potentially including mortality of fish, waterbirds and aquatic vegetation, due to poor water quality;
- Deleterious impact to terrestrial ecology, potentially including mortality of terrestrial vegetation at the lakes edges and terrestrial fauna that interacted with contaminated waters; and
- Potential for negative human health impacts, the watercourse would have to incorporate a stringent management program to attempt to prevent human interaction with contaminated water.

The release of sewage to the watercourse would also be a pollution event under the Protection of the Environment Operations Act (1997) and would require notification to the NSW Environmental Protection Authority (EPA). The pollution event may be considered an offence, subject to penalties such as fines and gaol time.

Council's Geocortex mapping system was reviewed to demonstrate examples of sewerage infrastructure that may be affected during flood events (*Figures 7* and *8*).

Figure 7- Sewer manhole at 1.89mAHD that would be subject to flood inundation adjacent to Kenwood Drive and Lakeside Way

Figure 8- Sewer manhole at 1.89mAHD that would be subject to flood inundation at intersection of Tallong Drive and Glenugie Street

Council are also responsible for ensuring the safety of local residents utilising public infrastructure and not being subject to inundation of their private assets. This is an unfortunate consequence of allowing development within flood prone locations in the past.

Under natural conditions, ICOLLs do open when sand berms are broken as a result of environmental conditions being met (including pressure from high volume of water within the estuary behind the sand berm and tidal conditions from the beach at the front of the sand berm). These proposed activity will be undertaken when a high volume of water is built up behind the berm, and hence is considered to somewhat replicate natural conditions, and thus is considered justifiable when enacted to prevent sewage contamination and infrastructure flooding.

Zoning of the Proposed Activity Study Area

The proposed activity will be undertaken within W2 recreational Waterway, adjacent to areas of E2 and an unzoned location that is the beach at the lakes entrance (See *Figure 9*). The objectives of this zone as outlined in the PMHC LEP (2011) are to:

- *protect the ecological, scenic and recreation values of recreational waterways.*
- *allow for water-based recreation and related uses.*
- *provide for sustainable fishing industries and recreational fishing*

The legislative pathway to undertake the works is defined in the ISEPP as development for *'the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land'*. Hence the proposed activity to prevent contamination of the watercourse with sewage from inundation of council infrastructure are permissible within, and meet the objectives of, this zone.

Figure 9 - PMHC LEP (2011) Zoning of the Study Area

1.2	Description of timings, phasing and schedules:	The excavation works are expected to be completed within 1-2 days. PMHC has an 'Opening Strategy' for the Lake. An Opening Strategy decision making flow chart was first developed in 1994 (Webb, McKeown and Assoc., 1994) in an Estuary Management Plan. This was modified as outlined in the Environmental Review (Webb, McKeown and Assoc., 1995). The Opening Strategy, by recommendation of the Lake Cathie/Bonny Hills Estuary Management Sub-committee in late 2001, revised the opening height to 1.6mAHD from

		1.8mAHD, along with other criteria, in the decision making flowchart for opening the Lake. This height was likely adopted as it was considered by the decision makers at the time to be the most appropriate level to artificially open the lake and prevent impacts to infrastructure. The opening strategy is provided as *Appendix A*. A Standard Opening Procedure (SOP) has been established to detail specific actions to be undertaken in the lead up to, and upon, the trigger level of 1.6mAHD being reached. This outlines specific consultation, monitoring and action items to be undertaken by Council staff. The SOP is provided as *Appendix C*. DPI (Fisheries) recommend that: *In the event that the criteria for an artificial opening are met, breaching should be conducted during a falling tide (if possible, around a spring tide) so that the potential for establishing an entrance channel long enough to flush the water body is achieved.* The length of time that the lake remains open to the ocean is highly variable dependent on rainfall, channel scour depths and tidal influence. Records of duration that the lake remains open to the Ocean are provided in the Cumulative impacts of *Section 1.4*. Graphs displaying water levels recorded by the Manly Hydraulics Gauge following lake openings and comparing to rainfall conditions are provided in *Section 1.4*. Openings become tidally influenced while open, with rainfall having no discernible influence on water levels measured at the gauge. Upon enough sand becoming established, the water level no longer fluctuates with tidal conditions and the water level measured at the gauge becomes much more correlated with the rainfall levels within the catchment. Hence the length of time that the Lake remains open (and closed) is highly variable and difficult to predict due to difficulty in long term weather forecasting.
1.3	Ownership of the relevant land (noting whether Council owns the land, if easements or land acquisitions will be required for works. If Crown Land, special provisions may apply, a plan of management may apply or native title issues)	*Figure 10* was generated from PMHC's Geocortex mapping system and demonstrates the tenure of the Study Area. Key features are: • West of the Ocean Drive Bridge, the watercourse is the Lake Innes Nature Reserve and is under the tenure of National Park and Wildlife Service; • East of the Ocean Drive Bridge the watercourse is under the tenure of Department of Planning Industry and Environment (DPiE)(Crown Land); and • The beach (and the associated sand berm that builds across the lake entrance) is under the tenure of DPiE (Crown Land). As stated on by DPI (N.D.) (https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw) the responsibility for artificially opening ICOLLs typically falls to Local Councils under their duty of care to the local community, when infrastructure and public safety is under threat from rising water levels within the ICOLL. The proposed activity to be undertaken by PMHC, as a public authority, is to artificially open the Lake to: • prevent the inundation of sewerage infrastructure and thereby prevent a subsequent pollution event of sewage entering the watercourse; and • prevent inundation of public and private infrastructure. The proposed activity will be undertaken within land under the tenure of DPiE (Crown Land). The works will cause alterations, replicating a natural event, to hydrology within the Nature Reserve. The associated legislative/permitting requirements and the consultation with administering state government agencies is described further in *Section 1.6* and *1.10*, respectively. Access to the site will be provided by Council owned road reserves, with no requirement to enter onto land managed by NPWS. Boundary encroachment into NPWS land is not likely given the limit to the extent of works being east of the ocean Drive bridge, within the Study Area shown in *Figure 10*.

DE299

Figure 10 - Tenure of the Study Area

1.4	Description of the environment – relevant to the potential impacts. (This could include drainage systems, waterways, flora and fauna, visual/scenic quality, transportation routes, land use, traffic flow, land contamination etc.)	The following section details the existing environment and potential impacts of the proposed activity on environmental factors. **Hydrology/Flooding/Water Quality** **Existing Physical Characteristics of the Estuary** The Lake Cathie / Lake Innes catchment is defined by ridgelines within Port Macquarie to the north, the Pacific Highway to the west and Bonny Hills to the south (BMT WBM 2011). *Figure 11* demonstrates the extents of the system. Webb, McKeown and Assoc. (1994) report that 6% of the total catchment area drains to Lake Cathie, 34% to Cathie Creek and 60% to Lake Innes. The Lake Cathie / Lake Innes catchment (including water bodies) covers an area of approximately 12,450 hectares (BMT WBM 2011). The Estuary has a waterway area of 6.7 km² comprising a shallow lake system with low-lying foreshore topography (BMT WBM 2011). When the lake is open, the bed of Lake Cathie is exposed at low tide, with large intertidal vegetated areas (BMT WBM 2011). Lake Cathie is joined to Lake Innes via Cathie Creek. Lake Cathie, Lake Innes and Innes Swamp are back-beach barrier coastal lagoons (BMT WBM 2011). See *Figure 12* for aerial imagery of the system. Lake Cathie is a very shallow water body. Lake Cathie is largely situated within Lake Innes Reserve and is separated from Cathie Creek by a narrow channel crossed by Kenwood Drive Bridge (Webb, McKeown and Assoc., 1994). The channel is very shallow with most of the bed above mean ocean tide level. When the entrance is open, Lake Cathie can be characterised as being mostly mud flats (Webb, McKeown and Assoc., 1994). The bed elevation and waterway area are outlined in *Table T1*. Lake Innes is a large, relatively shallow, saline coastal water (BMT WBM, 2011). Lake water levels vary between 0 m AHD and +2.5 m AHD depending on conditions at the entrance and the volume of runoff received from adjacent catchments (Webb, McKeown and Assoc., 1994). Innes Swamp is a freshwater wetland system located adjacent to Lake Innes, which is connected to Cathie Creek to the south (at a level less than +2.0m AHD) and by a slightly higher connection with Kooloonbung Creek (approximately +2.5m AHD). Although connections between Innes Swamp and the main waterbody of the Estuary are present, they are at levels that would be not influence average tidal hydrodynamic conditions and would only be influential during major flood events (Webb, McKeown and Assoc., 1994). Cathie Creek provides a hydraulic connection between the main water bodies and the Pacific Ocean when open (BMT WBM 2011). The permanent channel is approximately 40m wide and 2m deep at low tide (BMT WBM 2011). Two bridges travers Cathie Creek, the Kenwood Bridge (western-most bridge) and Ocean Drive Bridge (as shown in *Figure 12*). Deep scour holes are present under Ocean Drive Bridge and downstream of Kenwood Drive Bridge (BMT WBM 2011). The scour at Ocean Drive bridge is upwards of negative 6mAHD (BMT WBM 2011). These bridges, the scour present, and the source of sand at the ocean entrance berm has caused significant alteration to the shoal formation in the area (BMT WBM 2011). BMT WBM (2011) also reference prior studies that have concluded the presence of the Kenwood Drive Biridge/culvert significantly influences tidal behaviour in Lake Cathie, with water level upstream due to the observed tidal range was considerably smaller than that observed downstream of the bridge. Cowarra Creek and Karikeree Creeks are fourth order watercourses that also join to the network as shown in *Figure 11*. Cowarra Creek has a catchment area of 39 km² with little storage (BMT WBM, 2011). During dry periods, the Creek is an ephemeral creek with no significant flow (BMT WBM, 2011). Cowarra Creek drains parts of Cowarra, Queens Lake and Burrawan State Forests (BMT WBM, 2011). Karikeree Creek drains parts of Cowarra State Forest and Lake Innes Estate to the north-western extents of Lake Innes (BMT WBM, 2011). The intrusion of saltwater into Lake Innes as a result of the excavated connection between itself and Cathie Creek has altered the tidal prism of the Estuary and resulted in the loss of freshwater habitat (Webb, McKeown and Assoc., 1994). (Webb, McKeown and Assoc., 1994) references that freshwater terrestrial and aquatic flora / fauna has been replaced with saline or saltwater tolerant species; vegetated islands that existed within Lake Innes have eroded; hypersaline conditions frequently occur during periods of low rainfall; sedimentation regimes have been altered; the frequency of ocean connection has been affected; and water quality has generally degraded. **Table T1 - Bed levels and waterway areas of Estuary features** Location / Bed Elevation / Waterway area Lake Cathie / Majority of bed elevations >0mAHD / 100 hectares (ha) (at water level of 0.75mAHD) Lake Innes / +0.75mAHD on average / 700ha

Cathie Creek	–	120HA (at water level of 0.75mAHD)

BMT WBM (2011) identify that flooding in Lake Cathie and Lake Innes is a highly complex combination of catchment runoff and entrance conditions (berm levels). Flooding within the Estuary is primarily a result of excess runoff from contributing catchments into Lake Innes and increased downstream flood levels which backflow into Lake Cathie via the Kenwood Drive Bridge (Webb, McKeown and Assoc, 1994).

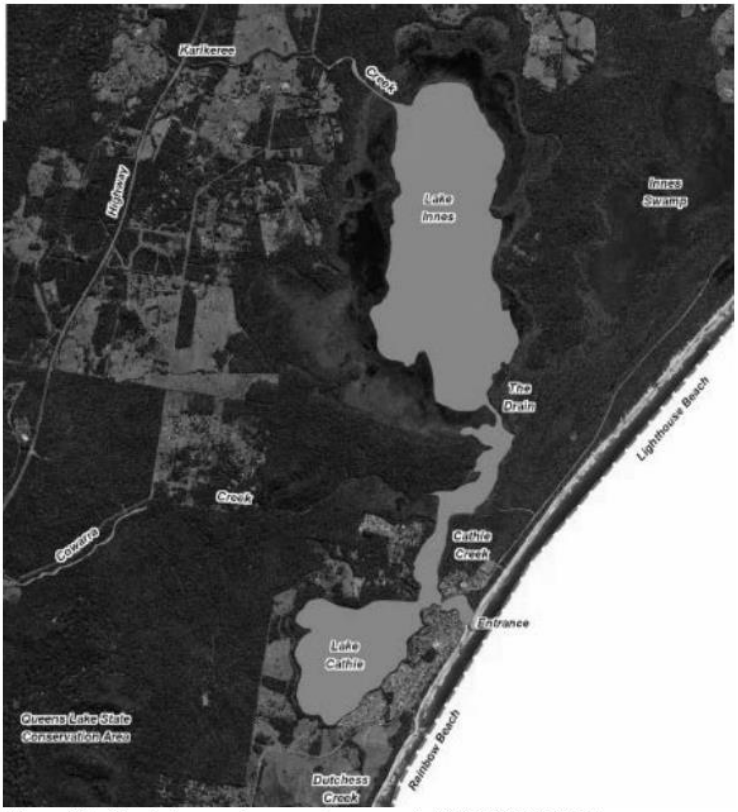


Figure 11 - The Lakes, estuary and surrounds (BMT WBM 2011)

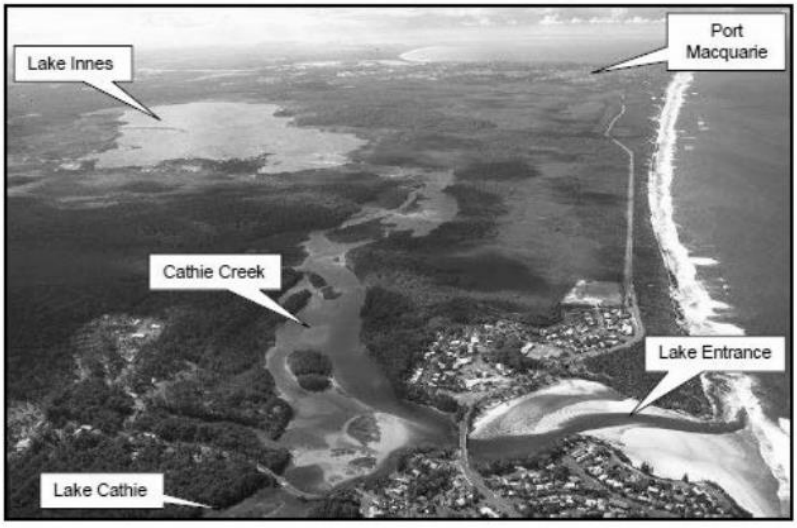


Figure 12 - Lake Cathie Estuary (BMT WBM 2011)

Sediment Dynamics

Sedimentation within the Estuary is primarily associated with reworked coastal and marine sands in the lower estuary, and catchment sediment loads are not considered significant (BMT WBM, 2011). PMHC (2007) identified that there are three main areas of significant sand shoaling:

- Lower Cathie Creek between Ocean Drive Bridge and the Entrance,
- Cathie Creek upstream of the Ocean Drive Bridge; and
- The flood tide delta at the artificially constructed channel entrance to Lake Innes.

The state of the entrance has been actively managed by human activities rather than natural events (BMT WBM, 2011). When the entrance is open, tidal flows transport marine sand from the active beach zone into the Estuary (BMT WBM, 2011). In general, entrance openings tend to last longer if caused by natural events rather than by mechanical means (BMT WBM, 2011). BMT WBM (2011) summarise previous sediment investigations, noting that

- Morphology of Lake Innes and Lake Cathie has been stable with the exception of the flood tide delta at "The Drain";
- There is a minor amount of sediment entering the Estuary from the catchment;
- Analysis of aerial photos does not show any widespread changes, other than growth of the Lake Innes flood tide delta at 'The Drain'; and
- Scour has occurred at the Kenwood Drive and Ocean Drive Bridges, with material redeposited nearby.

Potential Impacts

An ICOLL may naturally breakout when the berm if overtopped in response to rainwater raising water levels. If this happens it is commonly accompanied:

- Significant scour of flood-tide delta and entrance channel.
- Erosion of the beach berm and movement of sand offshore during large wave and /or storm surges.
- Entrance would be possibly open for months depending on follow-up rainfall.

In an artificial opening, which is the specific case of Lake Cathie, is prompted by the need to mitigate the impacts of possible damage to infrastructure or the impact on sewer lines and possible sewage leaks in to the lagoon the following may happen:

- Low to moderate channel scour during breakout
- Wave energy and flood-tides cause a net input of sand into the entrance channel
- The entrance is closed in weeks depending on entrance scour, follow-up rainfall and littoral sand supply.

Artificial opening due to wet weather events are common for local Councils. The response to artificially open a lagoon is due to the water rising above the 1.6m 'trigger level' as set in the

Following opening of the Estuary mouth (by natural or mechanical means), the Estuary becomes tidal with the degree of response dependent on the depth and width of the entrance channel (BMT WBM 2011) . The tidal range within the Estuary is noted by Webb, McKeown and Assoc., (1994) as being approximately 0.6 metres at the Ocean Drive Bridge and 0.3 metres within Lake Innes (upstream of "the drain") for an ocean tide range of 1 m and opening triggered at +1.5 m AHD.

Water quality in ICOLL's is highly variable in space and time due to the combined effects of entrance dynamics, a tendency to stratify, and the influence of groundwater inputs from surrounding low-lying catchments. Whist water quality variation may appear extreme this variation should be considered natural and an integral part of the greater coastal ecosystem. Webb, McKeown and Assoc (1994) undertook a qualitative assessment of estuary processes and noted that the amount of mixing is low, particularly after initial entrance opening due to the elongation of the main waterbody (Cathie Creek) and the potential for stratification within deeper waters such as Cathie Creek. The amount of exchange between incoming tidal waters and lake waters is therefore considered to be low.

Rainfall events result in freshwater inputs (overland flow and groundwater), lowering salinity and delivering nutrients, suspended sediments and pathogens. In Lake Cathie, the water quality is also significantly influenced by tannin-rich groundwater inputs from low-lying Lake Innes.

PMHC undertakes water quality monitoring at the Lake with the results of monitoring from early 2019 provided in *Appendix F*.

Due to the connection of Lake Cathie and Lake Innes it is assumed that the opening will slightly reduce water levels in the full estuarine system. As such this may affect the salt marsh, the sea grass, the sedge lands, the avifauna and the invertebrates. Because we won't know how much

		water will be removed from the system we are unable to determine the overall ecological impacts. We are aware that the outcomes could be: Drains only the surface layer: 1. If the surface layer only drains than this may leave water trapped in deeper parts of the basin. Tidal influence - not enough or too much: 2. The tidal influence is also unknown since it is too difficult to predict how much oceanic water will be mixed in with freshwater. 3. Tidal water will increase the salinity and stratification in deeper parts of the system. Ocean water can react with acidic runoff which may cause deoxygenations events and fish kills. The risk of not opening a system may result in low water quality. Under closed conditions, oxygen and temperature stratification can develop, and evaporation can significantly increase salinity and lower water levels. Therefore, based on the premise that the ecology fluctuates and relies heavily on salinity levels, DO levels and PH levels, as state above and based on the water quality testing as outlined, we are aware that during the time of extended drought and quite quickly reaching levels of flood the natural ecosystem has been significantly altered. As such, It is proposed that artificially opening the lagoon and allowing freshwater levels to recede and potentially allow salt water to enter will not create a significant negative impact on the existing ecology as it is replicating the natural cycle of an ICOLL. The need to mitigate possible sewer entering the system and flooding of infrastructure is the determining factor in progressing with the proposed activity. PMHC recognizes that entrance management in ICOLL systems must make trade-offs to balance the imperatives of maintaining ecosystem processes, protecting assets, and managing community expectations. There will always be risks associated with opening the Lake Cathie lagoon system. But due to Council needing to alleviate and mitigate risk to infrastructure including sewer lines it is recommended that the risk of opening at a high level, is the correct course of action. To assist in mitigating further impacts in the future it is proposed through the writing of the Coastal Management Program that a chapter will focus specifically on the Lake Cathie/Lake Innes to Rainbow Beach estuarine system. In this study further investigation will be completed to understand the benefits and consequences of reverting Lake Innes to freshwater, understanding they dynamic nature of the ASS risks, and improving the overall estuary health. Further investigations will be completed to ensure an opening strategy for Lake Cathie during flood events follows best practice to achieves minimal environmental disturbance. BMT WBM (2011) outlines previous investigations undertaken that have modelled flooding in the watercourse and surrounds. BMT WBM (2011) states changes to flood levels as a result of an open-closed entrance condition were predicted to alleviate peak flood levels by 100 mm to 200 mm when compared to the closed entrance condition. Conservative estimates of peak flood levels (i.e. predicted under closed entrance conditions) have previously been adopted for flooding planning purposes. The Flood planning levels utilised in the PMHC LEP 2011 are provided in *Figure 13* and *14*, overlayed with the location of sewerage infrastructure.

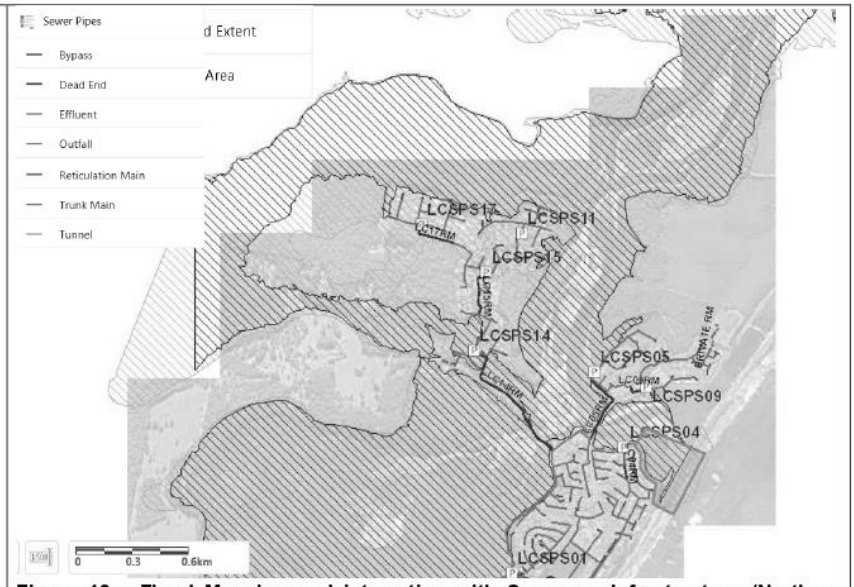


Figure 13 - Flood Mapping and interaction with Sewerage Infrastructure (Northern Portion)

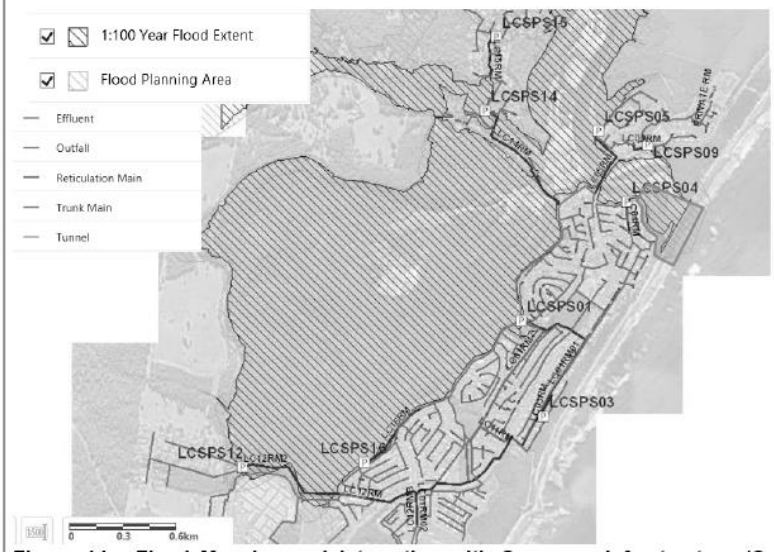


Figure 14 - Flood Mapping and interaction with Sewerage Infrastructure (Southern Portion)

Ecology

Lake Cathie is part of a greater estuarine system which connects Lake Cathie and Lake Innes. The features which form this system are:

- Lake Innes
- Lake Cathie
- Cathie Creek
- Innes Swamp
- Lighthouse/Rainbow Beach
- Small tributary streams

Lake Innes, Lake Cathie and Innes Swamp are back beach lagoon formations which are interconnected by Cathie Creek. Cathie Creek enters the ocean through Lighthouse/Rainbow Beach at the village of Lake Cathie.

Lake Cathie is a very shallow estuary with most of the bed above zero AHD. At 0.75m AHD the waterway area of the lake increases to nearly 100ha. The Lake has extensive mud flat areas

		and fringing vegetation of saltmarsh, sedges, reeds and paperbarks. Much of the area beyond the fringing vegetation has been cleared for residential/rural development. The fish and benthos of Lake Cathie are estuarine, and species distribution and abundance fluctuate rapidly in response to seasonal temperature variations, depths and salinity levels. Wading birds utilise shoals and shallows exposed during periods of low water level. Lake Cathie is joined to Cathie Creek by a narrow channel which is crossed by the Kenwood Drive Bridge. The waterway area under the bridge is limited by the width of the opening and heavy armour stones across the bed. The channel opening restricts flow and limits the response of Lake Cathie to water level variations in Cathie Creek, under both tide and flood conditions. Lake Innes is a long shallow water body. Depending on conditions at the entrance and the volume of catchment runoff, the lake level varies from below mean sea level (0 AHD) up to +2.5m AHD. The 'average' lake level is around +.75m AHD at which the average depth is less than 1.5m and the waterway area is approximately 700ha. Lake Innes was a freshwater lake until recent history. Lake Innes was joined with Lake Cathie in 1931 when an approximately 2m wide and 0.3m deep drain was built between Lake Innes and Cathie Creek. Outflowing of waters and subsequent tides and floods have increased the drain to a size greater than 30m wide and 3m deep. The introduction of saline water and tidal water variations has resulted in extensive changes to the biology of the Lake, including the loss of most of the original freshwater habitat and much of the freshwater avifauna. In average rainfall years the lake is an established estuarine system, with extensive brackish water sedge lands, seasonal seagrass meadows and intertidal saltmarsh areas. The benthic flora, fauna and fish populations are now completely estuarine and species distribution and abundance fluctuate in response to seasonal temperature variations, salinity fluctuations and entrance conditions. Distribution and abundance of three aquatic angiosperms, *Zostera capricorni, Ruppia maritima* and *Halophila sp.* which are important food items for some aquatic birds, fluctuate in response to salinity variations. Seasonally, wading birds utilise shoals and shallows exposed during periods of low water level. Remnant areas of freshwater species are still present around the lake margin. In 2018/2019 NSW suffered through an extensive drought. This left Lake Cathie and Lake Innes devoid of almost any water. The ongoing drought conditions produced one of the lowest annual rainfall totals since 1885 during those 12 months. A total of 760mm of rainfall was recorded in comparison to the long term of average of 1529mm. This resulted in lake water levels to continue to fall. In June water levels were at -0.194m AHD, falling on an average rate of approximately 3cm per month from 1st March 2019 (Aaso, 2019). During this record drought the sand berm has built up significantly, meaning that overtopping of the berm and a natural opening of the lagoon may be further delayed. This further delay exacerbates the risk of not opening the lagoon artificially since more water will be able to fill and spill in the lagoon catchment area before a natural opening occurs putting infrastructure at risk including sewer infrastructure. In March 2020 rainfall began to increase rapidly in the Lake Cathie region. As of April 18th, 2020 the lake level of Lake Cathie had risen up to 1.507 at its peak. This increase in water levels occurred over a less than a month and thus created a flooding risk to private and public infrastructure. During this time, extensive water quality monitoring was also being undertaken. The data exemplifies a decrease in salinity, a decrease in dissolved oxygen and an increase in the algae levels in the lake. There is also concern of debris and sediment entering the system due to runoff after extensive bushfires in the area. **Fish Habitat** The proposed activity area and associated watercourse is key fish habitat (see *Figure 15*). The proposed activity would most suitably be classed as Type 2 - Moderately sensitive key fish habitat, due to the area being an ICOLL that has been subject to previous artificial openings. The upper reaches of the water course would likely be Highly sensitive key fish habitat due to the presence of large areas of coastal saltmarsh and coastal wetlands.

DE299

Figure 15- Key Fish Habitat Mapping

The Fisheries NSW Spatial Data Portal (https://webmap.industry.nsw.gov.au/Html5Viewer/index.html?viewer=Fisheries_Data_Portal) was reviewed and identified the following:

- The freshwater fish community status of the Cowarra Creek and Karikeree Creek as fair and the Cathie Creek and Lake Innes as good.
- Estuarine Macrophytes include Saltmarsh, though only in locations west of the Ocean Drive Bridge. The proposed activity will be undertaken in a location where no estuarine macrophytes are currently mapped.
- The Southern Purple Spotted Gudegeon (freshwater fish) is present in upper reaches of Cowarra Creek (see *Figure 16*). This species is endangered in NSW (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf).

Figure 16 - Location of the Threatened Purple Spotted Gudgeon.

DPI (Fisheries) (n.d) states the following with regard to artificial openings and fish stocks within:

Estuarine fish are adapted to the varying conditions experienced in ICOLLs, such as changing water levels and salinity. They can survive for many years in closed ICOLLs without the need for the entrance to be open to maintain fish stocks. Decomposition of exposed aquatic vegetation can also result in deoxygenation of the water column (low dissolved oxygen (DO), which can lead to the death of fish from suffocation (i.e. fish kills).

Under natural conditions, closed ICOLLs break out over a relatively wide range of water levels which is termed the 'natural breakout range'. An occasional artificial opening of the entrance within this range is not likely to have a significant environmental impact since it falls within the expected natural variation. However, over the longer term, numerous artificial openings especially at a low water level is likely to have a significant environmental impact since the natural frequency and duration of opening and closing to the ocean will be significantly altered.

In the short term, more frequent openings can lead to increased exposure and death of aquatic vegetation and increased risk of low dissolved oxygen and incidence of fish kills. Over the long term, more frequent openings will lead to shifts in the structure and distribution of fringing riparian vegetation communities.

A test of significance of the project impacts on the Threatened Purple Spotted Gudgeon as required by the Fisheries Management Act (1994) is provided in *Appendix E*.

It is noted that commercial fishery licences apply to Lake Innes. These commercial operations have been subject to past natural and artificial lake openings.

No oyster growing or harvesting occurs within the system. Oyster leases are located within the Hastings River (and associated estuaries) to the North and the Camden Haven River (and associated estuaries). No impacts to these oyster leases will occur as a result of the proposed activity.

Previously Identified Threatened Flora Records

Bionet previously identified threatened flora records were sourced on the 18/04/2020 for Lake Cathie and surrounds (see *Figure 17*). No previously identified threatened flora was identified in the vicinity of the proposed activity, with the nearest threatened species being Native Guava (*Rhodomyrtus psidioides*) that is approximately one kilometre to the south of the Study Area. The Study Area is a deposited sand berm that has established since the last breach and opening of the lake to the Pacific Ocean. Review of aerial imagery (aerial from the 5 April 2020 provided in *Figure 18* below) and site walkover by Blayne West (Natural Resources Manager) on the 19 April 2020 has identified that limited vegetation is present in the area where the excavation works are proposed. The vegetation identified in the Study Area (including the access track at the northern end of Illaroo Road) inlcuded:

Native
Coastal Wattle (*Acacia longifolia subsp. sophorae*)
Beach Spinifex (*Spinifex sericeus*)
Sesuvium portulacastrum

Non-Native
Bitou Bush (*Chrysanthemoides monilifera subsp. rotundata (DC.) Norl.*);
Rambling Dock (*Acetosa sagittata*);
Coastal Morning Glory (*Ipomoea cairica*);
Largeleaf Pennywort (*Hydrocotyle bonariensis*);
Gazania rigens
American Sea Rocket *(Cakile edentula)*
Couch sp.

Photographs 2 and 3 demonstrate the vegetation in the proposed Study Area.

Photograph 2- Vegetation present within the Proposed Channel location

DE299

Photograph 3 - Vegetation present within the access location at the northern end of Illaroo Road

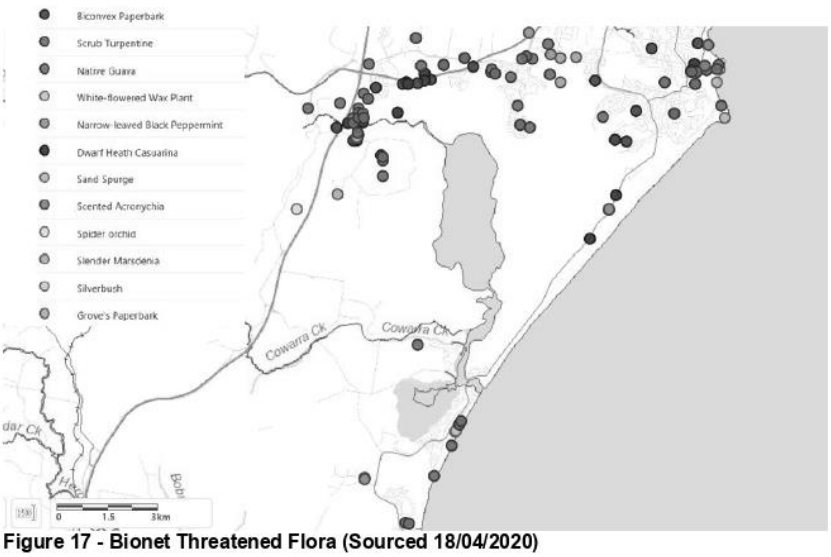


Figure 17 - Bionet Threatened Flora (Sourced 18/04/2020)

Figure 18- Aerial image of the sand berm, taken 5 April 2020 (source Nearmaps, 18/04/2020 - http://maps.au.nearmap.com/).

Previously Identified Threatened Fauna Records

Bionet previously identified threatened fauna records were sourced on the 18/04/2020 for Lake Cathie and surrounds, as shown in *Figure 19*.

The circular symbol in the middle of the study area and on land to the north of the study area are records of a Hawksbill Turtles (*Eretmochelys imbricata*) sighting. Both records indicate that the turtles seen were suffering from health issues. The ocean based record was a passing Southern Right Whale (*Eubalaena australis*) with calf. The closest circular symbol records are threatened bird species. The transient nature of Threatened bird species (that do not habit or nest within sand berms) will not be impacted by the works, given that the noise and activity will act as a deterrent from being in the study area during the proposed activity.

The majority of terrestrial/arboreal threatened fauna records adjacent to and within the study area are Koala (*Phascolarctos cinereus*) sightings. The transient nature of Koala's and there nature to predominately habit eucalyptus sp. Trees will allow for them to be avoided during the proposed activity, as the works are based within the sand berm and no vegetation removal is required.

Prior to activities commencing the study area and adjacent watercourse will be visually surveyed to identify the presence of any fauna. Should fauna be present works will cease until the fauna leaves of its own volition or appropriately trained handlers, such as FAWNA (contactable on 6581 4141) relocate the animal from the area. Untrained staff are not to interact with fauna.

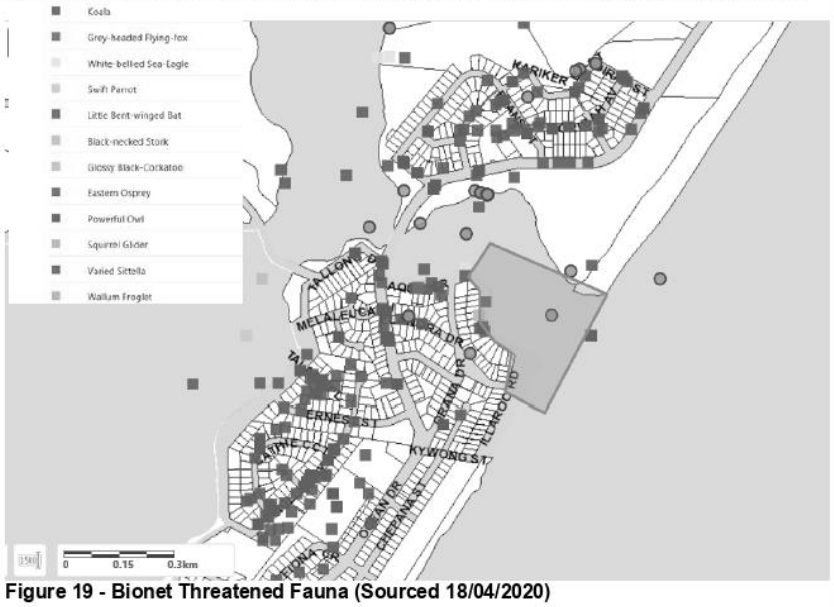


Figure 19 - Bionet Threatened Fauna (Sourced 18/04/2020)

Vegetation

No vegetation removal is proposed to allow the commencement of the proposed activity.

Endangered Ecological Communities (EEC)

The nearest EEC's are outside of the work zone, however will be demonstrated to contractors to ensure they remain undisturbed are shown in *Figure 20*. The closest EEC is the Broad-leaved Paperbark - Forest Red-Gum Swamp Forest at the northern most point of Bundella Avenue's creek side road reserve. No works are proposed in this location and no vegetation is to be removed during the works. Other EECs do fringe the watercourse edges, as shown in *Figure 20*. The artificial opening of the lake replicates opening during natural cycles, and it is considered that impacts will not be significant given that vegetation present is resilient and adapted to the dynamic nature of an ICOLL and the associated fluctuating water quality and water levels. *Appendix E* carries provides a 5-part test for the EEC's indirectly influenced by the proposed activity.

Figure 20 - Endangered Ecological Communities in the vicinity of the Study Area.

SEPP Coastal Management (2018) Mapped Littoral Rainforest and Coastal Wetland

The Study Area and proposed activity will be contained to an area outside of mapped Littoral Rainforest and Coastal Wetland (see *Figure 21*). The proposed activity will replicate a natural lake opening event, and will alter the hydrology water quality (mainly salinity) within the mapped coastal wetlands upstream and to the west of the Ocean Drive Bridge. The replication of the natural event is considered within the natural fluctuation range that these species are tolerant to, given that they inhabit this dynamic ecosystem and hydrological regime.

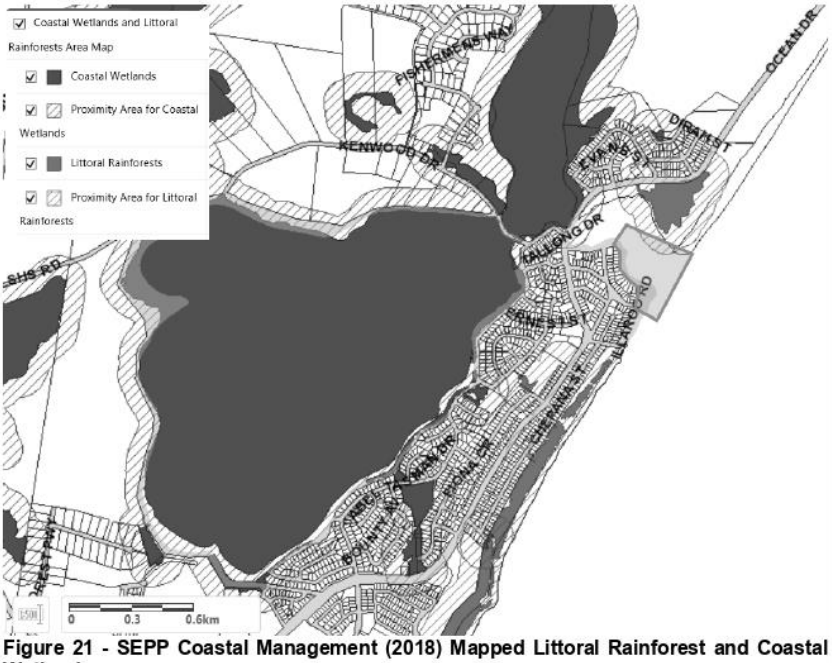


Figure 21 - SEPP Coastal Management (2018) Mapped Littoral Rainforest and Coastal Wetland

Koala Habitat

The proposed activity will not require the removal of any vegetation. Review of the PMHC geocortex mapping system identified that the proposed activity will not occur near core Koala Habitat; or an existing Koala Plan of Management.

Waterbirds

This REF has relied on the assessment conducted on waterbirds by ARS (2013). This report is provided in *Appendix D*. While the report was based on the proposal to revert Lake Innes back to freshwater, sufficient detail is provided to determine likelihood of occurrence, and the potential impacts of the proposed activity. Some of these species have been specifically identified in correspondence from the BCD as requiring an assessment to determine the potential impact posed by the proposed activity, These species are included in the list provided below. The 5-part tests of significance for threatened waterbird species likely to occur in the locality are provided after Table 4A.

Potential Impacts

The following threatened species and EEC's have been assessed using the five part test for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats:

- Native Guava (*Rhodomyrtus psidioides*)
- Hawksbill Turtle (*Eretmochelys imbricata*)
- Koala (*Phascolarctos cinereus)*
- Grey Headed Flying Fox *(Pteropus poliocephalus)*
- Pied Oyster Catcher (*Haematopus longirostris)*
- Eastern Osprey (*Pandion cristatus*)
- Beach Stone Curlew *(Esacus magnirostris*)
- Rose-crowned fruit-dove (*Ptilinopus regina*)
- Black-necked Stork (*Ephippiorhynchus asiaticus*)
- Australasian Bittern (*Botaurus poiciloptilus*)
- Eastern Grass Owl (*Tyto longimembris*)
- Wallum Froglet (*Crinia tinnula*)
- White-bellied Sea Eagle (*Haliaeetus leucogaster*)
- Varied Sitella (*Daphoenositta chrysoptera*)
- Green and Gold Bell Frog (*Litoria aurea*)
- EEC's - (Coastal wetlands mapped in SEPP Coastal Management (2018))
- Migratory Species (EPBC Act, CAMBA, JAMBA and ROKAMBA species)

These five-part tests are provided in Appendix E.

Heritage

Existing environment

Review of the Port Macquarie Local Environment Plan (LEP) (2011) identifies that there are no previously identified non-Aboriginal heritage items in the study area and surrounds. The closest previously identified non-Aboriginal heritage item is located to the north. The site is the Lake Innes House Ruins. This site is the closest listed item in the NSW State heritage register.

A search of the NSW DPiE Aboriginal Heritage Information Management System (AHIMS) was undertaken on the 9 April 2020. No previously identified Aboriginal sites or places were recorded in the location of the proposed activities. The AHIMS search results are provided in *Appendix G*. Site investigations for a Council project at the southern end of Illaroo Road (in the vicinity of the works) identified suspected midden heaps that are currently being investigated for cultural significance. The midden heaps are outside of the Study Area required to undertake the proposed activities.

Potential Impacts

No impacts to the nearest non-aboriginal heritage item (Lake Innes House Ruins) will occur as a result of the proposed activity. The site is greater than 3km from the area of the proposed activity.

A due diligence approach was undertaken in accordance with '*Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*' (DECCW, 2010). The due diligence process steps are outlined in *Table T2* below

Table T2 - Due diligence assessment for aboriginal cultural heritage potential

Due diligence steps	Response with regard to proposed activity
Step 1) Will the activity disturb the ground surface or any culturally modified trees?	No vegetation is present on the sand berm. Hence there is no possibility for culturally modified trees to exist on the site. The activity will disturb the grounds surface. The proposed activity will occur on the sand berm that has developed in the recent past, since the last opening of Lake Cathie (last aerial image recording a lake opening in July 2018). The dynamic nature of the accumulated sand that has been deposited in the past 18 months also limits the opportunity for aboriginal heritage items to be present.
2. Are there any: a) relevant confirmed site records or other associated landscape feature information on AHIMS? and/or b) any other sources of information of which a person is already aware? and/or c) landscape features that are likely to indicate presence of Aboriginal objects?	2 a) A search of the AHIMS register was undertaken on the 9 April 2020. No previously identified Aboriginal cultural heritage sites or places were recorded in the location of the proposed activities. The AHIMS search results are provided in *Appendix G*. DECCW (2010) states: *Aboriginal objects are often associated with particular landscape features as a result of Aboriginal people's use of those features in their everyday lives and for traditional cultural activities. Examples of such landscape features are rock shelters, sand dunes, waterways, waterholes and wetlands. Therefore it is essential to determine whether the site contains landscape features that indicate the likely existence of Aboriginal objects.* *Consequently, if your proposed activity is:* • *within 200m of waters, or* • *located within a sand dune system, or* • *located on a ridge top, ridge line or headland, or* • *located within 200m below or above a cliff face, or* • *within 20m of or in a cave, rock shelter, or a cave mouth* *and is on land that is not disturbed land* The study area is within 200m of waters and a sand berm. However the transitional and dynamic nature of the sand berm that establishes at the entrance of the ICOLL, has only been present for a short period of time and thus the opportunity for deposition of cultural heritage items has not existed. The locality has also previously been subject to natural removal of deposited sand and since the time of European settlement, artificial openings. For these reasons the study area is considered 'disturbed' with a very low probability of containing a cultural heritage item. 2 b) As outlined above, the recently discovered midden at the southern end of Illaroo Road is clear of the proposed works extent (including access point). DECCW (2010) states:

	If after completing steps 2a and 2b it is reasonable to conclude that there are no known Aboriginal objects or a low probability of objects occurring in the area of the proposed activity, you can proceed with caution without applying for an AHIP. Based on the aforementioned information it is considered reasonable to proceed with caution.

Should any unexpected relics be disturbed during excavation of the site they must be managed under the archaeological provisions of the NSW Heritage Act (essentially, works are to immediately cease on suspicion of heritage find and experts engaged to advise pathway for management).

Noise

Existing environment

Collection of existing ambient background noise levels were not collected as part of this assessment. The ambient noise environment of the study area could be qualitatively characterised as:

- Generally low background noise levels;
- Reflective of the location as a small coastal hamlet; and
- typically be influenced by ocean generated noise, road noise (the main contributor being the main thoroughfare of Ocean Drive) and environmental noise such as birds, insects and the like.

No significant noise sources (such as industry, rail or agricultural processes) are present in the locality.

In the absence of site specific background noise levels, a conservative rating background level of 35 decibels Db(A) is applicable for the site. A Highly Noise Affected Management Level (HNML) would apply at residential receptors, at a fixed value of 75 dB(A).

Potential Impacts

The primary noise issue associated with the proposed activity is the construction noise emissions attributed to operation of earthmoving equipment. Upon opening of the Lake, the equipment will leave site and no further noise impacts associated with the proposed activity that would cause nuisance are forecast to occur.

The earthmoving activities are predicted to be completed in less than 5 days. Thus any associated noise impacts will be short term and will not be persistent in the location.

The nearest receptors to the south are greater than 100m from the Study Area.

Works are likely to comprise the use of excavators and a bulldozer. Less equipment will simply take longer for the channel to be excavated. Should all the proposed earthmoving equipment be used to undertake the works, the cumulative noise caused will be counteracted by the works being completed in a reduced timeframe.

The implementation of the industry standard mitigation measures will manage construction noise generated by the proposed activity to the greatest extent practicable and are anticipated to result in compliance with the HNML and thus have limited impact on residential receptors.

The works will be contained to prevent the interaction of members of the public occupying the beach and pedestrian foot traffic interacting with the earth moving equipment. The separation distance provided by the containment measure will provide a measure of noise protection.

Road Traffic Noise

Road traffic noise associated with the project will be limited. Contribution to road traffic noise will include the transportation of earthmoving equipment to the site via float. Float movements will be limited to the commencement and cessation of works. Light vehicle movements of earthmoving equipment operator/s, and potentially a supervisor, will be required each day for the duration of the works. The limited duration of the works and limited number of movements required will have a negligible impact on existing road traffic noise.

Mitigation Measures are provided in Table 4.

Air Quality

Existing environment

The existing environment is reflective of the locality as a small coastal hamlet that is border to the east by the Pacific Ocean and predominately surrounded by National Parks and Conservation Areas to the north and west. The village of Bonny Hills and Rural residential land

is located to the south. Ocean Drive is the main thoroughfare in the town and conveys traffic from Port Macquarie in the north through to Lake Cathie and the villages of Bonny Hills, Dunbogan, North Haven and Laurieton to the south. General air quality is expected to good, with the key contribution to air quality issues limited to the vehicle emissions from traffic.

Potential Impacts

Negligible impacts to air quality are expected as a result of the proposed activity. Construction impacts are where impacts are most likely, to be caused by:

- Fugitive emissions from hydrocarbon driven construction equipment; and
- Limited dust generation from earthmoving activities.

Any potential impacts will be short term, limited to the duration of the earthworks activities.

The nearest receptors to the south are greater than 100m from the study area.

The DPI (Fisheries) website (https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw) states that odour issues can arise from artificial opening of ICOLLs due to a rapid lowering of the water level and the exposure of extensive areas of sediment and aquatic vegetation such as seagrass and algae. Exposure of sediments to the air and the death of aquatic vegetation can lead to the release of hydrogen sulphide (rotten egg gas) and other foul smelling gases. This may generate odour complaints from residents and visitors occupying locations adjacent to the Lake. The potential for odour issues are considered to be an acceptable impact to avoid potential contamination issues due to interaction off sewage with the lake from flooding of sewerage infrastructure. The artificial opening is to replicate a natural opening that would occur when water levels are high, and hence any associated odour impact would also have the potential to occur with an artificial opening.

Mitigation Measures are provided in Table 4.

Soil

Existing environment

The physiochemical conditions of both Lake Cathie and Lake Innes are governed by the interplay of rainfall, seasons, and the timing of lake opening events (Creighton, 1983). In times of high rainfall, the lake system fills up to a maximum level of 1.6m AHD before being artificially opened to the sea to drain. During a lake filling stage, both lakes transition from saline to brackish / freshwater conditions. When drought conditions proceed a lake opening event, ingressed seawater into the lakes evaporate, forming hypersaline conditions and often elevated water temperatures. During these periods of low water levels, Lake Innes experiences elevated levels of turbidity from the churning up of bed sediments associated with wind / wave action. In extreme cases, as in the case of the post July 2018 lake opening event, water levels can drop below - 0.1m AHD resulting in the complete desiccation Lake Cathie west of Kenwood Drive Bridge and water depths dropping to 0.1 to 0.5m deep in Lake Innes.

Figure 22- Acid Sulfate Soil (ASS) mapping from PMHC LEP 2011

During the 14 months preceding this REF there was unprecedented drought in NSW. The water in the estuary reduced dramatically resulting in the exposure of approximately 900ha and 170ha

of lakebed sediments in Lake Innes and Lake Cathie respectively. These exposed lake beds contain varying concentrations of Acid Sulphate Soil (ASS) materials. When exposed to oxygen, these ASS materials have the potential to generate sulphuric acid and metal leachate by-products within the pore waters of the lakebed sediments. This acidic water can impact on fish and benthic lake organisms through the directly toxicity of aluminium-rich, acid waters (Sammut, 2016) and the smothering of lakebed sediments with ferrous oxides (Johnston, S. Morgan, B., Burton E.D. , 2016)

There is still a large amount of unknown impacts of ASS. This is based on historical data gathered and reported through the Lake Cathie and Lake Innes Acid Sulphate Soil Risk Assessment (Aaso, 2019). It is hypothesized that rapid acidification of Monosulfidic Black Oozes (MBOs) is likely to occur after every lake opening event. It is also important to note that MBO-derived acidity is readily neutralised in the water body as carbonate levels increase with the ingress of seawater on flood tides during lake entrance opening periods.

Acid sulphate will have differing impacts based on the time-lapse. Immediately after opening acid discharge events are likely to be relatively benign, short lived and restricted close to source discharge points (Aaso, 2019). But they are also likely to have secondary long-lasting effects to the lake aquatic ecosystem, long after pH levels recover. More studies need to be completed to understand this issue. It is reiterated that the opening of the Lake when significant water volume has built up behind the berm is considered likely to be reflective of the natural occurrence whereby the lake opens without interference. The very nature of the ICOLL is dynamic and high water level openings are as close as possible to reflecting natural opening occurrences. The associated fluctuations of water levels and water quality are also considered highly likely to be within the ranges of a natural opening and are preferential to the introduction of sewage if said infrastructure was to be flooded.

PMHC is of the understanding that there is an imminent need to reduce risk of sewage contamination and consequent water quality issues due to clouding of infrastructure. Although there is a risk of acid sulphate discharge negatively impacting on the overall water quality and fish health within the estuary, given the historical fish kills (within the last 12 months between 2019 and early 2020) and the overall reduced water quality health (as outlined in section 1.4) the consequence of this risk is considered less of an impact. Though it is also recognized that future mitigation strategies that are more robust must be put in place to ensure the estuary health effectively managed. Therefore to better inform decision making and longer-term management of the estuary PMHC is undertaking the following:

- Studies of the acid sulphate soils in Lake Innes to better understand discharge models and lasting impacts, including soil samples and continued water quality monitoring.
- Investigations into reversion of Lake Innes to freshwater which will also block the flow between Lake Cathie and Lake Innes to reduce impact on the full estuarine system.

Contaminated Land

The proposed works are not located within previously identified contaminated land maps within PMHC Geocortex mapping system, as shown in *Figure 23*. Excavation will be limited to the sand berm that has accumulated the past 18 months. Contamination of the naturally established berm is highly unlikely.

Figure 23 - Previously identified contaminated site in the locality

The works are adjacent to asbestos on the bank and foreshore of Lake Cathie on Bundella Avenue, but this area will not be disturbed by the proposed activity or by the earthmoving equipment gaining access to the sand berm from the public road network. Works to remove the asbestos from the foreshore at Bundella Avenue, associated with the Illaroo stormwater project are underway and are scheduled for possible commencement in 2020/21. The location of the contamination is demonstrated in *Figure 24*.

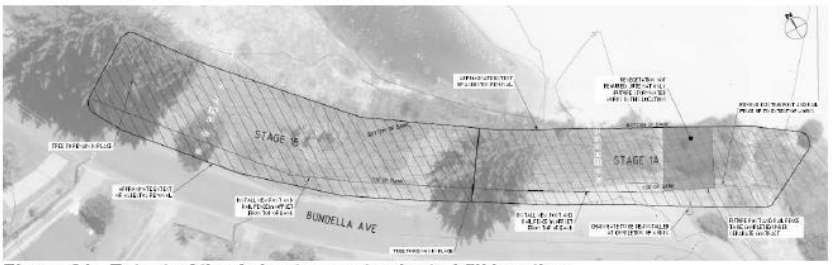


Figure 24 - Extent of the Asbestos contaminated fill location

Naturally Occurring Asbestos

The proposed works are not within an area of naturally occurring asbestos as mapped within the PMHC Geocortex mapping system, as shown in *Figure 25*. Excavation will be limited to the sand berm that has accumulated the past 18 months.

Figure 25 - Naturally Occurring Asbestos in the Locality

Erosion Potential

The Proposed activity is within a location mapped as moderate soil loss potential (See *Figure 26*). The works will predominately be the excavation of marine sands. As marine sands are at the coarser end of the Particle Size Distribution for aggregates (GHD 2004 undertook sampling and characterised the sand as medium grained, with little to no fine material), and the potential for fines is considered to be low, the potential for sediment generation is predicted to be low. The excavation will be subject to salt water intrusion, salt water is a natural flocculant and will assist with the settlement of any entrained fine grained that may be entrained during the conveyance of water through the excavated channel.

Figure 26 - Soil Erosion Potential

To mitigate against any sedimentation issues, the excavation of the last section of the crest ('daylighting' the channel) is to occur when water in the channel has had settlement time for any accumulated sediment in the water column, generated by previous excavation. Floating silt curtain will not be functional and its use is not recommended.

Traffic

Traffic associated with the project will be limited and will include:

- transportation of earthmoving equipment to the site via float (at the commencement and cessation of works);
- light vehicle movements of earthmoving equipment operator/s, and potentially a supervisor (each day for the duration of the works).

The limited duration of the works and limited number of movements required will have a negligible impact on existing traffic conditions within the locality.

Existing sealed car-parking areas will be utilised to accommodate construction vehicles.

The existing road network is considered suitable to accommodate the traffic generated by the proposed activity.

Land use

The proposed activity will result in a channel that will likely prevent pedestrian access to that portion of the beach. This is considered to replicate a natural event, and there has been numerous circumstances where this condition has been present at the beach.

The management of the ICOLL Lake Cathie is a contentious topic. Department of Primary Industries (Fisheries) state the following with regard to management of ICOLLs:

- Any proposals for artificial opening of ICOLLs must seek the approval or concurrence of I&I NSW under the Fisheries Management Act 1994;
- The Department supports minimal interference with ICOLL entrance barriers and advocates natural processes being allowed to operate to the greatest extent possible;
- The Department does not support the artificial opening of an ICOLL unless the proponent (i.e. Council or other agency) can demonstrate that the social, environmental and economic benefits greatly outweigh any potential adverse impacts; and
- The Department supports using estuary management plans and environmental assessment processes to analyse the issues relating to opening a particular ICOLL, and to develop an entrance management plan or entrance management policy. Proposals for artificial openings which are to be carried out according to a formulated entrance management plan or policy are more likely to be approved by I&I NSW.

Local community groups advocate for the best practice management of the estuarine system. The opening of the Lake to prevent contamination from sewage due to inundation because of rising water levels is the best form of management for the estuarine system and thus the majority of stakeholders are likely to be amenable to this reasonable course of action.

The opening of the Lake to ameliorate flooding impacts in the broader catchment will allow for land use to remain as normal, eliminating loss of function that may be caused by flooding. This may include the loss of functional private and public assets, including footpaths, park areas, portions of landowners lots, stormwater channels, boat ramps, and portions of the road network.

Estuary Use

Downstream of the Ocean Drive Bridge, the community utilise the watercourse for water based recreation including swimming, paddle boarding canoeing and fishing activities (WBM WMT 2011). The reserve in the area has facilities such as barbecues, undercover seating areas, formalised sealed carparking, public amenities and a playground. Consequently, this is the most intensively used area of the watercourse.

Upstream of the Ocean Drive Bridge, the watercourse is under the tenure of National Parks and Wildlife Services (the area is subject to a Plan of Management) and is predominately used for: recreational and commercial fishing, bushwalking, birdwatching and water based recreation such as canoeing. Use by members of the public is noted to be less intensive upstream (west) of the bridge.

Anecdotal evidence suggest that there is a community held assumption that when the lake is open water quality is 'improved', potentially due to the flushing of tannins that collect during closed conditions. As such, without significant impacts on water levels, it is predicted that impacts to the use of the estuary will not be negatively impacted.

Visual Amenity

The proposed activity will replicate a naturally occurring event. The opening of the Lake will ultimately close again following natural sand accumulation processes. The visual aesthetic of location is dynamic, subject to natural process of sand accumulation and breaches of the sand berm, that will be replicated by the proposed activity.

The temporary and short term presence of earth working equipment will have a negative impact during the excavation activities, however on the whole the visual impact of the lake opening is considered to be low.

Bushfire:

Comparison of the study area with bushfire prone land mapping demonstrates that the location is within the vegetation buffer/no rating area (See *Figure 27*). The works will not be undertaken within an Asset Protection Zone.

Figure 27 - Bushfire prone land mapping in the locality

The works will occur wholly within the accumulated sand berm that is void of vegetation, hence there will be no increase in bushfire potential within the Study Area as a consequence of the works.

Cumulative impacts

PMHC is aware that the entrance compartment after successive artificial openings over time will clog with sand which will consequently reduce the tidal prism and weaken the potential for the ICOLL to flush. Therefore, it has been Council's preference to open the lake when or above the adopted 1.6m trigger. Between 1992 when the first record was kept and 2017 (as per below data set) the lake has been artificially opened by Council 15 times with 4 of those below the 1.6m trigger. In addition the entrance has been opened by community members twice, naturally twice and unknown method once. This is a total of 20 openings over 28 years. Available records for previous opening events are provided in *Table T2*.

Table T3 - Previous Opening Events

Date	Action/ Event	Lake Level At Opening	Comments
1-Apr-92	Unknown method of opening	Unknown	
5-Jul-96	Artificial entrance opening by Council	1.76	
29-Aug-96	Lake closed naturally	---	Open for 4 months
1-Mar-97	Artificial entrance opening by Council	Unknown	
1-Sep-97	Lake Closed Naturally	---	Open for 6 months
10-Jun-98	Artificial entrance opening by Council	1.55	
Unknown	Lake Closed Naturally	---	
7-Apr-99	Opened by residents/natural causes	1.47	
Unknown	Lake Closed Naturally	---	
24-May-00	Unsuccessful attempt by unknown individuals to manually open Lake	Unknown	
14-Dec-00	Artificial entrance opening by Council	1.274	
Unknown	Lake Closed Naturally	---	
19-Jun-01	Unsuccessful attempt by unknown individuals to manually open Lake	1.426	
20-Apr-02	Artificial entrance opening by Council	1.573	Open for 3 months
2-Sep-02	Lake Closed Naturally	---	
27-May-03	Artificial entrance opening by Council	1.7	
28-Feb-04	Lake Closed Naturally	---	Open for 9 months
9-Nov-04	Artificial entrance opening by Council	1.6	
26-Feb-05	Lake Closed Naturally	---	Open for 4 months
30-Jun-05	Artificial entrance opening by Council	1.6	
4-Nov-05	Lake Closed Naturally	---	Open for 4 months
10-Nov-05	Lake Opened Naturally	---	Date approximate
1-Mar-06	Lake Closed Naturally	---	Open for 4 months
1-Mar-07	Unsuccesful attempt by unknown individuals to manually open Lake	1.4	
21-Jul-07	Artificial entrance opening by Council	1.65	
14-Mar-08	Lake Closed Naturally	---	Open for 7 months
30-May-08	Artificial entrance opening by Council	1.7	
20-Aug-08	Lake Closed Naturally	---	Open for 3 months
18-Feb-09	Artificial entrance opening by Council	1.8	
1-Oct-09	Lake Closed Naturally	---	Open for 8 months
20-Apr-11	Artificial entrance opening by Council	1.35	Berm height +2.0mAHD, width double previous opening. Lake opened too low due to error with MHL gauge.
1-Jun-11	Lake Closed Naturally	---	Open for 1.5 months
20-Jun-11	Artificial entrance opening by Council	1.75	
1-May-12	Lake Closed Naturally	---	Open for 11 months
22-Aug-12	Artificial entrance opening by Council	1.6	

1-Oct-12	Lake Closed Naturally	---	Open for 2 months
24-Feb-13	Lake Opened Naturally	2.1	Opened as a result of flooding occurring as a result of East Coast Low. Reservations held on whether this was a natural opening.
3-Mar-14	Lake Closed Naturally	---	Open for 12 months
25-Mar-15	Artificial entrance opening by Council	1.79	Dredging of lower lake and Illaroo dune renourished prior to this opening
8-Jul-15	Lake Closed Naturally	---	Open for 3 months
5-Jan-15	Successful attempt by unknown individuals to manually open Lake	1.8	Shallow channel opened by unknown individuals at northern side of entrance.
20-Sep-17	Lake Closed Naturally	---	Open for 2 years 9 months. Considerable erosion of foreshore reserve on northern side of Cathie Creek during this time.

Council is currently undertaking and developing the mitigation actions listed in *Table T3* as part of the Coastal Management Plan (CMP) for Lake Cathie/Rainbow Beach estuary specifically to ensure that Lake Cathie ICOLL is artificially opened only at the optimum conditions. These conditions will achieve a balance of reducing impact present and the ecological conditions.

Table T4 - Lake Cathie/Rainbow Beach Proposed Coastal Management Plan Mitigation Actions

Action	Timeline
Continued record keeping of lake opening dates, means of opening and duration of opening	Current and ongoing
Development of the Standard Operating Procedure for Lake Cathie	April 2020
Ongoing water quality data collection	Current and ongoing
Acid sulphate digestion model for Lake Innes	July 1 2020 - June 30 2021
Further investigate the possibility of reversion of Lake Innes.	July 1 2020 - June 30 2021
Condition assessment of saltmarsh of Lake Innes	July 1 2020 - June 30 2021
Ecological inventory of Lake Cathie with a focus on riparian edges of Lake Cathie	July 1 2020 - June 30 2021
Review of Lake Cathie entrance management plan with a focus on identifying impacted infrastructure and optimal water levels for riparian vegetation.	July 1 2020 - June 30 2021
Water quality studies which provide detailed guidance on point and non-point source pollution points, recommended management actions and responsible tenure.	July 1 2020 - June 30 2021

Monitoring

Currently a water quality monitoring program is undertaken at Lake Cathie. The samples are collected and analysed by staff of the PMHC NATA Accredited Laboratory. Water samples are collected at three locations, namely:

- Lake Cathie Playground;
- Perch Hole Reserve; and
- Lake Cathie Bridge.

Concentrations of the following analytes are derived:

- Enterococci (laboratory measurements);
- pH (field and laboratory measurements);
- Electrical Conductivity (field and laboratory measurements);
- Salinity (field measurement);
- Dissolved Oxygen (field measurement); and
- Temperature (field measurement).

Monitoring was undertaken on a weekly basis between 30 January 2019 and 16 July 2019. Monthly monitoring has been undertaken between 6 August 2018 through to 2 July 2019. Turbidity and true colour were collected during monthly sampling events.

The analytes above will continue to be tested on a monthly basis into the future, and therefore following any opening.

		The Manly Hydraulics water gauge provides 15 minute readings of water levels. The gauge will continue to operate following the proposed activity and provide on-going water level height data. The primary objective of the proposed activity is to prevent flooding of the sewerage infrastructure; hence the water level gauge will be vital to demonstrate that the objective has been achieved. A contingency is available should the manly hydraulics gauge fail, in the form of the flood sign gauge that is attached to the underside of the bridge. While less accurate this can effectively be used to monitor water levels.
1.5	Description of types and quantities of waste.	No waste will be generated by the proposed activity with excavated sand to be left on site. Sand to be excavated is Virgin Excavated Natural Material (VENM) as defined in the Protection of the Environment Operations Act 1997 (POEO Act) as: '*natural material (such as clay, gravel, sand, soil or rock fines):* *(a) that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities and* *(b) that does not contain any sulfidic ores or soils or any other waste and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.*' General solid waste generated by the consumables used by on-site staff will be retained and appropriately disposed of off-site. The limited duration of the works will not require establishment of waste collection receptacles.
1.6	Description of relevant Environmental Planning Instruments. (This could include LEPs, or SEPPs and if necessary, the relevant zoning, clause, provision or schedule)	**Commonwealth Legislation** Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act is the Australian Government's central piece of environmental legislation (http://www.environment.gov.au/epbc/about). The EPBC Act outlines proposed actions that have the potential to significantly impact on Matters of National Environmental Significance (MNES). The nine matters of national environmental significance (MNES) are: • world heritage properties • national heritage places • wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed) • nationally threatened species and ecological communities • migratory species • Commonwealth marine areas • the Great Barrier Reef Marine Park • nuclear actions (including uranium mining) • a water resource, in relation to coal seam gas development and large coal mining development (http://www.environment.gov.au/epbc/about). This REF will undertake an assessment to determine if the proposal, or action in the terms of the legislation, will significantly impact on or comprise one of the aforementioned matters. To assist with this determination the EPBC protected Matters Search tool was accessed on 9 April 2020. The results of the search are provided in Table 4a and *Appendix H*. The two relevant matters that require assessment are the nationally threatened species/ecological communities and migratory species. This is provided in the assessment. There is potential for the nationally threatened species/ecological communities and migratory species to be present on the site however the works are unlikely to impact on them, given the nature of the works replicating a natural occurrence and preventing more significant impacts if sewerage was to be introduced to the ICOLL. The lack of long-term negative impacts of the works on MNES precludes the requirement for referring the project to the Australia Government Department of Agriculture, Water and the Environment. **New South Wales State Legislation** **National Parks and Wildlife Act 1974 (NPW Act)** The NPW Act defines the powers, duties and functions of the NSW National Parks and Wildlife Service (NPWS) for: • National Parks; • Nature Reserves; • Historic sites; • Aboriginal areas. Guidance is provided within the Act for management of and conservation of native flora and fauna within the aforementioned locations.

The proposed activity will not occur within land reserved under the NPW Act. However are in an area adjoin the NPW Act reserved Lake Innes Nature Reserve and will temporarily influence the hydrology of the ICOLL in this reserve.

The principles within the NPWS 'Guidelines for developments adjoining land manager by the office of Environment and Heritage' have been applied to the assessment of environmental impacts of the proposed activity.

With regards to aboriginal cultural heritage, the process outlined in '*Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*' (DECCW, 2010) was followed.

Marine Estate Management Act 2014 (MEMA Act)

There are six marine parks in NSW (https://www.dpi.nsw.gov.au/fishing/marine-protected-areas/marine-parks). There are also 12 aquatic reserves regulated by the MEMA Act. The study area is not located within any of these marine estates or aquatic reserves. Under the MEMA Act, the *NSW Marine Estate Management Strategy 2018-2028* was developed. The underpinning principles for marine estate management have been used in guiding the action to be taken as part of the proposed activity. These principles are outlined below:

1. Effective community engagement to identify and prioritise benefits and threats
2. Identification of priority actions will be based on threat and risk assessment
3. Values will be assigned to enable trade-off decisions between alternative uses of the marine estate
4. Best available information will be used in trade-off decisions, but judgement will still be required
5. The wellbeing of future generations will be considered
6. Existing access arrangements will be respected
7. The precautionary principle will be applied
8. Efficient and cost-effective management to achieve community outcomes
9. Management decisions will be transparent and adjust in response to new information
10. Management performance will be measured, monitored and reported and information pursued to fill critical knowledge gaps.

Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the NSW planning and environmental assessment legislation that applies to the activity.

In accordance with Division 5.1 of the Act, the proposed works are considered an 'Activity', as it is 'the carrying out of a work' by a public authority and the works can be assessed under Part 5 of the Act.

Section 4.1 of the Act states that '*if an environmental planning instrument provides that specified development may be carried out without the need for development consent, a person may carry the development out, in accordance with the instrument, on land to which the provision applies*'

The ISEPP is such an environmental planning instrument and applies to the proposed works as described by the relevant clause discussed below.

Despite the proposed activity not requiring consent, there is a duty to consider environmental impact as required under Section 5.5. The determining authority must *examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*. This is undertaken within this Review of Environmental Factors (REF). Clause 228 of the *Environmental Planning and Assessment Regulation (2000)* includes a list of factors to be considered in determining the impacts of the proposed activity. These are addressed throughout this REF.

Should the REF identify a significant impact, an Environmental Impact Statement (EIS), or Species impact Statement (SIS) if the impact relates to a threatened flora or fauna species, is required as outlined in Section 5.7. The assessment provided in *Section 1.4* and *Appendices D* and *E*, have not identified a significant impact and as such an EIS is not required to allow for the legal permissibility of the proposed activity.

Biodiversity Conservation Act 2016 (BC Act)

The BC Act lists and protects threatened species, populations and ecological communities that are under threat of extinction in NSW. The NSW Office of Environment and Heritage (OEH) is responsible for administering the BC Act. Impacts to threatened species and endangered ecological communities listed under the BC Act are required to be assessed in accordance with Section 7.3 of the BC Act.

The EP&A Act states the following with regard to the BC Act:

Part 1, Section 1.7

This Act has effect subject to the provisions of Part 7 of the Biodiversity Conservation Act 2016 and Part 7A of the Fisheries Management Act 1994 that relate to the operation of this Act in connection with the terrestrial and aquatic environment.

Part 7 of the Act outlines the details of an Activity that are considered to be a significant impact, and the 'Test for determining whether proposed development or activity likely to significantly affect threatened species or ecological communities, or their habitats' (referred to as a 5-part test). These 5-part tests have been undertaken for the relevant threatened species.

Heritage Act 1977

The Heritage Act 1977 provides for the identification, registration and protection of non-Aboriginal heritage items or places of state significance. Searches of the following databases were undertaken:

- Australian Heritage Database,
- NSW State Heritage Register, and
- PMHC's Geocortex mapping database (that reflects the environmental heritage schedules of the Port Macquarie-Hastings LEP (Schedule 5).

The searches identified no registered or listed historical sites or items within the vicinity of the proposed activity. This is further discussed in *Section 1.4*.

Should any unexpected relics be disturbed during excavation of the site they must be managed under the archaeological provisions of the NSW Heritage Act (essentially, works are to immediately cease on suspicion of heritage find and experts engaged to advise pathway for management).

Fisheries Management Act 1994 (FM Act)

The objectives of the FM Act are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations, and in particular:

a) to conserve fish stocks and key fish habitats, and

b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and

c) to promote ecologically sustainable development, including the conservation of biological diversity.

To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation. Part 7 commonly applies to "integrated development" proposals as defined by the EP&A Act. However, there are other activities that may not require development consent under the EP&A Act but may still require a permit under Part 7 of the FM Act from NSW DPI. If a public authority (including a local council) is a determining authority under Part 5 of the EP&A Act, they may still be required to obtain the following approvals or undertake consultation under the following provisions:

- Section 200 – a permit is required for dredging or reclamation work carried out by a local government authority, unless these works are authorised by a relevant public authority (other than NSW DPI) or under the Crown Lands Act 1989.
- Section 205 - permit to harm (cut, remove, damage, destroy, shade etc) marine vegetation (saltmarshes, mangroves, seagrass and seaweeds),
- Section 219 – permit to obstruct the free passage of fish.

Section 200 of the FM Act applies and the permit will be obtained prior to commencing with the proposed activity.

Assessment of the proposed activity has identified that the works will not impact on marine vegetation (Seagrass/Seaweed, Mangroves or Saltmarsh), and as such a permit under Section 205 is not required.

Fish passage will not be obstructed by the proposed activity, and as such a permit under Section 219 is not required.

		Lake Cathie and the Pacific Ocean are mapped as Key Fish Habitat. The sand bar between the Lake and the Ocean is not mapped as key Fish Habitat. This is the location of the proposed activity. The likelihood of the works interacting the mapped zone and influencing the interaction of the Lake's hydrology with the hydrology of the Pacific Ocean has instigated the Threatened species test of significance, with no significant impact determined, therefore a Part 7A of FM Act permit to harm threatened species (and associated habitat) is not required. The Department of Primary Industries (Fisheries) administers the FM Act. The DPI have guidelines to the management of ICOLLs. A key recommendation of these guidelines are that: *Any proposals for artificial opening of ICOLLs must seek the approval or concurrence of the Department under the Fisheries Management Act 1994*. This will occur prior to the works commencing. **Protection of the Environment Operations Act 1997 (POEO Act)** The POEO Act is the key legislative mechanism for controlling pollution of the environment within NSW. Of most relevance to the proposed activity is Section 120 of the POEO Act, that states '*a person who pollutes any waters is guilty of an offence'*. Hence, The works are being undertaken to prevent the introduction of potential contaminants, primarily sewage, from the inundation of PMHC and private infrastructure adjoining Lake Cathie. Associated with the POEO Act is the POEO (Waste) Regulation 2014 that regulates waste in NSW. This regulation outlines exemptions and orders to allow for the beneficial reuse of certain waste types. The Virgin Excavated Natural Material (VENM) exemption will be implemented to allow for the reuse of the material on the beach. **Water Management Act 2000** The Water Management Act 2000 (WM Act) is administered by the NSW Office of Water and aims to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. It also provides formal protection and enhancement of the environmental quality of waterways and in-stream uses as providing protection of catchment conditions. The WM Act also requires controlled activity approvals to carry out specified controlled activities on or under waterfront land. The proposal would be undertaken on waterfront land (within 40 m of the bed of a river or estuary) and as such comprises a controlled activity under the WM Act. However, public authorities such as PMHC, are exempt from obtaining a controlled activity approval under Part 3, Division 2, Subdivision 4, Clause 41 of the Water Management (General) Regulation 2011: '*A public authority is exempt from section 91E(1) of the Act in relation to all controlled activities that it carries out in, on or under waterfront land*.' **Crown Land Management Act (1989) CLM Act** The objectives of the CLM Act are: (a) to provide for the ownership, use and management of the Crown land of New South Wales, and (b) to provide clarity concerning the law applicable to Crown land, and (c) to require environmental, social, cultural heritage and economic considerations to be taken into account in decision-making about Crown land, and (d) to provide for the consistent, efficient, fair and transparent management of Crown land for the benefit of the people of New South Wales, and (e) to facilitate the use of Crown land by the Aboriginal people of New South Wales because of the spiritual, social, cultural and economic importance of land to Aboriginal people and, where appropriate, to enable the co-management of dedicated or reserved Crown land, and (f) to provide for the management of Crown land having regard to the principles of Crown land management. Key to the CLM Act as it relates to the proposed activity is are ensuring that: (a) environmental protection principles be observed in relation to the management and administration of Crown land, and (b) the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible, and (c) public use and enjoyment of appropriate Crown land be encouraged, and (d) where appropriate, multiple use of Crown land be encouraged. The proposed activity will be undertaken on Crown land. Consultation with regard to the proposed activity has been undertaken with the NSW Department of Planning, Industry and Environment. As per previous advice from the aforementioned Department, council can utilise

		Section 191A of the Local Government Act to undertake the works without the requirement for a Crown Land permit. Section 191A of the Local Government Act states: *(1) Without limiting section 191, a council employee (or other person) authorised by a council may enter any premises to carry out water supply work, sewerage work or stormwater drainage work on or under the premises (being work that the council is authorised by this or any other Act to carry out).* *(2) Subsection (1) does not apply to premises that comprise a National Parks and Wildlife reserve.* Correspondence from the Department outlining the above is provided in *Appendix I*. PMHC plan to obtain a crown land permit, thus incorporating the Department into the decision making process, however will enact Section 191A in the event that works are required prior to receipt of the permit. The Department will be notified prior to opening the Lake. ***State Environmental Planning Policies (SEPPs)*** **SEPP (Infrastructure) 2007 (ISEPP)** ISEPP aims to facilitate the provision of infrastructure by Public Authorities, including local Councils, throughout NSW. The works are proposing to undertake flood mitigation works with intent of preventing impacts to public infrastructure, chiefly the inundation of sewer infrastructure. Under the Standard Instrument - Principal Local Environmental Plan: *flood mitigation work means work designed and constructed for the express purpose of mitigating flood impacts. It involves changing the characteristics of flood behaviour to alter the level, location, volume, speed or timing of flood waters to mitigate flood impacts. Types of works may include excavation, construction or enlargement of any fill, wall or levee that will alter riverine flood behaviour, local overland flooding, or tidal action so as to mitigate flood impacts.* *Note. Examples of flood mitigation work include levees, barrages, causeways, cuttings, embankments, floodgates and detention basins.* This is considered to adequately describe the nature of the works. Under Clause 50 of the ISEPP '*development for the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land*'. This clause also states that: '*A reference in this clause to development for the purpose of flood mitigation work includes a reference to development for any of the following purposes if the development is in connection with flood mitigation work—* *(a) construction works,* *(b) routine maintenance works,* *(c) environmental management works*'. On the basis that the activity is to be carried out on behalf of PMHC, a public authority, it can be undertaken without consent and assessed under Part 5 of the *Environmental Planning and Assessment Act (1979*). The excavation works to allow for the flood mitigation will be undertaken on the sandbank as shown in *Figure 2*. The activity is located outside of National Parks and mapped SEPP Coastal Areas and does not meet the requirements to be declared designated development. Part 2 of the ISEPP outlines public authority consultation requirements. As Council is the proponent, the following consultation requirements would typically apply: • *development adjacent to land reserved under the National Parks and Wildlife Act 1974 or to land acquired under Part 11 of that Act—the Office of Environment and Heritage,* Consultation undertaken as part of the proposed works, and under that are typically requirements of the ISEPP, are provided in *Section 1.9*.

		PMHC will continue on-going consultation with NPWS and notify prior to opening the Lake. It is however noted that consultation under the requirements of the ISEPP is not required if the proposed activity is to be undertaken as emergency works. **SEPP Coastal Management (2018) (SEPP Coastal)** The objective of SEPP Coastal is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the Coastal Management Act 2016, including the management objectives for each coastal management area, by— (a) managing development in the coastal zone and protecting the environmental assets of the coast, and (b) establishing a framework for land use planning to guide decision-making in the coastal zone, and (c) mapping the 4 coastal management areas that comprise the NSW coastal zone for the purpose of the definitions in the Coastal Management Act 2016 Of the four mapped coastal management areas, the coastal wetlands and littoral rainforest map identifies locations and proximity zones (buffers) where threatened ecological communities meeting this description have been identified. Works in the mapped coastal wetlands and littoral rainforest are a trigger for the proposed activity to become 'designated development'. The location where the proposed activity is to take place is outside of mapped coastal wetlands and littoral rainforest locations. The proposed activity is however within the mapped proximity area for littoral rainforest. Pursuant to Clause 11 of the Coastal Management SEPP, this in itself does not trigger the need for development consent and the Part 5 pathway remains appropriate. The proposed activity will influence mapped coastal wetland, however the physical works of the proposed activity are not within the mapped zone, hence it is considered that clause 10 (that would require consent and an approval under Part 4 of the EP&A Act does not apply). Clause 12, 13 and 14 of the SEPP, relate to development on land within the coastal vulnerability area, development on land within the coastal environment area, development on land within the coastal use area, respectively. The clauses do not create a requirement for development consent to be granted for development. Rather, it prescribes that when development consent is required to carry on development by an environmental planning instrument, the consent authority must be satisfied of the preconditions outlined prior to the granting of development consent. Since activities assessed under Part 5 of the Environmental Planning and Assessment Act (EPA Act) do not require development consent and the authority required to undertake the assessment of these activities is a determining authority as opposed to a consent authority, these clauses are not engaged in respect of the assessment of these activities. The intent of each of the clauses is nevertheless addressed through the environmental assessment provided in this REF. **SEPP Koala Habitat Protection (2019) (SEPP Koala)** The objective of SEPP Koala is to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline. SEPP Koala does not apply to assessments undertaken under Part 5 of the EP&A Act. The potential impact of the proposed activity on Koalas and Koala habitat has been considered in the ecological assessment provided in *Section 1.4*. **Local Environmental Plans** The proposed activity will occur within the Port Macquarie Hastings Local Government Area (LGA) and thus the PMHC Local Environment Plan (LEP) is the relevant local environmental plan. The clause within the ISEPP identifies that development for *'the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land'*, and hence prevails over the LEP.

1.7	s7.15 Biodiversity Conservation Act – development has been designed to Avoid, Minimise, then Mitigate impacts on native vegetation / habitat (It may be necessary to revisit this step after identifying any project specific Control Measures in STEP 6)	☑ REF documents the justified loss of native vegetation where other alternatives can not be found. ☑ Demonstration that the development proposal has minimised impacts on Biodiversity by way of design modification / alignment review / use of alternative technology etc. As discussed in *Section 1.4* the water quality in ICOLL's is highly variable in space and time due to the combined effects of entrance dynamics, a tendency to stratify, and the influence of groundwater inputs from surrounding low-lying catchments. Whist water quality variation may appear extreme this variation should be considered natural and an integral part of the greater coastal ecosystem. Rainfall events result in freshwater inputs (overland flow and groundwater), lowering salinity and delivering nutrients, suspended sediments and pathogens. In Lake Cathie, the water quality is also significantly influenced by tannin-rich groundwater inputs from low-lying Lake Innes. It is proposed that artificially opening the lagoon and allowing freshwater levels to recede and potentially allow salt water to enter will not create a significant negative impact on the existing ecology as it is replicating the natural cycle of an ICOLL. The need to mitigate possible sewer entering the system and flooding of infrastructure is the determining factor in progressing with the proposed activity. PMHC recognizes that entrance management in ICOLL systems must make trade-offs to balance the imperatives of maintaining ecosystem processes, protecting assets, and managing community expectations. There will always be risks associated with opening the naturally dynamic Lake Cathie lagoon system. But due to Council needing to alleviate and mitigate risk to infrastructure including sewer lines it is recommended that the risk of opening at a high water level, is the correct course of action as it replicates the natural opening characteristics demonstrated by the system. The location of the entrance channel is designed to be the create the least amount of impact possible. The duration the channel stays open will be dictated by natural processes.
1.8	What is the likely impact of the project on the community?	☐Low ☐ Moderate ☑ High Responsibility for undertaking artificial openings of the Lake Cathie ICOLL entrance resides with PMHC under their duty of care to the local community. The management of the Lake Cathie ICOLL entrance is a controversial issue in the local community. Competing interests and various perspectives differ between community members and various stakeholders. These views have caused angst historically. There is a community expectation that Lake Cathie should be opened when it is requested by the community. PMHC like many Councils that manage local ICOLLs find themselves balancing the social desires including recreation, aesthetic requests such visual and odour amenities at times in contrast to the need to reduce ecological impacts. Council is aware that more frequent openings of the ICOLL, particularly during drought conditions as this is not replicating natural cycles of the ICOLL openings, will result in negative overall ecological health of the estuary. Between 1992 and 2015 there have been five attempts by local community members to artificially open Lake Cathie. Two of the five attempts were successful. Such openings are illegal and can be very dangerous to the health and safety of our community as well as cause ecological impacts. As such, PMHC understands the importance of communicating with our local community. To ensure appropriate, timely and effective communication is provided to our community PMHC has developed a 'Standard Opening Procedure' which identifies key communication messages at triggers of 1.4m, 1.5m and 1.6mAHD to keep the community and key stakeholders well informed. In addition, the longer term solution is the development of a Coastal Management Plan (CMP) for the Lake Cathie to Rainbow Beach estuary in which a key component is a community and stakeholder engagement plan. Part of the CMP and subsequently the engagement plan will be to achieve targeted and effective management decisions which are by better understanding the interactions between system-specific attributes, local coastal processes, and hydrological factors in controlling entrance dynamics.
1.9	Description of community	PMHC has a dedicated page on its publically available website to detail the management of the Lake Innes and Lake Cathie Estuarine System. The page includes:

consultation undertaken or proposed. (Consultation methods should be added to Project Controls in Table 4.)

- Latest News and Frequently Asked Questions (FAQs) for Lake Cathie;
- Strategies, Plans and Studies;
- Roles and Responsibilities; and
- Water and Algal Level Testing.

The webpage includes a running commentary of activities taken with regard to the management activities of the Lake from Early 2019 through to present. PMHC also provide regular media releases to Local newspapers with regard to the Lake. The most recent media release published on the 16 April 2020 outlined the 1.6m trigger level to instigate an opening and that this environmental assessment was being completed. This messaging is prepared with the aim of keeping the local community informed of the Councils activities to manage the Lake.

The community will continue to be informed of any activities at the Lake via the PMHC website and media release. As the proposed activity will be undertaken under Part 5 of the EP&A Act, there is no requirement to publically display this REF or undertake public consultation.

Consultation regarding the opening of the Lake has been undertaken with relevant NSW State Government agencies. State government agencies have provided input into the requirements for the environmental assessment associated with the proposed opening. Details of the consultation is provided in the *Table T4* below.

Table T5 - NSW Government and Other Stakeholder Consultation

Agency	Date	Commentary
Crown	7th February 2020	A formal letter of request was sent to key stakeholders requesting their input into the consultant's brief for the opening (works and application undertaken by PMHC), of Lake Cathie under Part 5 of the EP&A Act. A copy of the email, formal letter and associated attachments can be found in *Appendix I*.
	20 February 2020	Response to request - email can be found in *Appendix I*.
	15th April 2020	Clarification email regarding roles in CMP management including management of Lake Cathie. Email can be found in *Appendix I*.
NPWS	7th February 2020	A formal letter of request was sent to key stakeholders requesting their input into the consultant's brief for the opening (works and application undertaken by PMHC), of Lake Cathie under Part 5 of the EP&A Act. A copy of the email, formal letter and associated attachments can be found in *Appendix I*.
	15th April 2020	Clarification email regarding roles in CMP management including management of Lake Cathie. Email can be found in *Appendix I*.
NSW Department of Planning, Industry and Environment - Biodiversity and Conservation Division (BCD)	7th February 2020	A formal letter of request was sent to key stakeholders requesting their input into the consultant's brief for the opening (works and application undertaken by PMHC), of Lake Cathie under Part 5 of the EP&A

DE299

				Act. A copy of the email, formal letter and associated attachments can be found in *Appendix I*.
			17th February 2020	Responding correspondence returned - formal response can be found in *Appendix I*.
		Fisheries	7th February 2020	A formal letter of request was sent to key stakeholders requesting their input into the consultant's brief for the opening (works and application undertaken by PMHC), of Lake Cathie under Part 5 of the EP&A Act. A copy of the email, formal letter and associated attachments can be found in *Appendix I*.
			14 February 2020	Correspondence returned from Fisheries. Full email can be found in *Appendix I*.
			15th April 2020	Clarification email regarding roles in CMP management including management of Lake Cathie. Email can be found in *Appendix I*.
		Birpai and Bunyah Local Aboriginal Land Councils	11 February 2020 4 March 2020	Invitation to become member of Coast, Estuary and Floodplain Sub-Committee (CEF) for management of these issues across the LGA (including Lake Cathie). Follow up email seeking response sent in March 2020. Emails provided in *Appendix I*.

DE299

TABLE 2 – APPROVALS, LICENCES and PERMITS

STEP 3

Item	Sensitive Areas Include:	Tick one
2.1	Working near Endangered, Threatened, Vulnerable or Protected Species, Populations, Ecological Communities or Critical Habitat (Flora and Fauna) –NSW Office of Environment and Heritage, Department of Primary Industries (NSW Fisheries).	☑ Yes ☐ No
2.2	Working within a national park, nature reserve, aboriginal area, wilderness area, conservation area or wild river – NSW Office of Environment and Heritage, National Parks and Wildlife Service.	☐ Yes ☑ No
2.3	Working adjacent to land reserved under the National Parks and Wildlife Act (eg national park, nature reserve, aboriginal area, wilderness area, conservation area or wild river) – NSW Office of Environment and Heritage	☑ Yes ☐ No
2.4	Working near Areas of National Environmental Significance (RAMSAR Wetlands, threatened species, migratory birds, World Heritage, National Heritage, nature reserve etc.) or on Commonwealth land or marine area – Department of the Environment (Commonwealth).	☑ Yes ☐ No
2.5	Working near areas protected by State Environmental Planning Policies for conservation purposes (eg SEPP (Coastal Management) 2018 – NSW Office of Environment and Heritage, NSW Department of Planning & Environment.	☑ Yes ☐ No
2.6	Working within an area that is subject to any conservation agreement entered into under the National Parks and Wildlife Act 1974 – NSW Office of Environment and Heritage, National Parks and Wildlife Service.	☐ Yes ☑ No
2.7	Working within an area that is subject to any plan of management under the National Parks and Wildlife Act 1974 – NSW Office of Environment and Heritage, National Parks and Wildlife Service.	☐ Yes ☑ No
2.8	Working within an area that is subject to any joint management agreement under the National Parks and Wildlife Act 1974 NSW Office of Environment and Heritage, National Parks and Wildlife Service.	☐ Yes ☑ No
2.9	Working near an aquatic reserve or 'Marine Vegetation' such as seagrass, mangroves etc – Department of Primary Industries (NSW Fisheries).	☐ Yes ☑ No
2.10	Working adjacent to a Marine Park declared under the Marine Parks Act - NSW Marine Parks Authority	☐ Yes ☑ No
2.11	Dredging or reclamation of water – Fisheries NSW, Waterways or NSW Department of Primary Industries (NSW Fisheries).	☑ Yes ☐ No
2.12	Development comprising a fixed or floating structure in or over navigable waters. Roads and Maritime Services	☐ Yes ☑ No
2.13	Working within the 'place' of a 'Heritage Item' identified on the Register of the National Estate, under the NSW Heritage Act or an environmental planning instrument – Heritage Council, Local Council, NSW Office of Environment and Heritage.	☐ Yes ☑ No
2.14	Working within the 'place' of a 'Heritage Item' as defined in other register – Heritage Council.	☐ Yes ☑ No
2.15	Working where a 'Relic' is likely to be discovered (eg Archaeological Zoning Plans) – Heritage Council or National Parks and Wildlife Service.	☐ Yes ☑ No
2.16	State Forest or area subject to Forest Agreement – Forests NSW, NSW Department of Primary Industries, Department of the Environment (Commonwealth).	☐ Yes ☑ No
2.17	Working near aboriginal relics or places –Local Aboriginal Land council, National Parks and Wildlife Service (Due diligence code of practice for the protection of Aboriginal objects in NSW).	☐ Yes ☑ No
2.18	Working at sites at which asbestos or asbestos containing materials exist (Determine if a licence or exemption will be required) - WorkCover	☐ Yes ☑ No

NOTE: If you have ticked any ☐ Yes above then you must either:

1. Attach a copy of the approval, licence or permit to the final EIA Checklist, OR
2. Detail who is responsible for obtaining the approval, licence or permit, OR
3. Explain why the project is exempt.

NOTE If you have ticked any ☐ yes at items 2.3, 2.9, 2.10 or 2.12 a referral to the relevant authority is required under the Infrastructure SEPP and a period of 21 days allowed for response. All responses are to be considered and included in this assessment.

NOTE: If you have ticked any ☐ Yes above then you should carefully complete Table 4.

DE299

Item	OTHER AREAS INCLUDE:		
2.19	Generating, handling, storing, transporting or disposing of hazardous, industrial or Group A waste or "controlled waste" – Environment Protection Authority and Local Council (eg wastes such as pesticides, lead, contaminated soil etc.).	☐ Yes	☑ No
2.20	Handling, storing, transporting or disposing of Dangerous Goods – Environment Protection Authority and WorkCover.	☐ Yes	☑ No
2.21	Handling, transporting or disposing of 'Controlled Chemicals' such as PCBs, OCPs etc – Environment Protection Authority and WorkCover.	☐ Yes	☑ No
2.22	Discharging anything to a waterway or stormwater drain – Environment Protection Authority and Local Council.	☐ Yes	☑ No
2.23	Discharging 'Trade Waste' to the sewer –Local Council.	☐ Yes	☑ No
2.24	Clearing "native vegetation", mapped as regulated category 2 lands as mapped on the Native Vegetation Regulatory Map https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap Local Land Services.	☐ Yes	☑ No
2.25	Working on a classified road including freeway, highway, main road, tourist road etc. – Roads and Maritime Services or Local Council.	☐ Yes	☑ No
2.26	Removing or lopping trees from "Crown-timber lands" – Forestry NSW	☐ Yes	☑ No
2.27	Disturbing subsurface or above ground utilities – Essential Energy, Telstra Local Council Water and Sewer.	☐ Yes	☑ No
2.28	Water management works – Local Council	☐ Yes	☑ No
2.29	Using flames during a Total Fire Ban or working within bushfire protected lands – NSW Rural Fire Service.	☐ Yes	☑ No
2.30	Working on Crown Lands – Department of Lands If yes, is the project consistent with the Plan of management for the site?	☑ Yes ☐ Yes	☐ No ☐ No
2.31	Other – please specify:	☐ Yes	☑ No

Description of area/issue identified above:	Item 2.1 - threatened Species are discussed in Section 1.4 and *Appendices E* and *H*. Item 2.3 - the works will be undertaken adjacent to Lake Innes Nature Reserve that is administered by National Parks and Wildlife Services. PMHC will consult with NPWS prior to undertaking the works. Item 2.4 - threatened Species and migratory birds are discussed in Section 1.4 and *Appendices D, E* and *H*. Item 2.5 - Coastal wetlands are present to the west of the Ocean Drive Bridge. The works will alter the current hyrological regime in the area, however will be with natural fluctuations and considered to be representative of natural system dynamics. Item 2.11 - A fisheries permit will be obtained. Item 2.30 - A license will be applied for with Crown Lands after the REF is endorsed. If during the process of obtaining a license the water level rises above 1.6m Council will inform Crown Lands that Council will enact section 191 of the Local Government Act in order to gain entry on to Crown Land to mitigate issues during an emergency.

NOTE: If you have ticked any ☐ Yes above then you must either:

1 Attach a copy of the approval, licence or permit to the final EIA Checklist, OR

2 Detail who is responsible for obtaining the approval, licence or permit, OR

3 Explain why the project is exempt.

DE299

TABLE 3 – OTHER SENSITIVE AREAS/ISSUES

STEP 4

Item	SENSITIVE AREAS INCLUDE:	Tick one
3.1	Wildlife corridors/refuges, native forests, Wildlife Management Areas, Significant Tree Registers (council), Koala Habitat (>1 hectare of bushland).	☐ Yes ☑ No
3.2	Is consultation with NSW Koala Preservation Society required	☐ Yes ☑ No
3.3	Working within 40m of a sensitive area (waterways, National parks etc.) or 5m upstream of a drain.	☑ Yes ☐ No
3.4	Areas with contaminated soil or water (ground or surface) or degraded air quality or Unhealthy Building Land Notice.	☐ Yes ☑ No
3.5	Areas subject to land rights claims or Registered Native Title or Register of Indigenous Land Use Agreements (Native title tribunal - www.ntt.gov.au)	☐ Yes ☑ No
3.6	Demolition of existing bridge (inspection for threatened species - and fishing bats)	☐ Yes ☑ No

NOTE: If you have ticked any ☐ Yes above then you should carefully complete Table 4
NOTE If you have ticked ☐ Yes to 3.2 then you must attach details of consultation and consider in completing Table 4

Item	OTHER AREAS INCLUDE :	
3.7	Areas or items of high architectural, historical, environmental protection or scientific value. The proposed works are located within the foreshore of Lake Cathie. Discussion regarding mitigation measures to reduce impact to these areas is discussed in section 1.4 and Table 4.	☑ Yes ☐ No
3.8	Environmental Protection Zones as defined by environmental planning instruments (eg foreshore scenic protection areas, conservation areas, scenic protection areas, beachfront scenic protection areas etc.).	☐ Yes ☑ No
3.9	Coastline and dune fields, caves, wetlands (not state significant) or other unique landforms. The proposed works are located within the foreshore of Lake Cathie. Discussion regarding mitigation measures to reduce impact to these areas is discussed in section 1.4 and Table 4.	☑ Yes ☐ No
3.10	Areas or items of high aesthetic or scenic value.	☑ Yes ☐ No
3.11	Recreational areas (beaches, foreshores, parks, picnic areas, lookouts, national features, tourist areas, tourist roads/routes etc.). The proposed works are located within the foreshore of Lake Cathie. Discussion regarding current and ongoing community engagement and safety measures are discussed in section 1.9 and Table 4.	☑ Yes ☐ No
3.12	Excavating near a river, lake, lagoon, wetland, drinking water catchment or flood prone area (within 40m). The proposed works are located within the foreshore of Lake Cathie. Lake Cathie is an ICOLL. Information regarding the excavation and associated mitigation measures are covered off in earlier sections of the REF.	☑ Yes ☐ No
3.13	Excavating near a mana-made stormwater infrastructure, such as gutter, stormwater channel, drain or inlet (within 40m up stream).	☐ Yes ☑ No
3.14	Use of Pile drivers, Hydraulic hammers, Machine-mounted rock breakers, Sand blasters, Steam cleaners, Mole borers or similar equipment in an urban area.	☐ Yes ☑ No
3.15	Erosion prone areas. Sediment control measure provided in Table 4.	☑ Yes ☐ No
3.16	Areas containing acid sulphate soils. The Study Area is not an area that contains Acid Sulphate soils. Landforms adjacent to Lake Cathie have ASS. This is discussed in length in section 1.4 and Table 4.	☐ Yes ☑ No
3.17	Cafes, restaurants, shops, outdoor dining, Pubs, places of worship etc.	☐ Yes ☑ No
3.18	Bush regeneration areas, dune regeneration areas etc. The proposed works are located within the foreshore of Lake Cathie. The works are in close proximity to public managed bushland areas but not within the works area.	☐ Yes ☑ No
3.19	Areas of high bushfire risk.	☐ Yes ☑ No
3.20	Presence of Invasive Weeds listed in appendices Northern River Regional Weeds Plan http://northcoast.lls.nsw.gov.au/__data/assets/pdf_file/0006/722760/north-coast-regional-weed-management-plan.pdf (Biosecurity Act)	☐ Yes ☑ No
3.21	Urban bushland or remnant roadside vegetation.	☐ Yes ☑ No

DE299

3.22	Major transport corridors (Highways, freeways, railways, shipping channels, airports etc.).	☐Yes	☑ No
3.23	Major pedestrian routes (eg foreshore walks, around sporting venues etc.). The works are within close proximity to a foreshore walk area and children's playground. But there are safety measures in place as explained in Table 4 to ensure fencing delineates the work zone, staff are in place to ensure no one enters the zone and safety signage is erected to inform the community of the work and the potential hazards.	☐Yes	☑ No
3.24	Schools, childcare centres, playgrounds etc. The works are within close proximity to a foreshore walk area and children's playground. But there are safety measures in place as explained in Table 4 to ensure fencing delineates the work zone, staff are in place to ensure no one enters the zone and safety signage is erected to inform the community of the work and the potential hazards.	☐Yes	☑ No
3.25	Works on Private land	☐Yes	☑ No
3.26	Other - please specify:	☐Yes	☑ No
Description of sensitive areas identified above: As noted above			

Can the project still proceed under Part 5	☑Yes	☐ No

PART 5 REF

TABLE 4 – ENVIRONMENTAL IMPACT ASSESSMENT

Steps:		5		6	7	8	9	10
				Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*	**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.1	**AIR**	**Construction:** Dust generation (excavating, disturbing soil, stockpiling, trenching, erosion prone sites, clearing of vegetation, transporting soil etc.) Fumes, odours and other air pollution from vehicles, equipment, machinery or other activities...	☐ **No Impact** ***If ticked, go to next issue***	Efficient work practices will be implemented to limit undue emissions and include, to the greatest extent practicable: • eliminating unnecessary engine idling; and • prevent over-revving of engines. Earthmoving equipment should be in good working order and maintained to minimise excess noise generation. Deposition of material from excavator bucket will be undertaken in a manner to prevent release from height, thus reducing likelihood of fugitive dust emission. Wind conditions will be monitored and works postponed/ceased if dust generation is likely. Wind conditions of greater than 25km/hr is a useful reference point to consider halting works.	3	1	1	3
4.2		**Operation-** Fumes, odours and other air pollution from vehicles, equipment, machinery or other activities...	☐ **No Impact** ***If ticked, go to next issue.*** **OR**	The potential for odour issues are considered to be an acceptable impact to avoid potential contamination issues due to interaction off sewage with the lake from flooding of sewerage infrastructure.				

PART 5 REF

Steps:		5		6	7	8	9	10
				Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*	**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.3	**WATER**	**Construction** Polluting waterways, wetlands, stormwater drains or groundwater (eg storing, transporting, handling or disposing of oils, fuels, pesticides, chemicals, pit/trench water or other liquids). Sedimentation of waterways, wetlands, stormwater drains or groundwater (eg excavating, disturbing soil, stockpiling, trenching, concrete cutting, access tracks, erosion prone sites etc.).	☐ **No Impact** ***If ticked, go to next issue***	The works are to remove a sand berm to allow for water to flush between the lagoon and open ocean. The natural wave and water action will move sands back into the entrance over time. In order to maximize the efficiency of the flushing and to achieve a desired duration of opening a Coastal Engineer has been contracted to design an optimal opening location and channel design. Full details of channel location and design are in section 1.1. The design of the artificial opening mimics the natural opening design as closely as possible. The excavation of the last section of the crest ('daylighting' the channel) is to occur when water in the channel has had settlement time for any accumulated sediment in the water column, generated by previous excavation.	3	2	1	6
4.4		**Operation -** Polluting waterways, wetlands, stormwater drains or groundwater (eg storing, transporting, handling or disposing of oils, fuels, pesticides, chemicals, pit/trench water or other liquids). Sedimentation of waterways, wetlands, stormwater drains or	☐ **No Impact** ***If ticked, go to next issue.*** **OR**	The works are to remove a sand berm to allow for water to flush between the lagoon and open ocean. The natural wave and water action will move sands back into the entrance over time. The duration of the opening is unknown at this time. Historical opening durations is variable as provide in Section 1.4. The design of the artificial opening mimics the natural opening design as closely as possible.				

PART 5 REF

4.5	NOISE AND VIBRATION	**Construction** noise/vibration (eg rockbreakers, concrete cutters, jackhammers, chainsaws, compressors, excavators, backhoes, trucks, vehicles, cranes, steel plates movements, generator etc.). Potential construction noise impacts are outlined in *Section 1.4*.	☐ **No Impact** ***If ticked, go to next issue.***		The key management measure for limiting noise impacts to the surrounding receptors will be to undertake the works during standard construction hours, where practicable. Standard construction hours are: • Monday to Friday: 7am to 6pm • Saturday: 8am to 1pm • Sunday and Public Holidays: no works. It is noted that as of Thursday 9 April 2020 the NSW Government released the *Environmental Planning and Assessment (COVID-19 Development—Infrastructure Construction Work Days) Order 2020* allowing works approved under Part 5 of the EP&A Act to extend work hours from 7am to 6pm to all weekdays and Public holidays. This order may be enacted while it remains valid. Efficient work practices will be implemented to conduct the works as expeditiously as possible and include, to the greatest extent practicable: • eliminating unnecessary engine idling; • limit reverse movements that generate safety alarms ; and • prevent over-revving of engines. It is presumed that the works will be undertaken by a single machine to limit the number of noise sources on-site. Should additional earthmoving equipment be used to undertake the works, the cumulative noise caused will be counteracted by the works being completed in a reduced timeframe. Earthmoving equipment should be in good working order and maintained to minimise excess noise generation. Containment of the site will provide separation distance from the plant to members of the public and adjacent pedestrians, affording limited noise protection. If any validated noise complaints are received, attended noise monitoring should be undertaken to allow for comparison with noise criteria outlined above. Further mitigation may be required if the proposed activity is generating noise levels greater than criteria.	3	1	2	6
4.6		**Operational** noise/vibration (eg pumps, generators).	☑ **No Impact** ***If ticked, go to next issue.***	**OR**					

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.7	CONTAMINATION AND WASTE	**Construction** Disturbing contaminated soil (eg known contamination, ASS, old industrial site, previous landfill etc.). Contaminating or polluting land (eg storing, handling or disposing of oils, fuels, pesticides, chemicals, pit/trench water or other liquids Environmental problems caused by generating, storing, handling, transporting or disposing of waste (eg soils, building materials, oils, solvents, etc.). Restricting current and potential activities associated with the land (eg amenity, buildings, parking).	☐ **No Impact** ***If ticked, go to next issue.***		The work site does not contain Acid Sulphate Soils. The water body adjoining to Lake Cathie may be impacted by reduced water levels which may impact on ASS in Lake Innes. As outlined in section 1.4 - sub-heading Soils: PMHC is of the understanding that there is an imminent need to reduce risk to infrastructure. And although there is a risk of acid sulphate discharge negatively impacting on the overall water quality and fish health within the estuary, given the historical fish kills (within the last 12 months) and the overall reduced water quality health (as outlined in section) the consequence of this risk is considered less of an impact. Though it is also recognized that future mitigation strategies that are more robust must be put in place to ensure the estuary health effectively managed. Therefore, to better inform decision making and longer-term management of the estuary PMHC is undertaking the following 1. Studies of the acid sulphate soils in Lake Innes to better understand discharge models and lasting impacts, including soil samples and continued water quality monitoring. 2. Investigations into reversion of Lake Innes to freshwater which will also block the flow between Lake Cathie and Lake Innes to reduce impact on the full estuarine system. No materials will be taken off site.	2	2	2	8

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.8		**Operational** Contaminating or polluting land (eg storing, handling or disposing of oils, fuels, pesticides, chemicals, pit/trench water or other liquids Environmental problems caused by generating, storing, handling, transporting or disposing of waste (eg soils, building materials, oils, solvents, etc.). Restricting current and potential activities associated with the land (eg amenity, buildings, parking).	☐ **No Impact** ***If ticked, go to next issue.***	**OR**	SWMS will be used to ensure safe work practices are followed during the excavation and replacement of sand on the berm. The sand removed from the excavated channel will be distributed. To allow for sand nourishment. A procedure/process for working on the site has been developed, and relevant staff will be trained. A spill kit will be located onsite of the works zone, in the event of an unintentional release.	1	1	3	3
4.9	LANDUSE AND TRANSPORT	**Construction** Restricting or affecting transport (eg pedestrian, car, bus, train, airports, boats, river crossings, bus stops, public transport corridors and infrastructure, construction related disturbances, property access, parking restrictions, etc.). Displacing, disturbing or damaging terrestrial or aquatic fauna (eg creating a barrier to fauna movement, clearing remnant vegetation or wildlife corridors, collisions etc.).	☐ **No Impact** ***If ticked, go to next issue.***	**OR**	The works are restricted to the Lake Cathie foreshore where there is impediment to local pedestrian access using the beach. Due to the lack of vegetation on the dune system and the open coastline there is no foreseen impact to barrier fauna movement or wildlife corridors. Access to the site will be controlled, using fencing. Additional staff members will be onsite to ensure no access to work zone. Signage on the foreshore will be erected to reduce foot traffic near the site and extensive communications will be distributed via several channels to forewarn community members of works being undertaken.	1	1	2	2

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.10		**Operation** Restricting or affecting transport (eg pedestrian, car, bus, train, airports, boats, river crossings, bus stops, public transport corridors and infrastructure, construction related disturbances, property access, parking restrictions, etc.). Displacing, disturbing or damaging terrestrial or aquatic fauna (eg creating a barrier to fauna movement, clearing remnant vegetation or wildlife corridors, collisions etc.).	☐ **No Impact** ***If ticked, go to next issue.***	**OR**	The works are restricted to the Lake Cathie foreshore where there is impediment to local pedestrian access using the beach. Due to the lack of vegetation on the dune system and the open coastline there is no foreseen impact to barrier fauna movement or wildlife corridors. Access to the site will be controlled, using fencing. Additional staff members will be onsite to ensure no access to work zone. Signage on the foreshore will be erected to reduce foot traffic near the site and extensive communications will be distributed via several channels to forewarn community members of works being undertaken.	1	1	1	1

PART 5 REF

4.11	FLORA AND FAUNA	**Construction** Clearing or modifying native vegetation (including trees, shrubs, grasses, roots, herbs or aquatic species) Introducing or spreading weeds (inc noxious) or vermin Introducing bushfire risk factors Endangering any species of animal, plant or other form of life, whether living on land, in water or in the air (eg. any danger to birds in the locality). Any other environmental impacts on the ecosystems of the locality	☐ **No Impact** ***If ticked, go to next issue.***		Work is being conducted in a sensitive area and although the impacts at the work site are low the impacts to the adjoining ecosystem have also been considered in this proposal. PMHC recognizes that entrance management in ICOLL systems must make trade-offs to balance the imperatives of maintaining ecosystem processes, protecting assets, and managing community expectations. There will always be risks associated with opening the Lake Cathie lagoon system. But due to Council needing to alleviate and mitigate risk to infrastructure including sewer lines it is recommended that the risk of opening at a high level, is the correct course of action. The location of the entrance channel is designed to be the create the least amount of impact possible. The duration the channel stays open will be dictated by natural processes. • Council is currently undertaking and developing the following mitigation actions as part of the CMP for Lake Cathie/Rainbow Beach estuary specifically to ensure that Lake Cathie ICOLL is artificially opened only at the optimum conditions. These conditions will achieve a balance of reducing impact present and the ecological conditions. Continued record keeping of lake opening dates, means of opening and duration of opening. • Development of the Standard Operating Procedure for Lake Cathie • Ongoing water quality data collection • Acid sulphate digestion model for Lake Innes • Further investigate the possibility of reversion of Lake Innes. Condition assessment of saltmarsh of Lake Innes • Ecological inventory of Lake Cathie with a focus on riparian edges of Lake Cathie • Review of Lake Cathie entrance management plan with a focus on identifying impacted infrastructure and optimal water levels for riparian vegetation.	2	1	2	4

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
					• Water quality studies which provide detailed guidance on point and non-point source pollution points, recommended management actions and responsible tenure.				
4.12		**Operation** Introducing or spreading weeds (inc noxious) or vermin. Introducing bushfire risk factors Endangering any species of animal, plant or other form of life, whether living on land, in water or in the air (eg. any danger to birds in the locality). Any other environmental impacts on the ecosystems of the locality	☐ **No Impact** ***If ticked, go to next issue.***		As above in Section 4.11	2	1	2	4

PART 5 REF

4.13	SOCIAL	**Construction** Creating a nuisance to the community (eg impact on amenity through noise, perceived risk of fires, explosions, property value devaluation etc.). Creating financial loss to members of the community (eg. restricting access to commercial premises, changing land use etc.).	☐ **No Impact** ***If ticked, go to next issue.***		As discussed in section 1.9 the management of the Lake Cathie ICOLL is highly controversial. To this end extensive community engagement is being undertaken to inform the public as to why Council manages the ICOLL in the manner it has chosen. The Lake Cathie opening strategy was developed under the Lake Cathie-Lake Innes Estuary Management Plan. It was undertaken by Council in close consultation with the community and the Lake Cathie-Bonny Hills Estuary Management Committee (now the Coast, Estuary & Floodplain Sub-Committee). established the Lake Cathie Opening Strategy in 1995. The Strategy was updated and reviewed in 2001, 2004/5 and 2011. Careful consideration of any changes to the Opening Strategy is needed as hydrodynamic impacts such as altered wave action entering the lower estuary, changes in longshore sand drift, tidal prism and wave environment could result in loss of existing sand shoals and beach areas. Changes in channel alignment and sediment dynamics could also be experienced within the lake which in turn could significantly change the duration of lake opening events and impact on water quality. Altering estuarine processes will likely create other management issues including impacting on access to the lake and foreshore, safety of wading and/or swimming areas, and altering the saline/freshwater balance within the greater lake system. Environmental issues including habitat loss for wading birds, fish and prawn species could also be potentially impacted by changing the Opening Strategy. Development and validation of the coastal model was undertaken to investigate and review the current entrance opening strategy and assist with demonstrating justification for any changes to the management approach in the future. Computer modelling was used as a tool to prepare a hydrodynamic model of the Estuary for the purpose of investigating and assessing changes to estuarine / coastal conditions and other specific site related issues	3	1	3	9

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
					including potential management actions identified by the Council and the wider community. In light of the information and computer modelling undertaken as part of the investigation, the 2011 Hydrodynamic Study did not recommend any changes be made to the adopted Opening Strategy. As such, the rigour around the strategies development has taken into consideration economic, social and ecological factors. The decision to open the lake at 1.6m has been adopted by Council and is communicated to the public via several media outlets. Key communication triggers are outlined in the Standard Opening Procedure (SOP) attached in *Appendix C*.				
4.14		**Operation** Creating a nuisance to the community (eg impact on amenity through noise, perceived risk of fires, explosions, property value devaluation etc.). Creating financial loss to members of the community (eg. restricting access to commercial premises, changing land use etc.).	☐ **No Impact** ***If ticked, go to next issue.***		As outlined in the SOP attached in *Appendix C*, as soon as a decision is made to open Lake Cathie the community will be informed via several media channels. Key stakeholders including NPWS, Fisheries, key community groups, and Crown land will be informed via email. Signage will be erected on site to ensure the health and safety of people that view the works or try to enter the work site. Additional staff including Surf Lifesavers will be at the site to conduct crowd control and ensure safety.	3	1	3	9

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.15	VISUAL AND HERITAGE	**Construction** Affecting a locality, item, place or building having aesthetic, anthropological, archaeological, architectural, historical, scientific, cultural or social significance or other special value (eg. visual effect on adjoining heritage buildings or items, disturb, move excavate Aboriginal object) or working where heritage items could be found (eg Archaeological Zoning Plans).Affecting any Aboriginal heritage (eg engravings, middens, carved trees, grinding grooves, paintings, burial sites, etc.).	☐ **No Impact** ***If ticked, go to next issue..***	**OR**	Should any unexpected relics be disturbed during excavation of the site they must be managed under the archaeological provisions of the NSW Heritage Act (essentially, works are to immediately cease on suspicion of heritage find and experts engaged to advise pathway for management). Site investigations for a Council project at the southern end of Illaroo Road (in the vicinity of the works) identified suspected midden heaps that are currently being investigated for cultural significance. The midden heaps are outside of the Study Area required to undertake the proposed activities. .	1	1	3	3
4.16		**Operational** Affecting a locality, item, place or building having aesthetic, anthropological, archaeological, architectural, historical, scientific, cultural or social significance or other special value (eg. visual effect on adjoining heritage buildings or items, disturb, move excavate Aboriginal object) or working where heritage items could be found (eg Archaeological Zoning Plans).Affecting any Aboriginal heritage (eg engravings, middens, carved trees, grinding grooves, paintings, burial sites, etc.). Changing the visual or scenic landscape (eg restricting views, removing trees.). Transforming a locality (e.g. significant earthworks).	☐ **No Impact** ***If ticked, go to next issue..***	**OR**	Site investigations for a Council project at the southern end of Illaroo Road (in the vicinity of the works) identified suspected midden heaps that are currently being investigated for cultural significance. The midden heaps are outside of the Study Area required to undertake the proposed activities.	1	1	3	3
4.17	OTHER ENVIRONMENTAL ISSUES	Long-term effects on the environment (e.g. as a result of waste emissions). Degrading of the quality of the environment (e.g. effect on surrounding bushland, contamination, erosion).	☐ **No Impact** ***If ticked, go to next issue.***	**OR**	Due to the nature of ICOLL's this environment is always changing and altering. The artificial opening of the system will not create a long term effect on the environment so long continued management of the system monitors the ongoing impact of artificial openings and their frequency. Further long term studies and actions have been listed in 4.11.	3	1	2	6

PART 5 REF

Steps:			5		6	7	8	9	10
					Multiply the 3 scores:	*1-3*	*1-3*	*1-3*	=
Item	**Issue**	**Examples of impacts**	**Description of Impacts AND Causes** *NOTE: Either tick 'no impact' OR provide details.*		**Project Specific Control Measures**	**Likelihood**	**Extent**	**Sensitivity**	**Environmental Score**
4.18		Any other risk to the safety of the environment	☑ **No Impact** ***If ticked, go to next issue.***	**OR**					
4.19		Reducing the range of beneficial uses of the environment (e.g. effect on surrounding land-uses and considering response of affected land owners).	☐ **No Impact** ***If ticked, go to next issue***	**OR**	ICOLL management is a balance between ecological requirements, social/recreational desires of the community and the need to manage for risk to the built environment. Although best practice ecological management may suggest to allow for only natural openings of the lagoon it is imperative Council also provides a duty of care to the community. To achieve this balance and to ensure long term beneficial use and ecology, Council has adopted an opening strategy for Lake Cathie (attached in *Appendix A*) which outlines conditions for artificially opening the lagoon are at 1.6m as long as optimal conditions are met including long term rain forecast and tidal considerations are taken into consideration.	1	2	3	6
4.20		Increasing demands on resources (natural or otherwise) that are, or are likely to become, in short supply (e.g. demand on water use).	☑ **No Impact** ***If ticked, go to next issue.***	**OR**					

PART 5 REF

4.21		Any cumulative environmental effect with other existing or likely future activities	☐ **No Impact** ***If ticked, go to next issue.***	**OR**	Work is being conducted in a sensitive area and although the impacts at the work site are low the impacts to the adjoining ecosystem have also been considered in this proposal. PMHC recognizes that entrance management in ICOLL systems must make trade-offs to balance the imperatives of maintaining ecosystem processes, protecting assets, and managing community expectations. There will always be risks associated with opening the Lake Cathie lagoon system. But due to Council needing to alleviate and mitigate risk to infrastructure including sewer lines it is recommended that the risk of opening at a high level, is the correct course of action. Council is currently undertaking and developing the following mitigation actions as part of the CMP for Lake Cathie/Rainbow Beach estuary specifically to ensure that Lake Cathie ICOLL is artificially opened only at the optimum conditions. These conditions will achieve a balance of reducing impact present and the ecological conditions. Continued record keeping of lake opening dates, means of opening and duration of opening. • Development of the Standard Operating Procedure for Lake Cathie • Ongoing water quality data collection • Acid sulphate digestion model for Lake Innes • Further investigate the possibility of reversion of Lake Innes. Condition assessment of saltmarsh of Lake Innes • Ecological inventory of Lake Cathie with a focus on riparian edges of Lake Cathie • Review of Lake Cathie entrance management plan with a focus on identifying impacted infrastructure and optimal water levels for riparian vegetation. • Water quality studies which provide detailed guidance on point and non-point source pollution points, recommended management actions and responsible tenure.	3	1	3	9
4.22	Other								

PART 5 REF

NOTE: Projects with any HIGH Environmental Scores (>10) may require consultant report to assess environmental issues or re-evaluation of the project options or mitigation measures. It is recommended that there be consultation with your supervisor to determine the most appropriate course of action. Where the project is modified, a revised REF will be required.

TABLE 4A – OTHER RELEVANT Council POLICIES/GUIDELINES

Item	RELEVANT POLICY/GUIDELINE:	Is the policy relevant?
4A.1	Acid Sulphate Soils Clause 7.1 of LEP (1) The objective of this clause is to ensure that development does not disturb, expose or drain acid sulfate soils and cause environmental damage. Refer *Section 1.4* for discussion relating to ASS.	☑ Yes ☐ No
4A.2	Acid Sulphate Soil Management Plan for Minor Works	☐ Yes ☑ No
4A.3	Acid Sulphate Soil Management Plan for Pipe Infrastructure Installations	☐ Yes ☑ No
4A.4	Water Sensitive Design and Maintenance Guidelines for Unsealed Roads	☐ Yes ☑ No
4A.5	Local Aboriginal Land Councils - Interim Consultation Policy Regarding Council Works, Development Applications and Draft LEPs\ Aboriginal Community Consultation is outlined in *Section 1.9*.	☐ Yes ☑ No
4A.6	Contaminated Lands Policy	☐ Yes ☑ No
4A.7	Assessment of Development Applications Requiring Heritage Assessment	☐ Yes ☑ No
4A.8	Port Macquarie-Hastings LGA Flood Policy (2018) Note the proposed activity is to alleviate flooding and consequent issues to infrastructure.	☐ Yes ☑ No
4A.9	Social Impact Assessment Policy (only when EIS is required)	☐ Yes ☑ No
4A.10	SEPP Vegetation (Non Rural Areas) 2017 http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SensitiveValues	☐ Yes ☑ No
4A.11	Trees on Private Land (see page 3-16 of PMH DCP 2011)	☐ Yes ☑ No
4A.12	Trees on Public Property (see page 3-15 of PMH DCP 2011)	☐ Yes ☑ No
4A.13	Airspace Protection (see page 3-22 of PMH DCP 2011)	☐ Yes ☑ No

NOTE: The person completing this Checklist must consider the policies identified in Table 4A that are relevant to the project. These policies may contain additional Control Measures to mitigate the Environmental Impacts of the project or additional requirements relating to how specific activities that are part of the project must be conducted. If there is a particular issue for which Council does not have a policy, the Assessing Officer should consult supervisor.

NOTE: Refer to sections 5A, 111 and 112 of the EPA Act, clause 228 of the EPA Regulation, DoP's guidelines "Is an EIS required?" and DECC's "Interim Community Guidelines for Community Consultation" for a full list of the matters that must be taken into account to determine the likely impact of an activity on the environment. The relevant documents can be found online at the following locations:

1 EP&A Act and EP&A Regulation: www.legislation.nsw.gov.au/maintop/scanact/inforce/NONE/0

2 DoPI's guidelines "Is an EIS required?":
www.planning.nsw.gov.au/assessingdev/pdf/gu_isaneisrequired.pdf

3 DECC's "Interim Community Guidelines for Community Consultation":
www.nationalparks.nsw.gov.au/PDFs/interim_consulation_guidelines.pdf

4 DPE SEPP Vegetation (Non Rural Areas) 2017 Guidelines
http://www.planning.nsw.gov.au/~/media/Files/DPE/Factsheets-and-faqs/faqs-for-councils-vegetation-sepp-2017-09.ashx

http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SensitiveValues

TABLE 4B – EPBC Act Assessment

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Protected Matters Search tool (http://environment.gov.au/epbc/protected-matters-search-tool) was accessed on the 9 April 2020, to identify the relevant matters of the Act that pertain to the study area. The Protected Matters Report is provided as *Appendix H*, and the information from the report summarised below.

Item	RELEVANT POLICY/GUIDELINE:	Tick one	
4B.1	Any environmental impact on a World Heritage Property?	☐ Yes	☑ No
4B.2	Any environmental impact on Wetlands of International Importance?	☐ Yes	☑ No
4B.3	Any environmental impact on National Heritage Place?	☐ Yes	☑ No
4B.4	Any environmental impact on Commonwealth listed Threatened Species or Ecological Communities? Refer to ecological assessment in *Section 1.4* and *Appendix E* for details that no significant impact to Commonwealth listed Threatened Species or Ecological Communities, hence referral and further consideration is not necessary.	☐ Yes	☑ No
4B.5	Any environmental impact on Commonwealth listed Migratory Species? Refer to ecological assessment in *Section 1.4* and *Appendix D* and *E* for details that no significant impact to Commonwealth listed Migratory Species, hence referral and further consideration is not necessary.	☐ Yes	☑ No
4B.6	Does any part of the proposal involve a Nuclear Action?	☐ Yes	☑ No
4B.7	Any environmental impact on a Commonwealth Marine Area?	☐ Yes	☑ No
4B.8	Any impact on Commonwealth land?	☐ Yes	☑ No

5 **NOTE:** You must tick ☐ No in Table 4B above to proceed with the project or obtain approval from the Commonwealth, For information to assist with completing Table 4B refer to the EPBC Act and the Environmental Defenders' Office Fact Sheet 3. http://www.edo.org.au/edonsw/site/factsh/fs03_1.php

References

Aaso (2019) **Lake Cathie and Lake Innes Acid Sulfate Soil Risk Assessment**. NSW Local Land Services - Soil Conservation Service.

ARS (2013) **Lake Innes: Waterbird Assessment.** Avifauna Research and Services

BMT WBM (2011) **Lake Cathie / Lake Innes Estuary Hydrodynamic Model Development and Investigation (Final Report).**

DPI (Fisheries) (n.d) **Management of coastal lakes and lagoons in NSW**. Sourced from https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw), Department of Primary Industries (Fisheries)

DECCW (2010) **Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales,** Department of Environment, Climate Change and Water

DPI (Fisheries) (2017) **Primefact - Southern Purple Spotted Gudgeon – *Mogurnda adspersa***. Primefact 1275, second edition, Threatened Species Unit, Department of Primary Industries (Fisheries)

GHD (2004) **Maintenance Dredging of Lake Cathie Review of Environmental Factors**, September 2004, Prepared for Hastings Shire Council.

Landcom (2004), **Managing Urban Stormwater: Soils and Construction, Volume 1, NSW Government.**

PMHC (2007) **Port Macquarie-Hastings Council Dredging Strategy**, Port Macquarie-Hastings Council, September 2007.

Webb, McKeown and Assoc. (1994) **Lake Cathie/Lake Innes Estuary Management Plan**. Webb, McKeown and Associates Pty Ltd - Consulting Engineers.

Webb, McKeown and Assoc. (1995) **Lake Cathie/Lake Innes Entrance Strategy Environmental Review**. Webb, McKeown and Associates Pty Ltd - Consulting Engineers.

TABLE 5 – DECISION

STEPS 11- 12

Person who prepares the EIA

I certify to the best of my knowledge that:

- I have completed this REF and
- The assessment meets the requirements of sections 5.5 and 5.7 of the EP&A Act, clause 228 of the EP&A Regulation and other relevant legislation and guidelines and
- The information contained in the REF is not materially misleading, and
- My assessment has been adequately completed, and
- My conclusion as to the likely environmental impact of the project is reasonable, and
- The community impacts are likely to be ☐ LOW ☐ MODERATE ☑ HIGH (tick one) though are noted to be manageable and are for ultimate public benefit, and
- There are HIGH Environmental Scores (rating>10) ☑ NO ☐ YES (tick one).
- I am satisfied that, subject to the inclusion of the mitigation measures included in table 4 included in Schedule 1 , the project will not have a significant impact on the environment during both the construction and operation phases.

Signature		**Date**	**04-05-2020**
Name	**Blayne West**	**Position**	**Natural Resource Manager**
Site Inspected	**Yes**	**Date**	**19-4-2020**

TABLE 5 – SIGN OFF

Determining Officer – Council Officer Who Verifies the RFF

I certify to the best of my knowledge and on behalf of Port Macquarie Hastings Council that:

☐ Based on the completed REF and my knowledge of the project, the assessment has been adequately completed, the project has minor and predictable impacts, the conclusion as to the likely environmental impact of the project is reasonable **and the project can proceed** subject to the relevant control measures and conditions in any approvals, licences or permits.

OR

☐ The project requires additional environmental assessment because:

- There are any HIGH Environmental Scores (rating>10) **TABLE 4**

NOTE: A site visit may be required depending on level of confidence and risk to the environment.

Signature		**Date**	**06-05-2020**
Name	**Jeffery Sharp**	**Position: Director Strategy and Growth**	

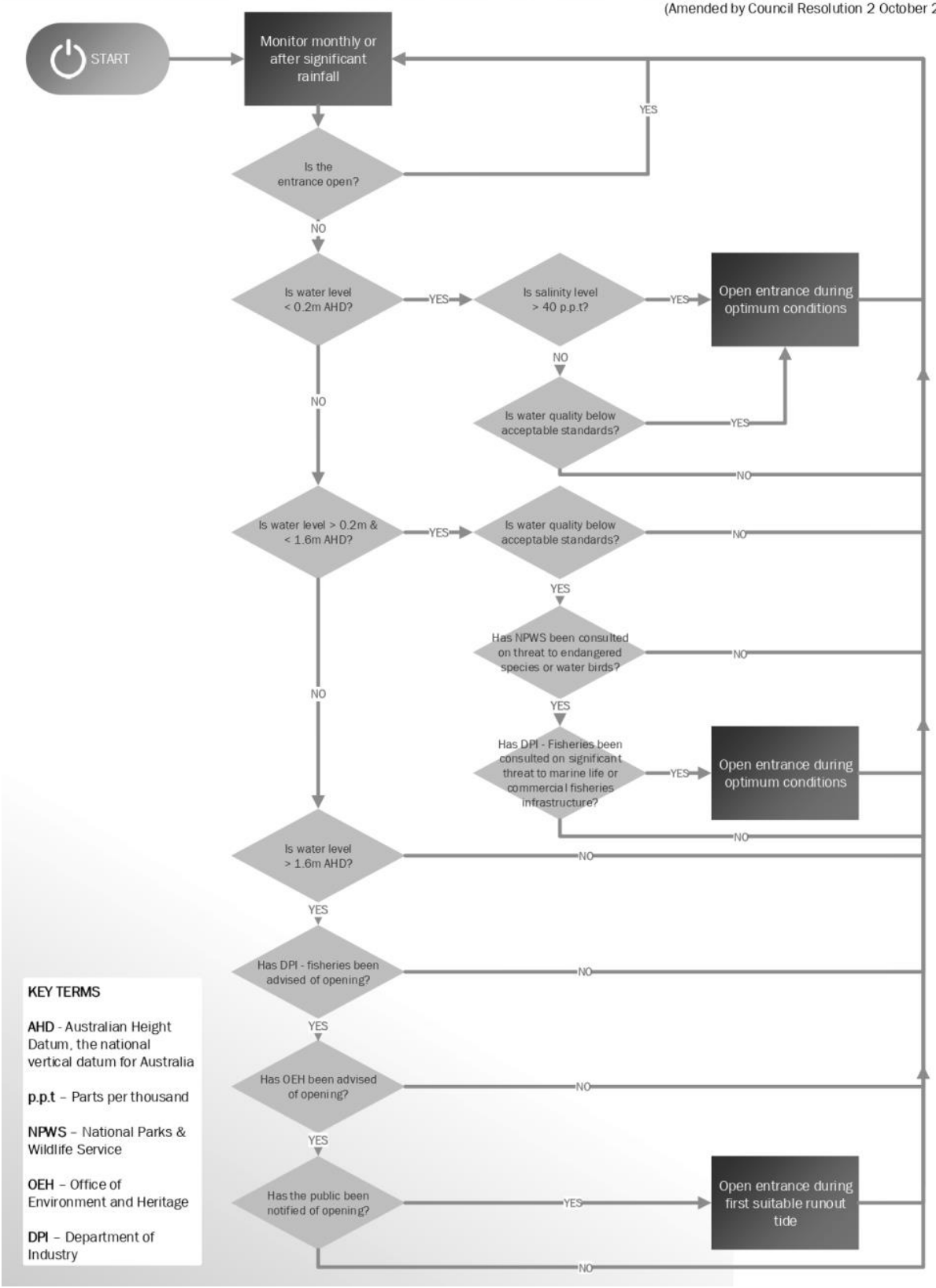
Appendices

Appendix A - Opening Strategy

PORT MACQUARIE HASTINGS COUNCIL

LAKE CATHIE
COMBINED ENTRANCE OPENING STRATEGY

(Amended by Council Resolution 2 October 2001)



Appendix B - Plans of Proposed Activity

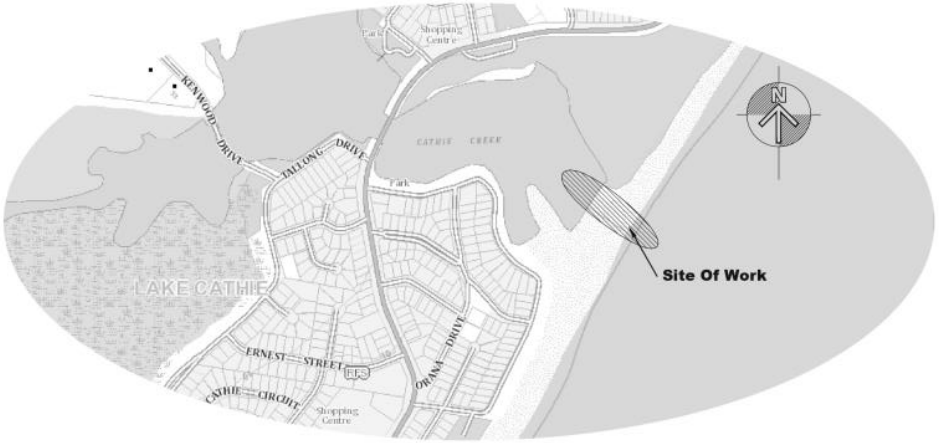
PORT MACQUARIE-HASTINGS COUNCIL

PORT MACQUARIE HASTINGS COUNCIL

LAKE CATHIE OPENING
NORTH CHANNEL

GENERAL NOTES

1. ALL LEVELS IN METRES TO AHD. ALL COORDINATES IN METRES TO MGA.
2. ALL WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH AUSPEC #1 CONSTRUCTION SPECIFICATIONS EDITION THREE 2004, AND THE TECHNICAL SPECIFICATION FOR THE WORKS. WHERE DIFFERENCES EXIST BETWEEN THE PLANS, THE TECHNICAL SPECIFICATION AND THE AUSPEC REQUIREMENTS, THESE PLANS SHALL TAKE PRECEDENCE.
3. THE CONTRACTOR SHALL NOT ENTER OR WORK IN ADJOINING PROPERTIES WITHOUT WRITTEN PERMISSION FROM THE PROPERTY OWNERS OR RESPONSIBLE AUTHORITIES.
4. THE CONTRACTOR SHALL CONTROL SEDIMENTATION, EROSION AND POLLUTION DURING CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE CURRENT EDITION OF THE 'SOILS AND CONSTRUCTION - MANAGING URBAN STORMWATER, HANDBOOK (OTHERWISE REFERRED TO AS THE 'BLUE BOOK'), COUNCIL AND THE APPROVED SOIL AND WATER MANAGEMENT PLAN.
5. THE CONTRACTOR WILL BE RESPONSIBLE FOR THE REPAIR OF ANY DAMAGE TO COUNCIL'S INFRASTRUCTURE. SUCH REPAIR OR REINSTATEMENT IS TO BE CARRIED OUT IMMEDIATELY TO THE SATISFACTION OF COUNCIL.



LOCALITY PLAN
NOT TO SCALE

LIST OF DRAWINGS

1. COVER SHEET
2. PLAN, DETAILS AND NOTES

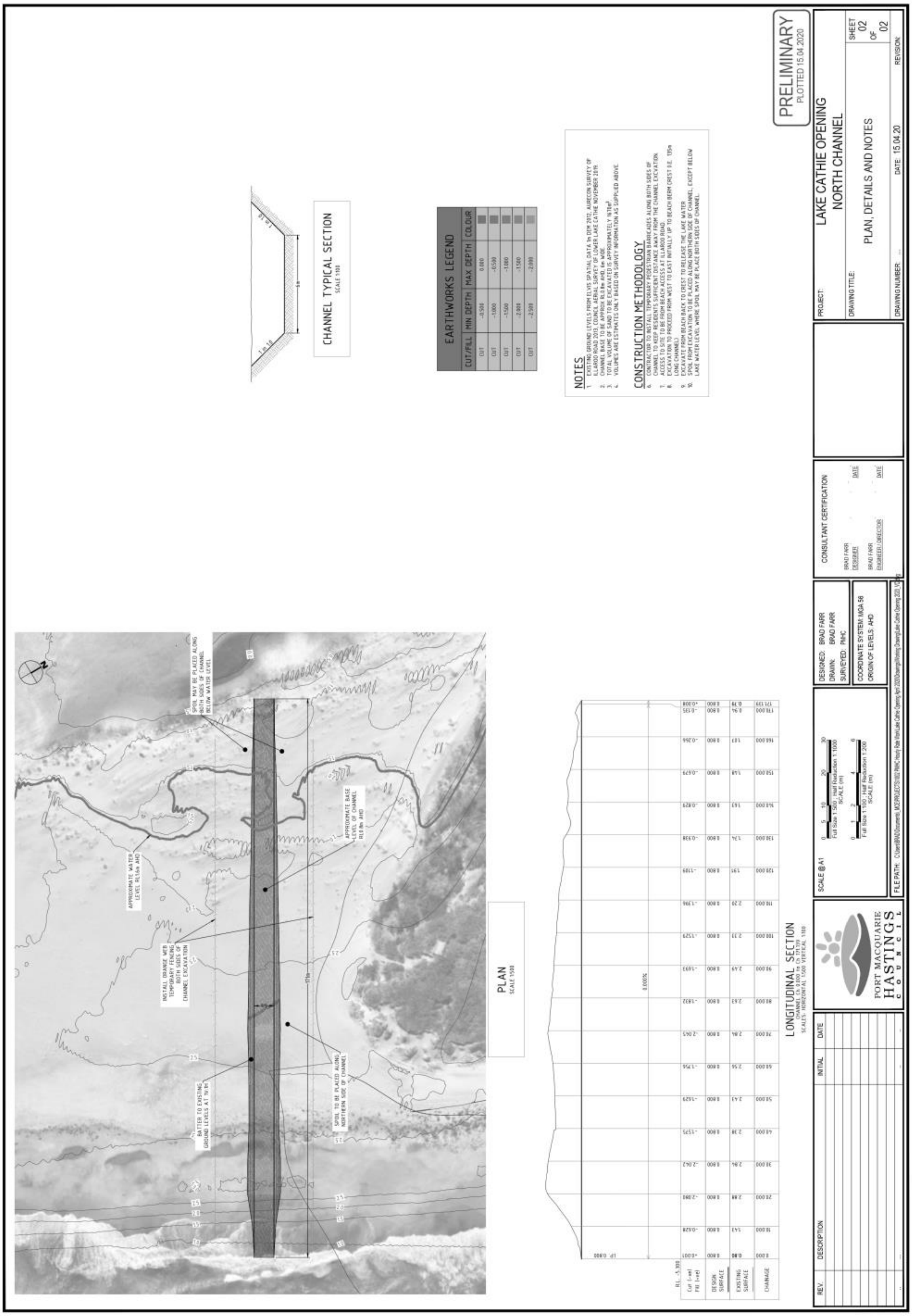
DIAL BEFORE YOU DIG
www.1100.com.au

CONTACT DIAL BEFORE YOU DIG PRIOR TO COMMENCING ANY EXCAVATION WORKS

ISSUE:
DATE 15.04.20

SHEET NO. 1 OF 2

PLAN NO. ....


PRELIMINARY
PLOTTED 15.04.2020
LAKE CATHIE OPENING
NORTH CHANNEL
PLAN, DETAILS AND NOTES
CHANNEL TYPICAL SECTION
EARTHWORKS LEGEND
NOTES
CONSTRUCTION METHODOLOGY
PLAN
LONGITUDINAL SECTION
PORT MACQUARIE HASTINGS COUNCIL

Appendix C - PMHC Standard Opening Procedure (SOP)

PORT MACQUARIE-HASTINGS COUNCIL

Lake Cathie

Standard Opening Procedure

pmhc.nsw.gov.au/lake-cathie

For enquiries please contact Council on (02) 6581 8787 or email council@pmhc.nsw.gov.au.

2 PORT MACQUARIE-HASTINGS COUNCIL

Introduction

Principles

- Staff makes decisions that are aligned with the adopted Lake Cathie Opening strategy
- Communication will be pre-approved by Group Manager before released on social media
- Opening to be approved by the General Manager in consultation with the Mayor following advice to Councillors

Rules to follow

- Checklist is to be enacted by Coast, Estuary, Flood Officer once level hits 1.4 m all staff that have actions are asked to fill out checklist as work is completed
- All correspondence is to be saved in appropriate TRIM containers
- Each year during the months of November/December the REF for Lake Cathie is reviewed and updated as required. An endorsed REF must be completed by February 1st each year which includes a drawing/plan for opening include detail on the location of excavation and estimated amount of sand being removed
- Once a recommendation to proceed with opening the Lake is issued by the NRM team a decision by the General Manager in consultation with the Mayor will be made within 48 hours.
- Email to Crown lands must be sent on the same day as approval is granted from the General Manager
- Notification of the opening is to be provided to DPIE-Fisheries, DPIE-Environment and Heritage before an artificial opening is enacted
- Notification to surrounding properties and the community is to be undertaken before an artificial opening is enacted

Table of Contents

pmhc.nsw.gov.au/lake-cathie

For enquiries please contact Council on (02) 6581 8787 or email council@pmhc.nsw.gov.au.

3 PORT MACQUARIE-HASTINGS COUNCIL

Water level reaches 1.4 in height

and is rising or has risen to this level quickly

ACTION	RESPONSIBILTY
2 x daily checks of Lake Cathie water levels published on MHL website at 9:00am and 4:00pm Log levels in excel sheet -> Content Manager (CM)	*Coast, Estuary, Flood Officer*
Communications	
Council is aware and is watching water levels. Council has mechanisms in place to open the lake in an emergency or if water levels reach 1.6m and optimal conditions prevail.	*Coast, Estuary, Flood Officer*
Draft communications sent through to NRM Manager and Group Manager for approval.	*Coast, Estuary, Flood Officer/ NRM Manager*
Approved communications sent through Communications team for distribution.	*Environmental and Regulatory Services GM*
Email to Senior Project Manager Transport and Stormwater, NRM Manager, Group Manager and Director to make them aware of situation	
Please be advised that the water level at Lake Cathie has reached 1.4m. Levels will now be monitored twice daily to determine whether an opening may be required. Further advice will be provided when the level reaches 1.5m at which time an on-site inspection will be carried out to record impact on infrastructure and homes. Please find attached the following: 1. Endorsed REF for opening Lake Cathie in a flood event. 2. Checklist for actions – if you are responsible for an action please record in CM ***<insert document number>*** when you have completed that action on this attached checklist. Also, please ensure I am cc'd on all appropriate correspondence, so I can record this in CM.	*Coast, Estuary, Flood Officer*

4 PORT MACQUARIE-HASTINGS COUNCIL

Water level reaches 1.5 in height

ACTION	RESPONSIBILTY
2 x daily checks of Lake Cathie water levels published on MHL website at 9:00am and 4:00pm Log levels in excel sheet -> Content Manager (CM) Media/Comms update required	*Coast, Estuary, Flood Officer*
Site visit to Lake Cathie • Photos of infrastructure and homes that effected. • Photos and notes of any issues identified. • File note recorded in CM.	*Coast, Estuary, Flood Officer*
Email to all Council asset owners Impacted The water levels at Lake Cathie have reached 1.5m. Council staff visited the site on **<date>**. As per the site inspection the following assets are being impacted: • **<include description or level of inundation>** Council asset owners are asked to manage their individual assets as they see appropriate and to please notify (Officer's name) **when** or **if any action** to mitigate issues has taken place by **<date>** (one day turnaround if possible). This information will be used as part of the community engagement that will be forthcoming.	*Coast, Estuary, Flood Officer*
File correspondence sent and received into CM	*Coast, Estuary, Flood Officer*

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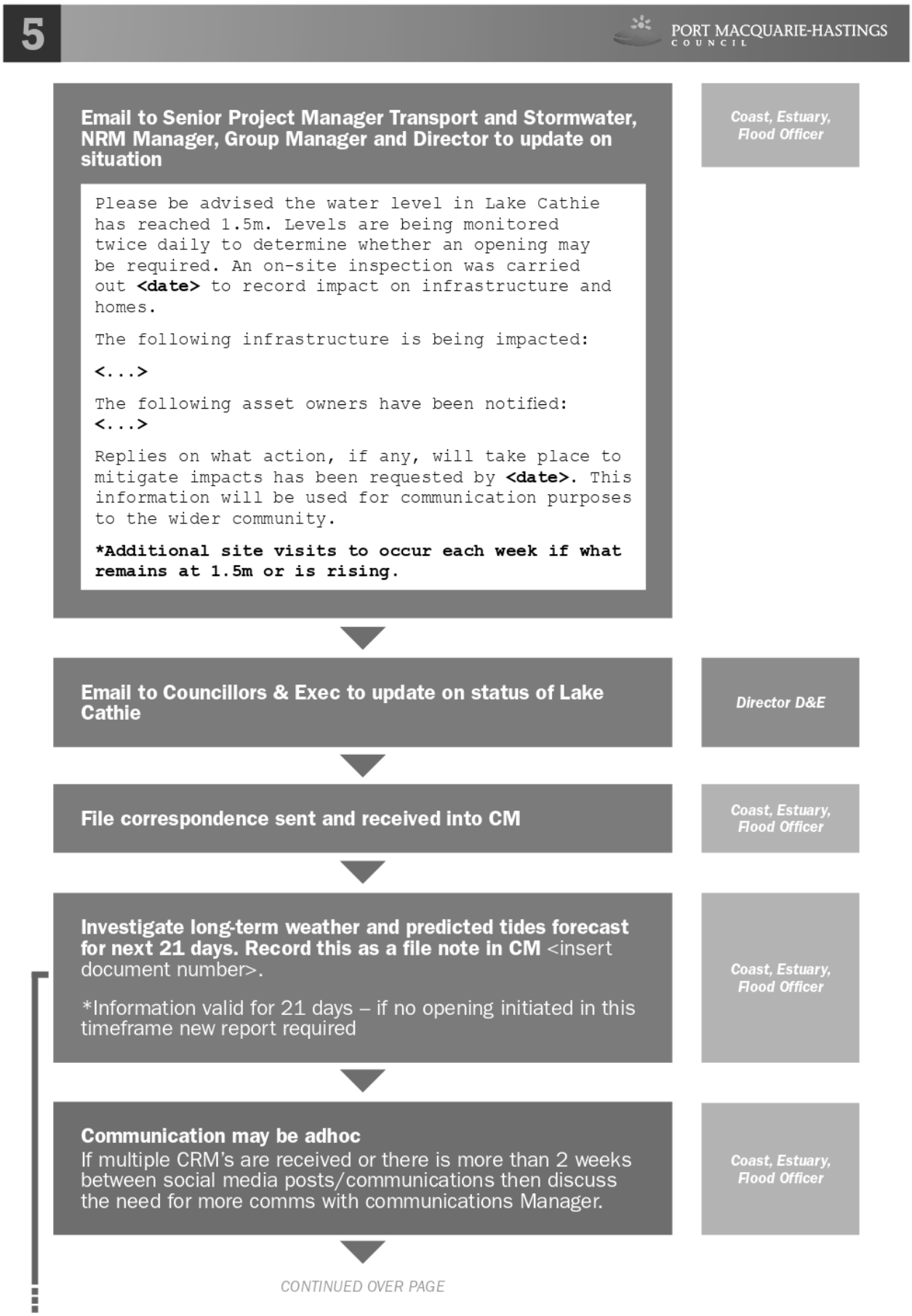
5
PORT MACQUARIE-HASTINGS COUNCIL
Email to Senior Project Manager Transport and Stormwater, NRM Manager, Group Manager and Director to update on situation
Please be advised the water level in Lake Cathie has reached 1.5m. Levels are being monitored twice daily to determine whether an opening may be required. An on-site inspection was carried out <date> to record impact on infrastructure and homes.
The following infrastructure is being impacted:
<...>
The following asset owners have been notified:
<...>
Replies on what action, if any, will take place to mitigate impacts has been requested by <date>. This information will be used for communication purposes to the wider community.
*Additional site visits to occur each week if what remains at 1.5m or is rising.
Coast, Estuary, Flood Officer
Email to Councillors & Exec to update on status of Lake Cathie
Director D&E
File correspondence sent and received into CM
Coast, Estuary, Flood Officer
Investigate long-term weather and predicted tides forecast for next 21 days. Record this as a file note in CM <insert document number>.
*Information valid for 21 days – if no opening initiated in this timeframe new report required
Coast, Estuary, Flood Officer
Communication may be adhoc
If multiple CRM's are received or there is more than 2 weeks between social media posts/communications then discuss the need for more comms with communications Manager.
Coast, Estuary, Flood Officer
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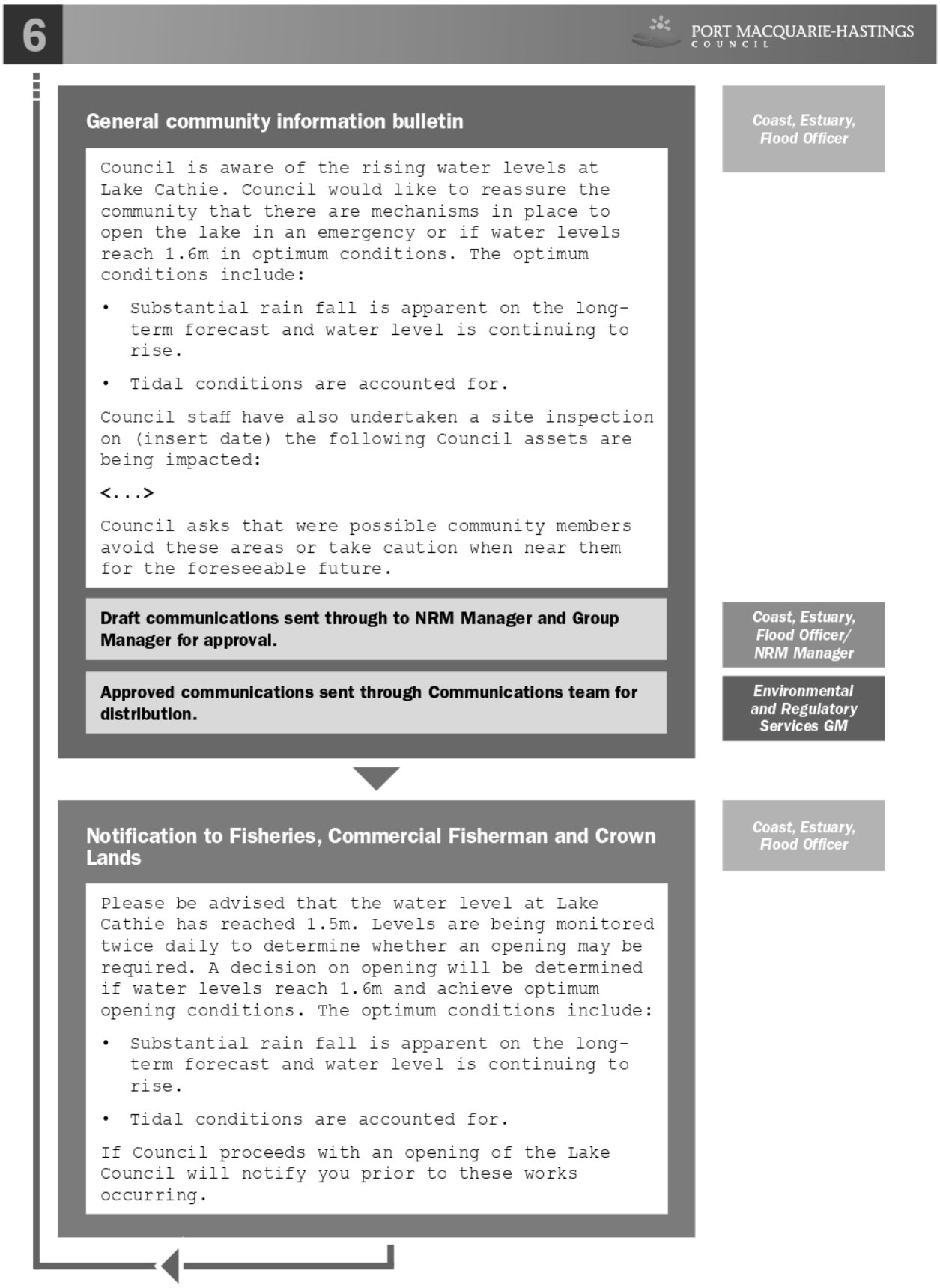
6
PORT MACQUARIE-HASTINGS COUNCIL
General community information bulletin
Council is aware of the rising water levels at Lake Cathie. Council would like to reassure the community that there are mechanisms in place to open the lake in an emergency or if water levels reach 1.6m in optimum conditions. The optimum conditions include:
• Substantial rain fall is apparent on the long-term forecast and water level is continuing to rise.
• Tidal conditions are accounted for.
Council staff have also undertaken a site inspection on (insert date) the following Council assets are being impacted:
<...>
Council asks that were possible community members avoid these areas or take caution when near them for the foreseeable future.
Draft communications sent through to NRM Manager and Group Manager for approval.
Approved communications sent through Communications team for distribution.
Coast, Estuary, Flood Officer
Coast, Estuary, Flood Officer/ NRM Manager
Environmental and Regulatory Services GM
Notification to Fisheries, Commercial Fisherman and Crown Lands
Please be advised that the water level at Lake Cathie has reached 1.5m. Levels are being monitored twice daily to determine whether an opening may be required. A decision on opening will be determined if water levels reach 1.6m and achieve optimum opening conditions. The optimum conditions include:
• Substantial rain fall is apparent on the long-term forecast and water level is continuing to rise.
• Tidal conditions are accounted for.
If Council proceeds with an opening of the Lake Council will notify you prior to these works occurring.
Coast, Estuary, Flood Officer

7 PORT MACQUARIE-HASTINGS COUNCIL

Water level reaches 1.6 in height

ACTION	RESPONSIBILTY
2 x daily checks of Lake Cathie water levels published on MHL website at 9:00am and 4:00pm Log levels in excel sheet -> Content Manager (CM)	*Coast, Estuary, Flood Officer*
Site visit to Lake Cathie • Photos of infrastructure and homes that effected. • Photos and notes of any issues identified. • File note recorded in CM.	*Coast, Estuary, Flood Officer*
Email to all Council asset owners Impacted The water levels at Lake Cathie have reached 1.6m. Council staff visited the site on XXX. As per the site inspection the following assets are being impacted: - (include description or level of inundation) Council asset owners are asked to manage their individual assets as they see appropriate and to please notify **<Officer's name>** when or if any action to mitigate issues has taken place by **<date>** (one day turnaround if possible). This information will be used as part of the community engagement that will be forthcoming. Staff are actively managing for the opening of Lake Cathie. Information will be forthcoming as soon as a decision is made as to whether the lagoon will be opened and the timing.	*Coast, Estuary, Flood Officer*
Investigate long-term weather and predicted tides forecast for next 21 days. Record this as a file note in CM <insert document number>. *Information valid for 21 days – if no opening initiated in this timeframe new report required	*Coast, Estuary, Flood Officer*

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8 PORT MACQUARIE-HASTINGS COUNCIL

Email to Senior Project Manager Transport and Stormwater, NRM Manager, Group Manager and Director to update on situation

Coast, Estuary, Flood Officer

Please be advised that the water level at Lake Cathie has reached 1.6m. Levels are being monitored twice daily to determine whether an opening may be required. The following on-site inspections have occurred:

<Insert date, infrastructure impacted and actions to mitigate impact>.

Based on the 21-day long-term forecast which is predicted to be **<insert information>** and the tides **<insert relevant information>**, we are recommending the following action be taken:

Option 1 - Lake Cathie be opened to alleviate flooding issues. Detailed information will be sent to relevant Council staff to initiate the opening.

Option 2 - Lake Cathie is not opened at this time due to:

- Stabilised lake levels
- No rainfall on the long-term forecast or minimal rainfall on the long-term forecast
- Mitigation measures in place as listed above to alleviate issues of impact on Council infrastructure.

Due to the urgent nature of this decision I am requesting a response to the opening of Lake Cathie within 48 hours please.

Email to Councillors to update on status of Lake Cathie

Director D&E

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General community information bulletin

Coast, Estuary, Flood Officer

The water level at Lake Cathie has reached 1.6m as such Council is now making a decision if an opening of the Lake will take place. The decision to open is based on the optimum conditions being met. Which include:

- Substantial rain fall is apparent on the long-term forecast and water level is continuing to rise.
- Tidal conditions are accounted for.

Council asks that where possible, community members avoid areas that are impacted by any flood water inundation during this time. Once a decision has been made by Council the community will be notified with further information.

Draft communications sent through to NRM Manager and Group Manager for approval.

Coast, Estuary, Flood Officer/ NRM Manager

Approved communications sent through Communications team for distribution.

Environmental and Regulatory Services GM

Notification to Fisheries, Commercial Fisherman and Crown Lands

Coast, Estuary, Flood Officer

The water level at Lake Cathie has reached 1.6m as such Council is now making a decision if an opening of the Lake will take place. The decision to open is based on the optimum conditions being met. Which include:

1. Substantial rain fall is apparent on the long-term forecast and water level is continuing to rise.
2. Tidal conditions are accounted for.

Council asks that were possible community members avoid areas that impacted by any flood water inundation during this time. Once a decision has been made by Council the community will be notified with further information.

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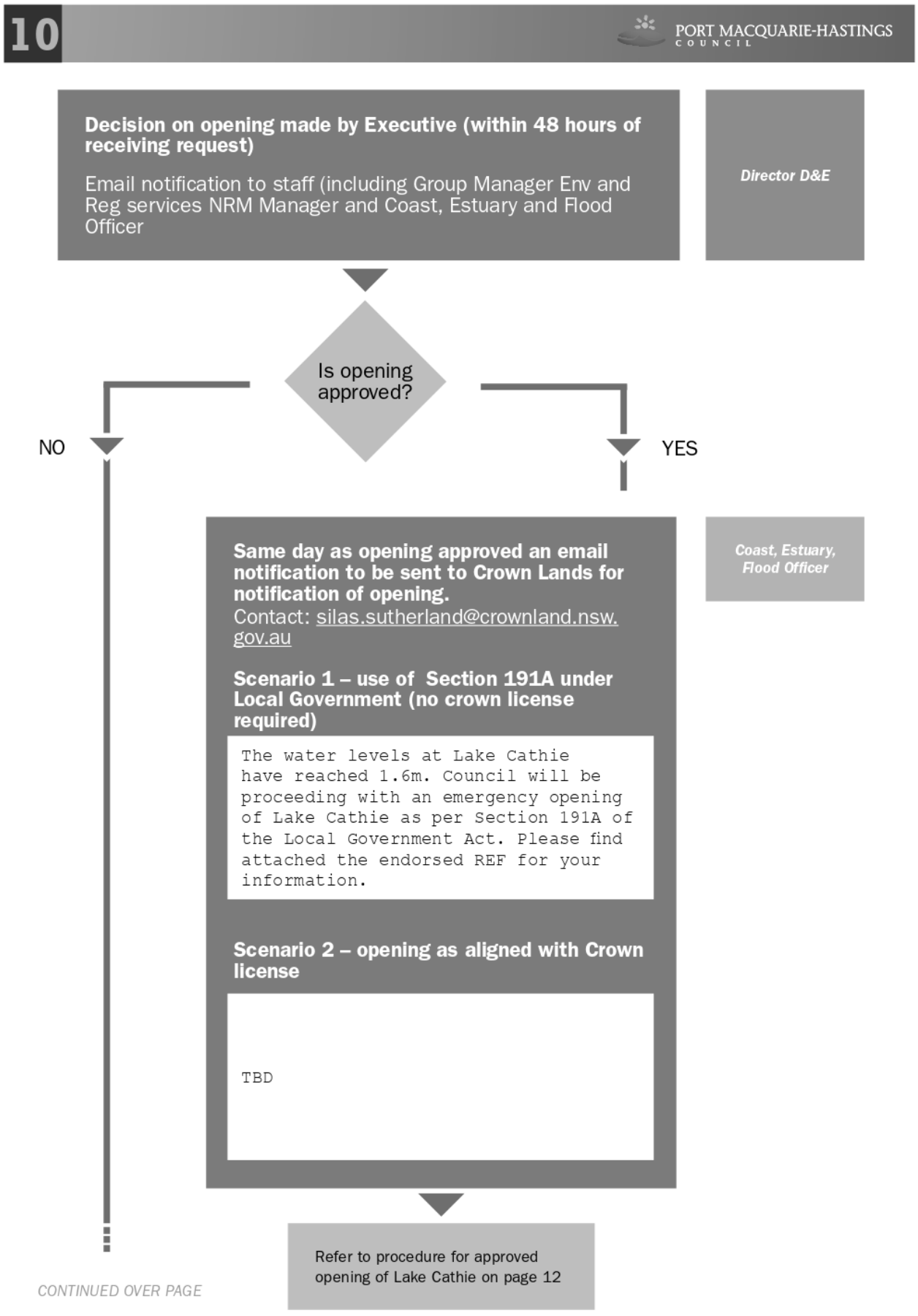
10
PORT MACQUARIE-HASTINGS COUNCIL
Decision on opening made by Executive (within 48 hours of receiving request)
Email notification to staff (including Group Manager Env and Reg services NRM Manager and Coast, Estuary and Flood Officer
Director D&E
Is opening approved?
NO
YES
Same day as opening approved an email notification to be sent to Crown Lands for notification of opening.
Contact: silas.sutherland@crownland.nsw.gov.au
Coast, Estuary, Flood Officer
Scenario 1 – use of Section 191A under Local Government (no crown license required)
The water levels at Lake Cathie have reached 1.6m. Council will be proceeding with an emergency opening of Lake Cathie as per Section 191A of the Local Government Act. Please find attached the endorsed REF for your information.
Scenario 2 – opening as aligned with Crown license
TBD
Refer to procedure for approved opening of Lake Cathie on page 12
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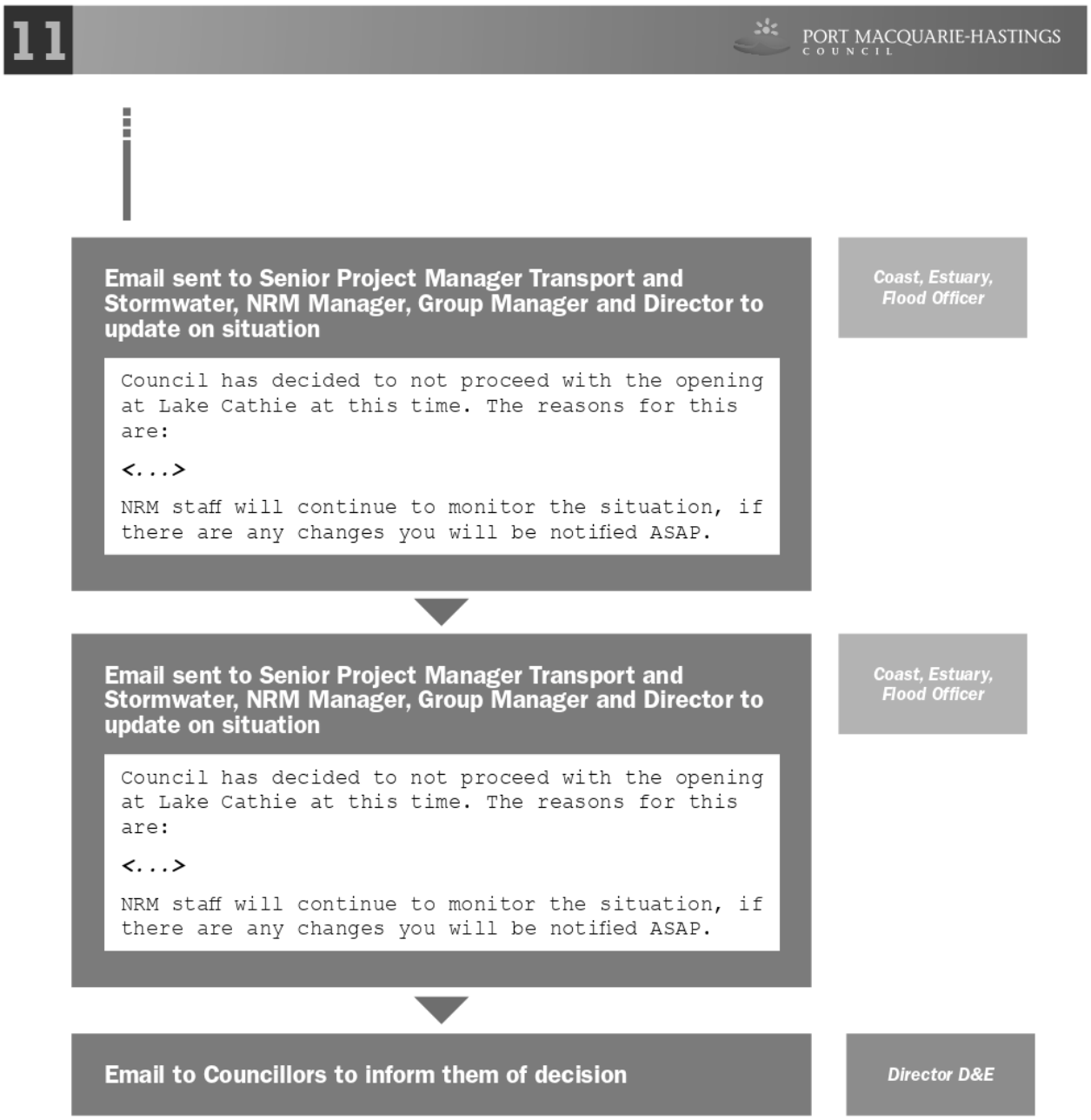
11
PORT MACQUARIE-HASTINGS COUNCIL
Email sent to Senior Project Manager Transport and Stormwater, NRM Manager, Group Manager and Director to update on situation
Council has decided to not proceed with the opening at Lake Cathie at this time. The reasons for this are:
<...>
NRM staff will continue to monitor the situation, if there are any changes you will be notified ASAP.
Coast, Estuary, Flood Officer
Email sent to Senior Project Manager Transport and Stormwater, NRM Manager, Group Manager and Director to update on situation
Council has decided to not proceed with the opening at Lake Cathie at this time. The reasons for this are:
<...>
NRM staff will continue to monitor the situation, if there are any changes you will be notified ASAP.
Coast, Estuary, Flood Officer
Email to Councillors to inform them of decision
Director D&E

12 PORT MACQUARIE-HASTINGS COUNCIL

Procedure for approved opening

Steps to be followed immediately after approval issued

ACTION	RESPONSIBILTY
Immediately after receiving confirmation from Exec of opening the Lake: • Email to Infrastructure delivery - Senior Project Manager Transport and Stormwater Network making them aware of the situation. • Formal memo provided for works to commence	*Coast, Estuary, Flood Officer*
Councillors are informed of decision	*Director D&E*
Notification to Fisheries, Commercial Fisherman and Crown Lands Please be advised that the water level at Lake Cathie has reached 1.6m. A decision has been made to open Lake Cathie. Council is currently making the necessary provisions to do so. When a date and time is finalized, we will contact you again.	*Coast, Estuary, Flood Officer*
Notification to Council staff Please be advised that the water level at Lake Cathie has reached 1.6m. A decision has been made to open Lake Cathie. Council is currently making the necessary provisions to do so. When a date and time is finalized, we will contact you again.	*Coast, Estuary, Flood Officer*
Contract excavator contacted and engaged and Watercraft for washdown at end of the day	*Project Delivery officer*

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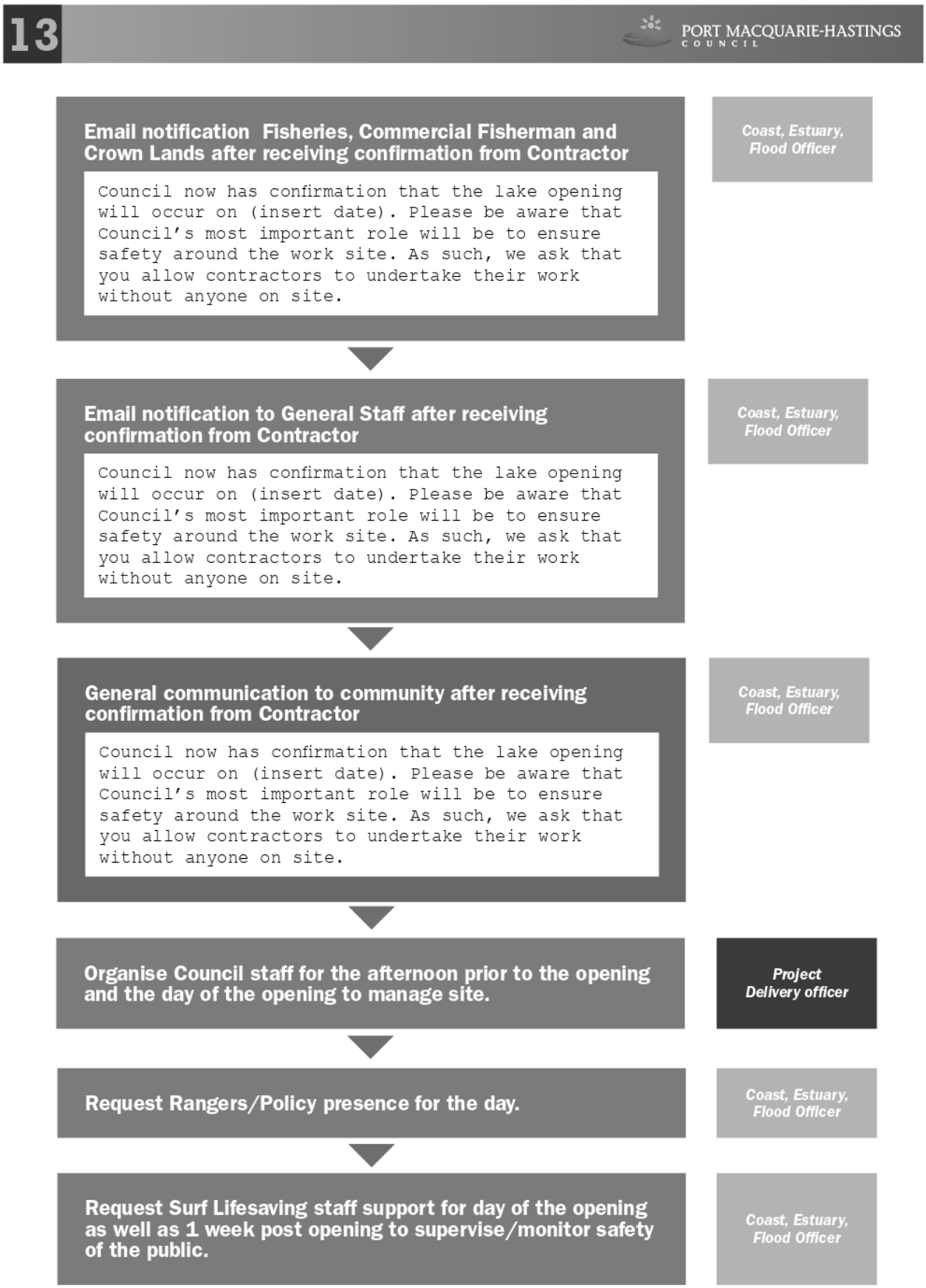
13
PORT MACQUARIE-HASTINGS COUNCIL
Email notification Fisheries, Commercial Fisherman and Crown Lands after receiving confirmation from Contractor
Council now has confirmation that the lake opening will occur on (insert date). Please be aware that Council's most important role will be to ensure safety around the work site. As such, we ask that you allow contractors to undertake their work without anyone on site.
Coast, Estuary, Flood Officer
Email notification to General Staff after receiving confirmation from Contractor
Council now has confirmation that the lake opening will occur on (insert date). Please be aware that Council's most important role will be to ensure safety around the work site. As such, we ask that you allow contractors to undertake their work without anyone on site.
Coast, Estuary, Flood Officer
General communication to community after receiving confirmation from Contractor
Council now has confirmation that the lake opening will occur on (insert date). Please be aware that Council's most important role will be to ensure safety around the work site. As such, we ask that you allow contractors to undertake their work without anyone on site.
Coast, Estuary, Flood Officer
Organise Council staff for the afternoon prior to the opening and the day of the opening to manage site.
Project Delivery officer
Request Rangers/Policy presence for the day.
Coast, Estuary, Flood Officer
Request Surf Lifesaving staff support for day of the opening as well as 1 week post opening to supervise/monitor safety of the public.
Coast, Estuary, Flood Officer

14 PORT MACQUARIE-HASTINGS COUNCIL

Procedure for approved opening

Steps to be followed 1 day prior to opening

ACTION	RESPONSIBILTY
Excavator floated to site in the afternoon preceding the opening. There is some associated traffic control for unloading at the end of Aqua Crescent.	*Project Delivery officer*
Excavator parked on the southern headland overnight.	*Project Delivery officer*
Council staff advise location of paraweb fencing.	*Coast, Estuary, Flood Officer*
Council staff erect paraweb fencing on either side of the agreed channel location	*Project Delivery officer*
"Dangerous Current' Signage installed	*Project Delivery officer*

15 PORT MACQUARIE-HASTINGS COUNCIL

Procedure for approved opening

Steps to be followed on day of opening and post opening management

ACTION	RESPONSIBILTY
General communication to community Council now will be undertaking the Lake Cathie opening today. Please be aware that Council's most important role will be to ensure safety around the work site. As such, we ask that you allow contractors to undertake their work without anyone on site.	*Coast, Estuary, Flood Officer*
Excavator walks out and commences dig working from east to west. Normally commences within the lake at depth (1 – 1.5m).	*Project Delivery officer*
Cut is made from the ocean side before the tide comes in too high to leave a small bund between west and east trench.	*Project Delivery officer*
Watercraft arrives mid-morning to wash out excavator at conclusion of opening.	*Project Delivery officer*
Bund is removed when both east and west trenches have been completed and sand has been pushed sufficiently clear of the channel.	*Project Delivery officer*
Bund normally removed to coincide with the next high tide.	*Project Delivery officer*

Appendix D - Lake Innes Waterbird Assessment - Avifauna Research and Services (2013)

Lake Innes: Waterbird Assessment

Avifauna Research & Services

March 2013

PO Box 2006, Rockdale, NSW 2216

Table of Contents

Introduction

Located on the mid-north coast of NSW approximately 8 km south of Port Macquarie, Lake Innes is a large coastal lake that was connected to Lake Cathie via Cathie Creek in 1933. At the present time the lake system is basically an ICOLL (Intermittently Closed and Open Lake or Lagoon), connected to the ocean at intervals when there is tidal flushing of the waterway.

In NSW the size and number of breeding habitats for many waterbird species have greatly diminished, largely due to human interference. This has resulted in a corresponding decline in the populations of species that depend on these habitats for survival, either as breeding grounds or as drought refuges. Some of these species are now listed as endangered in NSW, and in some cases nationally (for example the Australasian Bittern). These circumstances place an increasing importance on the management of wetlands for waterbird populations, to provide or restore the right environmental conditions for these habitats, especially those at risk of local or global extinction.

In the past there has been wholesale loss of freshwater wetlands in Australia through development, agricultural use and large-scale salination due to poor management processes. This has resulted in a steep decline in the numbers of waterbirds, especially those heading towards local extinction in NSW as well as the vegetation and fish communities that support them. The main consideration for the restoration of Lake Innes as a freshwater system that would support healthy populations of waterbirds all year round must be as an offset for this loss.

The remediation and management of wetlands, especially freshwater wetlands, for conservation purposes is a widespread practice worldwide, though it is applied at a comparatively low level in Australia. In some cases wetlands have been constructed from scratch while others have been restored or converted from highly degraded sites. By comparison the restoration of Lake Innes is relatively straightforward from an engineering and ecological perspective though it is highly unlikely that it could be restored to its original state. It may take a numbers of years to establish an ecosystem approximating its former value.

Because of the climatic conditions in Australia all waterbirds are forced to be nomadic at certain times. During periods of drought they must be prepared to leave an area when the water is drying up and fly, often over great distances, to find other stretches of water where they can take refuge. This nomadic life is not without hazard. For example in 1958 a severe drought dried out inland waters resulting in huge numbers of waterbirds being forced to leave. “The result of this exodus”, wrote Frith, “was that by the middle of 1958 the inland was almost devoid of teal, but every swamp and water body on the coast and highlands carried unprecedented numbers including areas where Grey Teal are not normally common.” Bird banding revealed that during 1957 and 1958 “the teal were flying back and forth across the continent, in all directions, searching for water, in what can only be described as a desperation scatter. Those that found water survived, but the majority of birds were unsuccessful and perished.” (Frith 1967). On such occasions many teal also fly out to sea and, failing to find land, are drowned (Serventy 1985).

In Australia waterbirds tend to breed at inland ephemeral wetlands and only occur in significant numbers near the coast during times of severe drought in the inland areas of Australia. At such times the lack of drought refuges can mean the loss of huge numbers of waterbirds through starvation.

Confidence in the management of Lake Innes for waterbirds is based on the effective management of hundreds of degraded or altered wetlands worldwide. For example out of the 200 or so nature reserves managed by the Royal Society for the Protection of Birds in the UK about 100 are actively managed for wetland dependent species of birds. This includes restored and remediated natural wetland systems as well as the construction of extensive wetlands from agricultural land, gravel pits etc. Most of the 2000 plus Ramsar wetlands of international importance around the world are also managed to varying degrees for birds that are associated with wetland habitats. The longest history of success is at Minsmere Nature Reserve in the UK with a mixture of fresh and brackish systems (pers. obs. 1965 – 2010). The management of many of these wetland systems face challenges as or more complex than the Lake Innes closure.

Saltwater wetlands converted to freshwater are less common. However, extensive freshwater wetlands have been created on previous tidal areas, mangrove forest, and saltwater fishponds. These converted wetlands now support freshwater vegetation such as water lilies and many freshwater specialist waterbirds. An example is the extensive wetlands nature reserve at Mai Po in Hong Kong (pers. obs. 1999 – 2012). These examples have been highly successful although a far greater challenge than the proposed reversal of Lake Innes

Summary

Lake Innes was undoubtedly the largest and one of the most important freshwater wetlands in coastal New South Wales prior to its demise in 1933. Since that time the lake has been transformed from a relatively stable freshwater condition to a highly variable state as is typical of intermittently closed and open lakes and lagoons (ICOLLs) so common along the NSW coast. The consequence of this is that one of Australia's most important drought refuges for very large numbers of waterfowl has been highly degraded with a loss of a large number freshwater plant, fish and waterbird species that previously depended on the wetland. The situation has been exacerbated by the wholesale loss of wetlands of similar value from across much of Australia. Anything resembling the original state of Lake Innes would now qualify for nomination of a Ramsar wetland of international importance based on waterbirds alone.

Waterbird species that previously used Lake Innes have declined and are now listed as vulnerable or endangered under the TSC Act of NSW as well as nationally under the EPBC Act due to a large extent on the loss of the former values of the lake along so many other wetlands. Based on the above reasons Lake Innes should be restored if it is feasible.

A consequence of restoring Lake Innes to a comparatively deep freshwater wetland would be the loss of a large area of coastal saltmarsh as well as a commercial fishery dependant on fish and prawns that currently use Lake Innes during part of their life cycle. It would also result in loss of part of the available shorebird habitat at the north end of Cathie Creek that is accessible during periods after the lake has opened to the sea.

Coastal saltmarsh in the region of the Lakes' location is listed as an Endangered Ecological Community. This situation has to be balanced when deciding whether to raise the Lake to pre-existing water levels because a large part of the saltmarsh community would be lost to drowning or being out competed by other plant species. If the Lake is restored it would no doubt revert back to freshwater vegetation (see Boon 2013).

Freshwater vegetation typical of Lake Innes include water lilies and other floating vegetation, a dense fringing reedbed as well as other submerged and emergent plant species providing a complex aquatic ecosystem along with rich aquatic flora and fauna, supporting a wide range of waterbird species at the top of the food chain.

The original fish population was largely lost when Lake Innes was exposed to saltwater infiltration when opened to tidal influences. It is not known what native fish species were lost during the opening of the Lake but it would most likely take many years for a stable freshwater fish population to establish (see Lloyd 2013). However, it is likely that there would be a freshwater fish and aquatic invertebrate community established that would provide an adequate food supply to support waterbirds.

The challenge of reverting a salt influenced wetland the size of Lake Innes to a freshwater wetland is not without precedents, though the reverse has been more common and easy to achieve. Of the 2098 Ramsar sites across 164 countries most are managed to some extent for waterbirds. Some of these face similar challenges of maintaining or remediating freshwater wetlands affected by saltwater. One such wetland is part of the Mai Po Wetland Nature Park in Hong Kong where freshwater wetlands have been created on what was not so long ago mangrove forest and marine fishponds. These include salt sensitive plants such as water lilies and many birds that frequent freshwater wetlands.

The engineering solution to reverting Lake Innes is possible (see Rayner and Glamore 2013) although most likely costs will be considerable (see Aither 2013). The design will be important for managing water quality and well as water levels, water flows and fish passage, length of the levee etc.

To ensure its success a Lake Innes reversal project would have to be monitored on a regular basis by suitably experienced ecologists working in close association with engineers and the site managers.

Lake Innes historical context

Originally Lake Innes was the largest freshwater coastal lake in NSW and was not subject to tidal influence. It provided important habitat for species depending on freshwater wetlands. No systematic waterbird studies of the lake have been carried out, but it is evident from the information available that Lake Innes was once one of the most important drought refuges for waterbirds in eastern Australia. To a much lesser extent Lake Innes is still an important drought refuge, albeit for a smaller suite of different bird species, when water levels are suitable.

In its current state Lake Innes is regularly undergoing dramatic changes in conditions. This is typical of an ICOLL situation. Vegetation and fish communities have changed, with the loss of many species. Those now surviving in the lake have had to adapt to the rapidly changing conditions, waxing and waning as the lake varies in salinity and water depth when it opens and closes. These conditions suit some fish and crustaceans that respond to flushes of freshwater after heavy rains, which in turn suit some waterbirds over a relatively short period of time.

Although there are no comprehensive data for the waterbird population of Lake Innes it is evident that the lake was one of the most important freshwater lakes in NSW and probably on a national scale. The lake was particularly important as a drought refuge for thousands of waterbirds including species now listed as vulnerable or endangered under the TSC Act 1995. It also provided important breeding habitat for waterbirds, some of which are now listed as vulnerable or endangered under the TSC Act and EPBC Act. The snippets of information from the 'Dick Diaries' during a non-drought period in eastern Australia clearly show that the site would meet the criteria of a wetland of international significance (Ramsar listing) based on the numbers of waterbirds alone.

Count data for Lake Innes do not include systematic or comprehensive counts of the whole lake and can only provide an estimate of the minimum number of species present. The size of the lake would have made it difficult to observe and record all species occurring on the lake unless the whole area was covered by boat, which seldom if ever occurred. Regular counts at the Lake Innes Nature Reserve did not include waterbirds observed on the lake on a regular basis until 1996 and even then did not include comprehensive counts, recording presence only in the southern portion of the lake.

Other data sources are no more informative, based to a large extent on counts by local birdwatchers outlined above. For example the Atlas of Australian Birds 1977 – 1981 covered the whole of Australia but site coverage varied immensely and did not include records for specific sites, instead using a grid system to record birds of 1^0 blocks or 10' blocks where possible. Presence only was recorded, and there was no attempt to measure abundance. The New Atlas of Australian Birds 1998 – 2002 included distribution maps for four seasons of the year as well as a breeding distribution map. However it was decided that estimates of abundance would not include counts of birds and the printed version of the book did not include annotation of species.

Any count data provide an indication of the presence of a particular species at the site, whereas the lack of data is in no way an indication that species were not present at a particular time. Therefore an assessment of species presence has been made based on the likelihood of occurrence of birds using the available habitats at Lake Innes and the known occurrence of species in the area (Table 1). The likelihood of the occurrence of a species at Lake Innes is based on the variable habitat typical of the lake.

The current connection to Cathie Creek, and periodically with the ocean, provides passage of fish and other forms of aquatic fauna to and from the lake, a situation that may have occurred to some extent before the opening of the lake to Cathie Creek.

Lake Innes since becoming an ICOLL

Lake Innes, prior to linking to tidal influence, was no doubt the largest freshwater lake in coastal NSW and one of the most important drought refuges for waterbirds in Australia. Since the channel was cut between the lake and Cathie Creek in 1933 the character of the lake has changed dramatically. The lake now resembles an ICOLL similar in an ecological point of view to many of the 70 or so ICOLLs on the NSW coast. Any vegetation has to be able to withstand changes in water levels and salinity, sometimes at a rapid pace. For example some saltmarsh species such as *Sarcocornia quinqueflora* can withstand prolonged inundation and high levels of salt. The lake and its surrounds now support a large area of saltmarsh, which is listed as a threatened ecological community under the TSC Act 1995.

ICOLLs provide habitat for many waterbirds such as ducks, swans, grebes and a variety of other birds that take advantage of gradually increasing depths of water and often declining salinities until water levels become sufficient to breach berms and allow the system to drain to the sea. The habitat then changes rapidly to suit completely different groups of species such as shorebirds that take advantage of exposed mudflats and other species of waterbirds that favour the newly exposed habitats and aquatic life. The time the open or closed system is maintained depends on the balance between the height of seas to push back the sand across the mouth of the ICOLL and the force of fresh water to maintain the open system. As such the wetland may only provide habitat for a relatively short period of time for species such as shorebirds and may not provide a reliable habitat for those species that tend to be site faithful. This presents a conflict when determining a management plans for ICOLL wetlands as to which communities they should be managed for. An example is Lake Wollumboola on the NSW south coast, where Birdlife Australia faced the dilemma of whether to list the site as an internationally important bird area (IBA) for the Black Swan that occurs at the site in very large numbers when the lake water level is high, or for the many species of migratory shorebirds that may pass through the wetland on migration stopping to use the site when water levels are low. The former group was chosen due to the unreliability of habitat for shorebirds, which would be very difficult to maintain.

Prior to the opening of Lake Innes to tidal flows the Lake provided a rare and valuable freshwater habitat for many waterbird species and was undoubtedly one of the most important drought refuges for many species on the east Australian coast. The opening of the lake clearly changed all this and resulted in a system that is highly variable system benefiting many species some of the time, but few species all of the time.

The drainage of the lake in 1933 had a devastating effect on the waterbirds, freshwater vegetation and fisheries over a two-year period from 1933 to the end of 1934, by which time the nature of the lake had almost totally changed. Particularly hard hit were ducks such as Hardhead, Freckled Duck, Pacific Black Duck, Australasian Shoveler, Pink-eared Duck, Grey Teal and other waterbirds including Comb-crested Jacana, Eurasian Coot, crakes, rails, moorhens and swamphens. The last of the freshwater fish such as the freshwater catfish and most of the salt intolerant vegetation such as water lilies appeared to be dead by the beginning of 1935.

Since the alteration of the hydrology of the lake it has become an ICOLL where habitats adjust due to changing conditions, suiting different bird species whether the lake is full of largely freshwater or periodically drained to the sea when it acquires characteristics similar to those of an estuary. During current high water levels, when the lake is separated from the sea, it still attracts large numbers of ducks but not to the extent as in the pre-1930s. At low water level the lake entrance and Cathie Creek attract a variety of shorebirds that visit the site opportunistically, as it does not provide consistent quality habitat for these birds. Juvenile migratory shorebirds that have not yet become site faithful and are moving through on migration may stay in the area until conditions change and they are forced to move elsewhere.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be considered as important habitat under the EPBC classified as significant under the EPBC Act Policy Statement 3.21 for migratory species.

Hardhead prefer deep permanent freshwater lakes and swamps in which to live. Unfortunately, the number of suitable refuges has been greatly reduced since European settlement by the drainage of so many swamps and lakes for grazing. There is a good deal of evidence from A. J. North and other writers that until 1900 White-eyed Ducks [Hardhead] outnumbered all other species on the coasts of New South Wales and Victoria. Today the species is relatively uncommon on the coast of New South Wales though small flocks still appear there. In 1929 there were 8-10,000 Hardheads on Lake Innes and as late as 1933 A. Dick counted a flock of 4000 on the lake, which was then still freshwater. Today they have gone from the area. Frith (1967) concluded that there must be “serious doubt for its survival as a common species”.

Benefits of a reversal of Lake Innes to freshwater

During this Environmental Assessment for the potential closing of the lake to Cathie Creek, it has been important to assess the impacts on waterbird species, whether the lake is artificially closed or remains open. Where possible this needs to be considered in harmony with other studies, measuring the potential changes to fringing and lake bottom vegetation as well as fish and other potential food sources for waterbirds found in the area.

In the case of Lake Innes the conversion of the lake back to a freshwater system would favour 60% of birds that may use the site (for example those listed as benefitting from a moderate to very high level in

Table 1) including many species of ducks, crakes and rails that frequent freshwater wetlands especially during severe droughts in inland Australia.

One negative aspect to the reversal of Lake Innes would be on the saltmarsh communities, in particular *Sarcocornia quinqueflora*, would be affected in the long term due to prolonged submersion or being out-competed by more dominant freshwater species (see Boon 2013).

Once the site becomes relatively stable enabling freshwater vegetation and fish to re-establish, the importance of the lake for many bird species would be increased immensely.

Important components of a fully functional freshwater wetland, with some semblance of the original lake, would include extensive fringing reedbeds dominated by *Phragmites australis* from the margins of the Lake to a depth of approximately 1.5 m. This type of vegetation provides habitat for bitterns, crakes, rails, reed-warblers, as well as a lot of not strictly wetland birds. Beyond this depth floating attached vegetation including water lilies such as Giant Waterlily (*Nymphaea gigantean*) will grow in depths of 1-3 metres depth. Water lilies provide prime habitat for Comb-crested Jacanas that used to be found in Lake Innes. The similar, introduced water lily, Cape Waterlily has been reported in freshwater drains adjacent to Lake Innes. Its function as a habitat for waterbirds is very similar to native species, though less desirable as an exotic species. Other types of floating aquatic plants also provide habitat for many waterbirds including grebes, marsh terns (e.g. Whiskered Tern), coots, etc. An example is *Ceratophyllum demersum* or 'Hornwort', though currently not listed for the Lake. Such plants were likely to have been those that comprised of the 'floating islands' described in historical literature.

Until the time of opening Lake Innes appeared to have had an abundant population of freshwater fish but these were killed as a result of sudden exposure to high salinity levels after the lake was opened. How many fish species moved between Lake Innes and downstream from the lake is unknown. An abundant fish population would be an advantage to many species of waterbirds.

After assessing the potential impact of the closure of Lake Innes from Cathie Creek we have concluded that negative impacts on waterbird populations, particularly threatened species, will be less with the closure of the lake and its reversion to a freshwater wetland system than retaining the current ICOLL condition of the lake while connected to Cathie Creek.

These recommendations for waterbird management at Lake Innes are based on the assumption that Lake Innes will be closed between the lake and Cathie Creek with a levee and that water flows and levels will be managed with the use of appropriate sluice gates and weirs. The ability to control flows and water levels will result in a more rapid transition from an ICOLL situation to a freshwater (initially brackish) wetland. Water quality can also be managed more effectively if flows and levels can be managed.

The assessment of waterbird populations shows that a freshwater system will provide habitat for a greater number of threatened species than an ICOLL system, especially during periods of drought across any part of inland Australia (bearing in mind that waterbirds travel thousands of kilometres in response rain events/drought).

Since the opening of the lake, associated habitats have also greatly changed and it is important to examine the value of these habitats when assessing the impact of potential restoration of a freshwater wetland system. Examples include reedbeds of species such as *Phragmites australis* and *Cladium procerum* that previously occurred to a greater extent than now (Creighton 1985). Submerged vegetation and floating vegetation is important for many waterbirds as well as the oxygenation of the water. Over time it is highly likely that Lake Innes can be restored as an important freshwater wetland and could be considered for listing as a Ramsar wetland of international importance based on the percentage of the world population of some species as well as other characteristics.

Bird species and impact assessments (in taxonomic order)

The birds listed below have been observed at or near Lake Innes historically as well as during regular visits by local birdwatchers in recent years, are listed as threatened under the TSC Act or EPBC Act, or are likely to occur in the vicinity based on their distribution and habitat preferences. This approach is particularly important because of the lack of systematic or targeted surveys of the Lake. Many of the species are either cryptic or difficult do observe across such a large lake without the use of survey transects by boat.

Family Phasianidae - Quails and Pheasants

Quails are notoriously difficult to locate and are rarely seen unless flushed, virtually from underfoot. Both Brown and Stubble Quail are likely to be observed close to freshwater wetlands, in particularly the Brown Quail, sometimes referred to as Swamp Quail.

The Stubble Quail is widely distributed across eastern Australia as well as in the west of Western Australia and is most likely the most common quail in Australia. It typically inhabits grassy plains and other types of open country adapting well to open cropland and stubble fields. Listed as Marine under the EPBC Act (for reasons that are not clear). The Brown Quail is more typically associated with a wide variety of habitats but prefers thick grass and herbage, very common near rivers and swampy areas.

The Brown Quail is most likely to be associated with the Lake Innes Nature Reserve and is likely to benefit from the restoration of Lake Innes to a freshwater system.

Family Anseranatidae - Magpie Goose

Magpie Goose *Anseranas semipalmata* (listed as Vulnerable in NSW)

It is not known whether this species occurred at Lake Innes during its existence as a freshwater system but is highly likely it did occur when the species was numerous and widespread across NSW and much of Australia, prior to the widespread decline of the species as a result of hunter pressure and the draining of their wetland habitats for agriculture. The species was virtually extinct over most of NSW until the 1970s. They have since slowly become re-established in coastal wetlands of the state and are increasing in numbers. It is considered likely that this species would become established at Lake Innes if it were successfully reinstated as a freshwater system with the return of original aquatic vegetation. The Magpie Goose is the only species represented in the family Anseranatidae being unique in many ways. It feeds mainly on vegetation including grasses, root tubers and seeds of many aquatic plant species. The restoration of Lake Innes to a freshwater system would therefore be highly beneficial to this species.

Family Anatidae - Ducks, Geese and Swans

Plumed Whistling-Duck *Dendrocygna eytoni*

This species feeds at grassy margins of swamps or lagoons, pastures or floodplains where it feeds on grasses, legumes, herbs, sedges and rushes. This species is highly nomadic, although its main movements are towards coastal plain during dry season. In this respect the species would benefit from the restoration of Lake Innes as a freshwater wetland during inland drought periods.
This species was recorded in December 1932 and is likely to have occurred from time to time, especially as a drought refuge, though no other records for the lake appear to exist.

Wandering Whistling-Duck *Dendrocygna arcuata*

Unlike the Plumed Whistling-Duck, the Wandering Whistling Duck dives freely and always feeds in water, often in large flocks. This species was not likely in the region of Lake Innes prior to the opening of the lake because it has relatively recently extended its range south of 30º S and is now considered a resident species south as far as the Hunter River. It has not been recorded at Lake Innes but suitable habitat would be created if the lake were reinstated as a freshwater system.

Musk Duck *Biziura lobata*

This species dive constantly when feeding and feeds mainly on aquatic animals such as insects and their larvae also freshwater crayfish, snails, molluscs, fish and frogs. It is also known to feed on seeds of aquatic plants. Occasionally observed at Lake Innes (up to 15 observed) in deeper water when the lake is closed off to tidal influences. This species predominately uses freshwater habitats and would benefit if the lake were reinstated as a freshwater system.

Freckled Duck *Stictonetta naevosa* (Listed as Vulnerable in NSW)

The Freckled Duck is relatively sedentary remaining on permanent cumbungi and lignum swamps; also large open lakes and floodwaters. Feeds on algae, seeds of grasses and water weeds as well as

insects. During severe droughts this bird is found on coastal wetlands, which form important drought refuges. The Freckled Duck was present at Lake Innes up until 1933/34. Ten birds were recorded by Dick in June 1929 and small numbers, up to six in July 1933 but no records since the lake was opened to tidal influence. The importance of Lake Innes, as a freshwater system, would be very high for this species during severe drought periods.

Black Swan *Cygnus atratus*

Inhabits a wide variety of wetlands from extensive inland ephemeral wetlands, where the majority of birds nest in colonies, to small lakes and ponds in parklands and coastal wetlands where the total water body may include a single breeding territory, excluding other swans while nesting. They accumulate in medium to very large flocks when not breeding including coastal wetlands and bays.
Food includes aquatic vegetation, mainly algae, duckweed, pondweed and cumbungi.
Present in Lake Innes when water levels are high at times over 1000 birds, whether brackish or fresh. Otherwise absent or small numbers in Lake Cathie or Lake Innes 'entrance'. Food plants are unknown during these times.

Australian Shelduck *Tadorna tadornoides*

Infrequent as far north as Port Macquarie, generally found in south east and south west Australia typically on estuarine mudflats and muddy shores of extensive shallow wetlands, including fresh, brackish or tidal. Also found on grasslands, pastures and other crops and irrigated areas.
Feeds mainly on vegetation such as green algae, couch, duckweed as well as insect larvae, crustaceans and molluscs. Recorded at the Perch Hole in October 1999.

Australian Wood Duck *Chenonetta jubata*

This species occurs in areas of lightly timbered country near water and short grass. It frequents margins of lagoons and has benefited human activity of cutting grass when it grazes with its short goose-like bill. A few records associated with the nature reserve (grassed areas).

Pink-eared Duck *Malacorhynchus membranaceus*

The Pink-eared Duck is one of the most numerous ducks on inland wetlands in Australia. However, like so many inland species of waterbirds, it depends on coastal drought refuges during times of drought throughout the inland. Food for this highly specialised feeder includes microscopic aquatic animals and plants, especially water-fleas, copepods and ostracods and freshwater algae and floating seeds of clovers and smartweeds (Polygonum). This species depends on stable to ephemeral wetlands but must wait, unlike species such as the Grey Teal, for sufficient insect life has built up before breeding can take place. Records of this species at Lake Innes include their presence being noted by Dick in 1934. Not reported since. The restoration of Lake Innes would be highly beneficial to this species once the system starts to stabilise as a freshwater wetland.

Green Pygmy-goose *Nettapus pulchellus*

The Green Pygmy-goose occurs mainly across the north of Australia and along the east coast of Queensland, occasionally occurring in NSW. It is mainly sedentary with mainly local movements in response to seasonal changes in water level. Partly nocturnal in behaviour the Green Pygmy-goose feeds almost entirely on aquatic plants, especially flowers and seeds of water lilies, feeding just below the surface with occasional brief dives below the surface to pull up emergent plants.

Habitat occurring in Lake Innes prior to opening would have provided ideal habitat for this species during any influxes into NSW. The restoration of Lake Innes would be highly beneficial to this species once the system starts to stabilize. This species is listed as Marine under the EPBC Act.

Cotton Pygmy-goose *Nettapus coromandelianus* (Listed as Endangered in NSW)

Largely sedentary; gregarious, usually in small groups. It is completely aquatic but seldom dives during feeding, Feeds among water lilies dabbling on the surface, stripping seeds from floating aquatic plants and occasionally on aquatic insects.

It is likely that the Cotton Pygmy-goose occurred at Lake Innes prior to the opening of the Lake where it may have bred as well as along the Clarence, Richmond and Tweed Rivers in northern NSW. However most of the lagoons that it preferred have been drained for agriculture and the bird has since disappeared from these areas except for occasional vagrants. This species is listed as Endangered under the TSC Act.

Garganey *Anas querquedula*

Rare visitor in Australia. Prefers mainly sheltered and shallow freshwater wetlands and areas of grassland. Feeds mainly on aquatic insects and their larvae, small crustaceans and molluscs. Also seeds of aquatic plants. Not recorded at Lake Innes but it would benefit the restoration of Lake Innes as a freshwater wetland system. Listed as Marine under the EPBC Act.

Australasian Shoveler *Anas rhynchotis*

The Australasian Shoveler inhabits a variety of wetland types but has a preference for extensive permanent wetlands with abundant cumbungi growth in the interior and melaleuca swamps on the coast. It appeared to be a fairly common species in the coastal wetlands of NSW in the nineteenth century but is becoming increasingly rare and seldom seen on the coast now except in times of drought (Serventy et al 1985). This species nested on Lake Innes prior to the opening of the lake to Cathie Creek. But there have been no recent records of this species. The restoration of Lake Innes would be highly beneficial to this species once the system starts to stabilise as a freshwater wetland.

Northern Shoveler *Anas clypeata*

Vagrant to Australia from the northern hemisphere. Inhabits mainly large freshwater wetlands. Feeds mainly on small crustaceans and molluscs as well as aquatic insects and their larvae, and seeds of aquatic plants. Strongly migratory. Not recorded at Lake Innes but may at times have visited the lake in the past as it has been recorded in Australia since 1839. Would benefit the restoration of Lake Innes as a freshwater wetland.

Grey Teal *Anas gracilis*

Regularly seen in small numbers (occasionally 100's) from the pre-1930s up until 2004.
Highly dispersive and versatile the Grey Teal is one of the most diverse species of ducks in Australia occurring in wetlands across the whole of the country but most numerous in inland wetlands, particularly the Murray-Darling Basin and floodwaters, where it quickly takes advantage of newly flooded areas to breed. Despite this the Grey Teal needs the refuge of coastal wetlands during severe droughts. The loss of many wetlands around the Australian coastline was reflected in the devastating drought in 1957/58 where a large part of the Australian population perished for the lack of wetlands with water, as described by Frith (1967). Can be critically important as a drought refuge. Present in small numbers at Lake Innes (up to 250 1933-34).

Chestnut Teal *Anas castanea*

Chestnut Teal occur to a large extent on brackish to salt-water lakes and estuaries. It occurs occasionally at Lake Innes but not in large numbers on a regular basis as it does on other coastal wetlands. Although the Chestnut Teal does not need freshwater it is often on coastal freshwater wetlands in company to other duck species.

Northern Pintail *Anas acuta*

Rare vagrant from the northern hemisphere. Listed at Marine under the EBPC Act. May have occurred at Lake Innes on rare occasions in the past when conditions are suitable prior the opening of the Lake. The restoration of Lake Inness would be highly beneficial for species such as the Northern Pintail.

Pacific Black Duck *Anas superciliosa*

Versatile species, found in virtually all kinds of wetlands from fresh, brackish to saltwater but prefers deep permanent freshwaters with abundant aquatic vegetation. Feeds mainly on vegetation and seeds of a wide variety of wetland plants, grasses, smartweeds, also aquatic insects and their larvae, crustaceans and molluscs. Observed on a regular basis at Lake Innes but not in the numbers reported by Dick, who observed flocks of 2000 birds.

Hardhead (White-eyed Duck) *Aythya australis*

This species prefers extensive deep waters of freshwater lakes and swamps with emergent vegetation especially cumbungi but also brackish waters. The Hardhead feeds largely by diving for food and feeds on aquatic plant material and insects, molluscs and crustaceans.
This species has greatly declined in numbers from a species that was reputed to have outnumbered other duck species combined not long before the opening of Lake Innes to tidal flows. The species occurred in large flocks of up to 10 000 birds in 1929 and up to 4000 birds just before the lake was opened. Much smaller numbers have since been counted on the lake at irregular intervals with 500 counted during high water levels in March 2002. The restoration of the lake as a freshwater system would greatly benefit this species.

Blue-billed Duck *Oxyura australis* (Listed as Vulnerable in NSW)

This vulnerable species was not reported to have been seen on Lake Innes but this small duck that spends much time underwater and can easily be missed, especially amongst coots etc. Small numbers are likely to have occurred at the lake prior to its opening. The lake would be particularly during severe drought periods.

Family Podicipedidae - Grebes

Australasian Grebe *Tachybaptus novaehollandiae*

This species has been recorded in small numbers over the years but, as with the Hoary-headed Grebe, would be easily overlooked at Lake Innes. Frequently observed in the smaller Lake Cathie. The loss of floating vegetation, such as lilies, would have reduced nesting habitat when fresh deep water was available.

Hoary-headed Grebe *Poliocephalus poliocephalus*

The Hoary-headed Grebe occurs across most of Australia on lakes, reservoirs, floodwaters, large swamps and often sheltered coastal bays. It prefers freshwater habitats for breeding but will occur in flocks in brackish waters to feed and congregate during winter. Occurs on just about any coastal wetland at times. There are no records noted for Lake Innes but likely to have occurred in at least small numbers in association with Australasian Grebes. Both these small grebes are easily overlooked on such a large wetland among flocks of ducks.

Great Crested Grebe *Podiceps cristatus*

Most likely occurred occasionally in small numbers at Lake Innes before it was opened to tidal influence. The Great Crested Grebe favours large deep open bodies of freshwater although non-breeding birds will congregate on large saline lakes. Feeds largely on fish captured by diving. This species would only occur at Lake Innes when the water level was high and water relatively clear. Although not reported by Dick this species would have been highly likely to be present among the huge flocks of ducks that occurred on the lake. It occurred in small numbers during the lake filling in 2002 and in June 2003 when four birds were observed.

Family Anhingidae – Darters

Australasian Darter *Anhinga melanogaster*

The Australasian Darter has been observed during most surveys at Lake Innes with up to 13 present at any one time. Mostly a bird of freshwater but also occurs in bays and estuaries around coastal Australia. Inhabits extensive shallow wetlands, mainly fresh: rivers, lakes, lagoons and other wetlands. Feeds mainly on fish; crustaceans, molluscs and aquatic insects.

Family Phalacrocoracidae - Cormorants

Four species of cormorants are common in the vicinity of Lake Innes, the Great Cormorant, Little Black Cormorant, Pied Cormorant and Little Pied Cormorant. All four have similar requirements and habits. The diet of these birds is mainly fish or other aquatic animals, which are pursued underwater. All four species are common across most of Australia and frequent fresh, brackish to marine habitats though the

Little Black has a greater preference to freshwater systems. They all nest in colonies from a few birds to many hundreds often sharing nesting sites in trees in or close to wetlands.

The four species occur in Lake Innes on a regular basis in small flocks but exceeding 100 birds at times.

Family Pelecanidae – Pelicans

Australian Pelican *Pelecanus conspicillatus*

The Australian Pelican is largely nomadic and subject to a wide and erratic fluctuations in population, for example one irruption in the mid 1970s at Lake Eyre was followed by abundant rains only to be followed by one of the most severe droughts by 1977 forcing birds to the coast in search of food. It is times like this that drought refuges for this species can save mass mortality of birds. Some birds have formed local populations on the coast such as in the vicinity of Lake Cathie and Lake Innes and are present in small numbers throughout most years. Peaks at Lake Innes tend to coincide with low water when shallow water suits this species for feeding. Pelicans feed mainly on fish but also crustaceans but will feed on anything available at the time including amphibians (tadpoles) and small birds.

Family Ciconiidae - Storks

Black-necked Stork *Ephippiorhynchus asiaticus* (Listed as Endangered in NSW)

Occurs in lagoons, swamps, estuarine mudflats, flood plains etc. It occurs irregularly, up to two or three in some years at Lake Innes. Water levels do not appear to influence numbers as it feeds along lake margins feeding largely on fish and frogs, also crustaceans. Has been recorded as breeding at Lake Innes both in pre-conversion freshwater period as well as during saltwater periods, although largely associated with freshwater wetlands in mid to central coastal NSW. Considered to be advantaged by the restoration of Lake Innes to freshwater conditions (Bischoff 2005).

Family Ardeidae – Herons, Egrets and Bitterns

Australasian Bittern *Botaurus poiciloptilus* (Listed as Endangered in NSW and nationally)

This endangered species is a very secretive bird and hard to locate. It prefers permanent heavily vegetated freshwater wetlands dominated by reedbeds for nesting and foraging. Very few observations recorded at Lake Innes, which is no indication as presence is usually determined through dedicated surveys to flush birds from reeds or listening for 'booming' males during the breeding surveys.
Recent studies indicate a decline in populations leading to its listing as Endangered under the TSC Act and the EPBC Act. Restoration of the lake to its freshwater and healthy reedbed status would advantage this species.

Australasian Little Bittern *Ixobrychus dubius*

Appears to be migratory but seldom seen; solitary and extremely secretive. Habitat is generally exclusively reed and cumbungi areas of swamps, lakes and rivers. Although there are no records of birds at Lake Innes it is highly likely that this species has occurred during times of eruptions when the lake was freshwater but was overlooked.

Black Bittern *Ixobrychus flavicollis* (Listed as Vulnerable in NSW)

The Black Bittern prefers dense vegetation along coastal rivers, also mangroves or melaleuca swamps, margins of lagoons, estuaries and tidal creeks. Most likely occurred in the past at Lake Innes but extremely difficult to observe. A stable habitat in a restored Lake Innes would be beneficial to this species rather than a constantly changing one as is currently the case.

White-necked Heron *Ardea pacifica*

The White-faced Heron is more restricted to freshwater than other Australian herons, preferring grasslands and wet paddocks, lagoons and other freshwater bodies. Nests in trees standing in water, where possible. Rarely occurs in salt or brackish waters. Feeds on small aquatic animals of all kinds but especially fish, amphibians and insects. The restoration of Lake Innes as a freshwater would advantage this species but it is not likely to occur in large numbers.

Eastern Great Egret *Ardea modesta*

This species prefers shallow water along rivers, estuaries, tidal mudflats, freshwater swamps and lagoons, flooded grasslands etc. It feeds largely on fish, also on frogs and aquatic insects and their larvae as well as on molluscs, crustaceans and small reptiles. It is observed regularly on Lake Innes in small numbers occasionally up to 42 birds. Would most likely nest in association with other herons nesting habitats (trees in or near water) were improved.

Intermediate Egret *Ardea intermedia*

Frequents fresh, brackish or marine shallow waters but with a marked preference to freshwater habitats. Feeds largely on small fish, frogs and aquatic invertebrates. Observed in Lake Innes occasionally with counts of up to 24 birds in March 1998. Nesting opportunities would be improved if the health and size of trees in and near water were improved.

Cattle Egret *Ardea ibis*

This species only marginally uses wetlands preferring dairy pastures and grazing land, but also flood plains and swamp margins. This species started its colonisation of Australia in the 1940s therefore was not in the area during the original freshwater state of Lake Innes. The surrounding farmland and grasslands provide habitat for this species while the trees, for example melaleuca woodlands, round the lake provide suitable nesting habitat. The raising of the lake during restoration, as a freshwater wetland would make a more attractive nesting habitat for this species.

Striated Heron *Butorides striata*

In Australia, almost exclusively mangrove wetlands, tidal mudflats and estuaries. A few sightings of this species have been recorded by the Hastings Birdwatchers, probably during low water.

White-faced Heron *Egretta novaehollandiae*

Shallow water and mudflats almost anywhere; swamps, lagoons, wet paddocks, city parks, estuaries and grasslands. Feeds on a highly diverse range of small animals, fish, frogs and aquatic insects. Dick (April 1937) observed 100. This was one week after the ocean entrance was opened and coincided with opportunist populations of birds of prey and cormorants. This species is found equally during most lake conditions. The restoration of the lake as a freshwater system would not especially benefit this species.

Little Egret *Egretta garzetta*

Forages in shallow fresh to brackish waters or tidal estuaries and mudflats. Feeds on small fish, frogs, crustaceans and insects. This species is found equally during most lake conditions. The restoration of the lake as a freshwater system would not especially benefit this species though nesting habitats would be restored round the lake.

Eastern Reef Egret *Egretta sacra*

Almost exclusively littoral rocky reefs and offshore islands, sometimes mudflats and beaches. No observations reported in Lake Innes.

Nankeen Night-Heron *Nycticorax caledonicus*

Shallows waters of sheltered ponds, or backwaters of extensive swamps and lagoons, river margins and occasionally mangrove-lined estuaries. Nests in dense trees near or in water, no observations report for Lake Innes, though occurs occasionally at Lake Cathie.

Family Threskiornidae – Ibises and Spoonbills

Glossy Ibis *Plegadis falcinellus*

Prefers shallow freshwater wetlands, lagoons, flooded pastures and occasionally estuarine wetlands. Often occurring during none breeding seasons in large numbers. Feeds mainly on insects and their larvae, small fish, crustaceans and molluscs. Although observed in nearby wetlands it has not been

recorded at Lake Innes.

Australian White Ibis *Threskiornis molucca*

Extremely adaptable and flexible, taking advantage of food resources and parklands. Otherwise generally flood plains, irrigated farmland, estuaries, lagoons and swamps. Also most types of grassland and increasingly rubbish tips. Regularly seen at Lake Innes in some years, up to 50 birds and a single observation of more than 350 birds in May 1998.

Straw-necked Ibis *Threskiornis spinicollis*

Occurs mainly in grassland habitats, flooded or otherwise, croplands or margins of wetlands including lagoons and swamps. Generally not coastal. Observed at Lake Innes irregularly in small flocks in 1998, 2003 and 2008.

Royal Spoonbill *Platalea regia*

Frequents shallow freshwater wetlands across eastern Australia, also margins of lagoons, swamps and floodwaters, also estuarine mudflats. Feeds mainly on fish, molluscs and crustaceans. Nests in colonies influenced by local flooding, often with ibises and Yellow-billed Spoonbills. Occasionally observed at Lake Innes in small numbers, but up to 50 birds, during local birds surveys.

Yellow-billed Spoonbill *Platalea flavipes*

Frequents shallow freshwater wetlands across Australia. Feeds along the margins of lagoons and swamps, claypans and small freshwater wetlands such as pools and farm dams. Feeds mainly on aquatic insects and their larvae. Likely to be seen in coastal wetlands as a result of inland droughts.

Family Gruidae – Cranes

Brolga *Grus rubicunda* (Listed as Vulnerable in NSW)

Frequents extensive open wetlands including flood plains, grasslands, irrigated pastures, crops and stubbles. It is regularly seen in the district and most likely occurred from time to time at Lake Innes in the past before it was opened. Feeds on frogs, crustaceans, molluscs and terrestrial insects. To a large extent feeds on plant material such as tubers of aquatic plants. This species would benefit the restoration of Lake Innes as a freshwater wetland.

Family Accipitridae – Kites, Goshawks, Eagles and Harriers

Eastern Osprey *Pandion cristatus* (Listed as Vulnerable in NSW)

The Eastern Osprey nests at Lake Innes and is likely to forage along over the Lake and along the ocean shores over a large range of its territory. This species occurs around almost the entire coastline of Australia, favouring mouths of large rivers, lagoons and lakes, but also occurs far inland on rivers and lakes, using both fresh and saltwater environments for foraging. Nests in trees in or close to rivers, but in coastal habitats from woodland to open forest, usually within one kilometre of the sea, sometimes in the ground on isolated islands.

Listed as Vulnerable under the TSC Act and as Marine under the EPBC Act. The restoration of Lake Innes would have a neutral effect on this species and would most likely to continue to nest in or around the Lake as it appears to have done for many years during high and low water levels.

Brahminy Kite *Haliastur indus*

The Brahminy Kite is coastal in distribution, from northern NSW round the top end to Carnarvon in Western Australia. It feeds on a variety of prey including insects, crustaceans, fish reptiles, frogs, small mammals and birds, either freshly caught or as carrion. Forages along the coast in areas of mangroves, mudflats, tidal creeks and inlets. The restoration of Lake Innes would have neutral benefit for this species.

Whistling Kite *Haliastur sphenurus*

The Whistling Kite is found throughout Australia where it feeds on small mammals, birds (including nestlings) reptiles, fish, amphibians, crustaceans and insects as well as carrion. This species would moderately benefit the restoration of Lake Innes.

White-bellied Sea-Eagle *Haliaeetus leucogaster*

The White-bellied Sea-Eagle feeds on fish, crustaceans, turtles, small mammals, as well as carrion. This species is mainly coastal but is also found along major inland rivers, lakes and reservoirs. The restoration of Lake Innes would have a neutral effect on this species.

Brown Goshawk *Accipiter fasciatus*

The Brown Goshawk occurs across the whole of Australia and has been observed around Lake Innes. It is a species that prefers areas where trees abut grassland or clearings. It feeds mainly on small mammals and birds, a large part of its diet is rabbits where they are abundant, otherwise largely birds such as passerines but also feeds on insects, reptiles and occasionally carrion. The restoration of Lake Innes would moderately benefit this species.

Swamp Harrier *Circus approximans*

The Swamp Harrier prefers open country, rarely far from water. Inhabits swamps, marshes and croplands favouring long vegetation to hunt over, such as reedbeds. Also nests in reeds, such as Phragmites and other tall reeds. The restoration of Lake Innes would be very high benefit to this species.

Nankeen Kestrel *Falco cenchroides*

Another bird of prey observed at Lake Innes, the Nankeen Kestrel is widespread across Australia where it if found across all kinds of open country, preferring grassland and open woodland. The diet of this species is varied, feeding on insects and other arthropods as well as small mammals, occasionally frogs and small birds. The restoration of Lake Innes would be of high benefit to this species being not an estuarine or marine species.

Family Rallidae – Crakes, Rails, Swamphens and Coots

Crakes and rails are cryptic species which hard to locate and not often seen other than by experienced observers. Surveys are generally done using call back recordings during the breeding season or by flushing birds out from reeds or other dense vegetation in and around a wetland. Most crakes and rails associate with freshwater wetlands, though will tolerate brackish conditions where the vegetation of the wetland survives in good condition. Species of this group move from wetland to wetland at night when they are least likely to fall prey to birds of prey, due to their relatively weak flight.
Any of the five species listed (Table 1) may occur at Lake Innes but would have been more likely to have occurred prior to the lake being opened. Few data is available about the food taken by this group but appears to be mainly small invertebrates in the form of insects, spiders and molluscs but also feed on seeds and tender plant shoots.

Purple Swamphen *Porphyrio porphyrio*

Frequents a variety of permanent freshwater habitats, rarely brackish or marine. Feeds on succulent shoots of reeds and rushes. This species would have declined with the opening of Lake Innes. Now observed irregularly in small numbers. This species would benefit the restoration of Lake Innes as a freshwater wetland.

Lewin's Rail *Lewinia pectoralis*

The Lewin's Rail occurs along coastal areas of south east Australia from southern Queensland to South Australia. It inhabits dense vegetation bordering streams and swamps; dense rushes in fresh, brackish or saline wetlands. Feeds largely on molluscs, earthworms, insects and crustaceans. Crepuscular in nature, therefore not often observed. This species would benefit the restoration of Lake Innes as a result of the vegetation bordering the wetland.

Buff-banded Rail *Gallirallus philippensis*

This species feeds mostly on crustaceans, molluscs, worms, insects and sometimes seeds and other vegetable matter, fruits, frogs and eggs of other birds. Occurs across most of the north and east of Australia other than arid regions, in dense vegetation near swamps and streams, tussocks in wet paddocks as well as woodland and samphire flats. There would be a moderate benefit to this species with the restoration of Lake Innes.

Baillon's Crake *Porzana pusilla*

The Baillon's Crake prefers aquatic vegetation growing along the margins of freshwater to brackish wetlands, either dense reedbeds but also floating vegetation, occasionally saltmarsh. It feeds on aquatic insects, also seeds, snails and crustaceans. There would be a high benefit to this species with the restoration of Lake Innes.

Australian Spotted Crake *Porzana fluminea*

The Australian Spotted Crake feeds on aquatic seeds, molluscs, insects, crustaceans and spiders by probing on mudflats and in reed beds, wading in shallow water and occasionally swimming. Inhabits well vegetated margins of permanent or ephemeral freshwater to brackish wetlands but also coastal wetlands. There would be a moderate benefit to this species with the restoration of Lake Innes.

Spotless Crake *Porzana tabuensis*

The Spotless Crake occurs across the whole of south east Australia in deep permanent swamps with abundant vegetation including reed beds, sedges, from freshwater to brackish wetlands and occasionally well vegetated saltmarsh. It feeds on seeds, fruits, shoots of grasses and aquatic plants, insects, molluscs, crustaceans, spiders and carrion.

There would be a moderate benefit to this species with the restoration of Lake Innes with dense vegetation margins to the Lake.

Black-tailed Native-hen *Tribonyx mortierii*

The Black-tailed Native Hen breeds at inland wetlands but is highly eruptive in its movements usually as a result of a drought after periods of high breeding activity followed by drought. It feeds mainly on plant material, including seeds, as well as insects. The restoration of Lake Innes would be of very high benefit to this species, especially as a drought refuge.

Dusky Moorhen *Gallinula tenebrosa*

Frequents well-vegetated permanent freshwater wetlands, rarely brackish or salt. Occurs in a variety of wetlands from city parks and grasslands to margins of rivers. Omnivorous, feeding on shoots of aquatic plants, small invertebrates and seeds. Would benefit the restoration of Lake Innes as a freshwater system.

Eurasian Coot *Fulica atra*

The Eurasian Coot prefers deep permanent swamps, lakes, and reservoirs. Spends most of its time on water feeding on aquatic vegetation, diving frequently, rarely moving from the waters edge to graze like moorhens and swamphens. At Lake Innes there were much higher numbers when the lake is full (up to 1000 at a time, Fig. 1).

Family Burhinidae – Stone Curlews

Bush Stone-curlew *Burhinus grallarius* (Listed as Endangered in NSW)

This species inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber and infrequently visit intertidal areas.

This species has a low likelihood of occurrence in the vicinity of Lake Innes. The restoration of Lake Innes would have a neutral benefit for this species.

Beach Stone-curlew Esacus magnirostris (Listed as Critically Endangered in NSW)

This species inhabits coastal undisturbed beaches, coral reefs, tidal mudflats and mangroves. It is found across northern and north-eastern Australia as far south as north-eastern NSW. It is extremely rare in NSW and has not been recorded at Lake Innes and has a low likelihood of occurrence in the vicinity of the Lake. The restoration of Lake Innes will have no benefit or disadvantage to this species.

Family Haematopodidae – Oystercatchers

Australian Pied Oystercatcher *Haematopus longirostris* (Listed as Endangered in NSW)

The Pied Oystercatcher frequents ocean beaches and estuaries feeding on bivalve molluscs, small crustaceans and polycheates. It is found round the whole coastal region of Australia. The population appears to have increased substantially in the southern half of coastal NSW, but not in northern NSW. It has rarely been observed in the vicinity of Lake Innes and would not benefit significantly by the restoration of Lake Innes.

Sooty Oystercatcher *Haematopus fuliginosus* (Listed and Vulnerable in NSW)

The Sooty Oystercatcher occurs along the entire coastal region of Australia where if largely frequents rock ledges and reefs and rock pools, occasionally on beaches and estuaries. There appears to be no records of this species in the vicinity of Lake Innes and would not benefit the restoration of the Lake.

Family Recurvirostridae – Stilts and Avocets

Black-winged Stilt *Himantopus himantopus*

The Black-winged Stilt occurs across the whole of Australia where there are wetlands, fresh or brackish, including margins of lakes, estuarine mudflats, sewage treatment works, etc. It feeds largely on insects and their larvae, especially Chironomids. This species was recorded at Lake Innes prior the opening of the Lake by Albert Dick who noted 'dozens' following heavy rain. The restoration of Lake Innes would be of high benefit for this species.

Red-necked Avocet *Recurvirostra novaehollandiae*

The Red-necked Avocet occurs across most of Australia where suitable habitat exists including shallow wetlands whether fresh, brackish or estuarine mudflats. It feeds mainly on aquatic insects and their larvae, small crustaceans and occasionally seeds. The restoration of Lake Innes would have low benefit for this species.

Migratory Shorebirds

Most migratory shorebirds inhabit the intertidal zones of bays and estuaries, feeding on insects and small marine invertebrates such as polycheates, crustaceans, and molluscs. Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. In particular, juvenile migratory shorebirds are likely to use the habitat at this time, as they have not yet become site faithful. However this group of birds may benefit from the predicted more frequent opening of Lake Cathie and especially Cathie Creek.

The most regular of the shorebirds visiting Lake Innes and Lake Cathie when water levels are low include the Bar-tailed Godwit (counts of up to 35 – 110). The restoration of Lake Innes would be of low benefit for this species although the predicted increased frequency of the opening of a smaller area of habitat at Lake Cathie would benefit this species. Some species observed in relatively large numbers that are more tolerant of aquatic vegetation and freshwater wetlands include Sharp-tailed Sandpipers with counts of up to 300, and Common Greenshank which occurs in groups of up to 9 birds, Marsh Sandpiper (occasional 1 -14 birds) and may occur in the margins of Lake Innes if it were reinstated as a freshwater wetland.

The restoration of Lakes Innes would be of low benefit for other species that occur in the vicinity when mudflats are exposed. These include Whimbrel and Eastern Curlew (both rare solitary occurrences),

Red Knot (rare, up to 26 birds), Ruddy Turnstone (rare, 1 – 5 birds), Grey-tailed Tattler (one solitary occasion). Others that are found on tidal flats include, Common Sandpiper (rare solitary birds), Red-necked Stint (occasional 7 – 146), Curlew Sandpiper, rare (1 - 5 birds) and the Double-banded Plover (a winter visitor nesting in New Zealand) occasionally present in numbers between 2 – 50 birds). Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie, although these areas would most likely be open to tidal influences on a more regular, but shorter, periods of time.

The balance between migratory shorebirds and waterbirds relying on extensive freshwater habitat is difficult in that both extremes include protected species. While the habitat for migratory shorebirds will be reduced if Lake Innes is closed, waterbirds that are facing severe declines also have to be taken into consideration since one of the most valuable wetlands in Australia was severely degraded when Lake Innes was opened to the sea in 1933. Lake Innes, as a freshwater lake, is becoming increasing valuable as coastal wetlands (critical to the survival of large numbers of birds during drought events) are lost to development. The value of the reinstated lake will no doubt become more relevant due to climate change with more and longer droughts.

Family Jacanidae – Jacanas

Comb-crested Jacana *Irediparra gallinacea* (Listed as Vulnerable in NSW)

The Comb-crested Jacana occurs along the north of Australia, north east Queensland and down as far as northern NSW.

The Comb-crested Jacana has been listed as Vulnerable under the TSC Act due to the decline in the NSW population as a result in habitat loss of suitable freshwater wetlands. This species occurred at Lake Innes until the freshwater vegetation was killed when the lake was opened to tidal flushing and has not been observed there since. The Comb-crested Jacana inhabits deep freshwater wetlands with floating vegetation, in particular water lilies, for foraging as well as nesting. It feeds on water plants, including seeds, and aquatic insects.

The restoration of Lake Innes would be highly beneficial to this species, especially in the long term as the freshwater vegetation returns to the Lake.

Family Rostratulidae – Painted Snipe

Australian Painted Snipe *Rostratula australis* (Listed as Endangered in NSW and Vulnerable nationally)

The Australian Painted Snipe has been listed as Endangered under the TSC Act and Vulnerable under the EPBC Act due to its small population and possible decline in line with the loss of suitable habitat. A special project was initiated by BirdLife Australia to attempt to find reasons for the decline of this species. BirdLife Australia have also nominated this species for listing as Endangered under the EPBC Act.

This freshwater species is found along the fringes of swamps, dams and marshy areas where there is cover of low vegetation, foraging on freshwater mudflats and in shallow water.

The Painted Snipe has not been recorded at Lake Innes; however, targeted surveys have not been conducted along the mid-north coast of NSW. Preferring freshwater habitats, it is predicted that the proposed works will highly advantage this species.

The restoration of Lake Innes would be highly beneficial for the species.

Latham's Snipe *Gallinago hardwickii*]

The Latham's Snipe is associated with freshwater wetlands bordered by dense low vegetation and muddy margins across eastern and south eastern Australia where the entire world population spends its non breeding season, migratory from Southeast Asia. It is largely crepuscular in behaviour and seldom seen, unless flushed, feeding by probing in soft mud for earthworms as well as feeding on insect larvae and seeds. There have been no targeted surveys for this species at Lake Innes and consequently has not been recorded for the site. The restoration of Lake Innes would be highly beneficial to this species.

Terns

Lake Innes is used by a variety of terns and gulls at all stages of filling and draining. Sea terns feed mainly on small fish that may occur in the lake as supplementary foraging habitat to the coastal shores and estuaries, especially when the lake is low and brackish and the water clear. A number of sea terns do take advantage of coastal freshwater lakes, in particular the Little Tern, to catch insects, small fish and crustaceans.

As a freshwater habitat Lake Innes would provide habitat for nesting marsh terns (Chlidonias spp.). These birds nest on floating vegetation and feed on aquatic insects and small fishes found in freshwater lakes. A restored Lake Innes would be highly beneficial for these terns.

Gulls

The Silver Gull is the only gull species to occur in the region of Lake Innes. It is very abundant and very much an opportunistic feeder and will take advantage of any food supplies include parks and rubbish tips. The Silver Gull would take advantage of Lake Innes in all states and water levels.

Monitoring and Managing Changes

An assessment of the importance of Lake Innes to waterbirds is essential in determining the pros and cons of reverting the lake back to a freshwater system, leaving it as is, or adopting another strategy for management of the site.

A very important part of the management of Lake Innes during the conversion process would be the ability to manage water levels and flows for the time it takes for these changes to take place. This would allow the drainage of saline waters, should this be required, but enable the partial or complete closure of the lake to retain runoff from large rainfall events, thus gradually reducing the salinity of the water as well as soils over time.

Lake Innes has changed from its original state with the initial dramatic shock to the system in 1933 and the subsequent 80 years of periodical inundation with tidal flows and flushing with runoff. The time required to revert the lake to a freshwater system would depend on the amount of freshwater input from the catchment after the construction of a suitable levee bank and water control devices. This in turn will determine how long it would take to leach the build up of salts from the substrate of the lake.

As stated in the Hydrological Modeling report, if the lake is restored as a freshwater system a bund will have to be built to retain its waters. The infrastructure will need to include suitable structures to manage water flows and depths leading up to the eventual reversion to a freshwater lake. Leaving the structures open until a suitable rainfall event occurred to flush out brackish water would shorten the conversion process. Control structures would also allow release of any large pulses of freshwater after heavy rains while at the same time allowing passage of some fish and prawns.

Managing a lake reversal to a freshwater ecosystem is not without its challenges. However, more severe conditions have been overcome overseas where freshwater wetlands have been created from converted marine wetlands, such as mangrove forest and marine fish farms. Such an example is at Mai Po Nature Reserve in Hong Kong (pers. obs. 1999 to 2012).

The most effective way to manage the wetland as a freshwater system similar to that of its original form prior to 1933 would be the construction of a levee between the lake and Cathie Creek. The size of the levee will need to be determined from hydrological studies of the relevant levels of the lake where water flows from the lake at a pre-determined water height and its relationship to Cathie Creek, Innes Swamp and sea level rise over a determined period. Studies of the Innes Swamp in these respects will determine whether a levee can be constructed across the shortest distance mentioned in the hydrology report or would have to be lengthened to protect Innes Swamp from undesirable inundation from Lake Innes, as also outlined in the report.

The construction of a levee without facilities to manage water levels and flows would result in a high risk of poor water quality and subsequent negative impacts on the wetland. It is therefore recommended that detailed studies and design should be carried out at the beginning of the planning process for the lake.

The reversion of the Lake could be completed quite rapidly with manipulation of flows, possibly too rapidly for aquatic fauna and flora to cope if not managed appropriately. Regular monitoring of conditions during the Lake reversion would therefore need high priority by an appropriately experienced ecologist in association with water quality and levels management.

Table 1: Wetland dependent birds with likely association with Lake Innes (closed)							
Scientific name	Common name	TSC	EPBC	Ma	Likelihood of occurrence	Observed at Lake Innes	Benefit of Closure
Family Phasianidae							
Coturnix pectoralis	Stubble Quail			#	m		M
Family Anseranatidae							
Anseranas semipalmata	Magpie Goose	V		#	m		VH
Family Anatidae							
Anas acuta	Northern Pintail			#	l		VH
Dendrocygna eytoni	Plumed Whistling-Duck				l	+	H
Dendrocygna arcuata	Wandering Whistling-Duck			#	m		H
Biziura lobata	Musk Duck			#	h	+	VH
Stictonetta naevosa	Freckled Duck	V			m	+	VH
Cygnus atratus	Black Swan				h	+	M
Tadorna tadornoides	Australian Shelduck				l	+	H
Chenonetta jubata	Australian Wood Duck				h	+	M
Malacorhynchus membranaceus	Pink-eared Duck				m	+	VH
Nettapus pulchellus	Green Pygmy-goose			#	l		VH
Nettapus coromandelianus	Cotton Pygmy-goose	E			l		VH
Anas querquedula	Garganey		*M*	#	l		VH
Anas rhynchotis	Australasian Shoveler				m	+	VH
Anas clypeata	Northern Shoveler.		*M*	#	l		VH
Anas gracilis	Grey Teal				h	+	VH
Anas castanea	Chestnut Teal				h	+	N
Anas platyrhynchos	Mallard				l		VH
Anas superciliosa	Pacific Black Duck				h	+	VH
Aythya australis	Hardhead (White-eyed Duck)				h	+	VH
Oxyura australis	Blue-billed Duck	V			l		VH
Family Podicipedidae							
Tachybaptus novaehollandiae	Australasian Grebe				h	+	H
Poliocephalus poliocephalus	Hoary-headed Grebe						M
Podiceps cristatus	Great Crested Grebe				m	+	VH
Family Anhingidae							
Anhinga melanogaster	Australasian Darter				h	+	H
Family Phalacrocoracidae							
Phalacrocorax melanoleucos	Little Pied Cormorant				h	+	M
Phalacrocorax carbo,	Great Cormorant				h	+	N
Phalacrocorax sulcirostris,	Little Black Cormorant				h	+	M
Phalacrocorax varius	Pied Cormorant				h	+	M
Family Pelecanidae							
Pelecanus conspicillatus	Australian Pelican			#	h	+	M
Family Ciconiidae							
Ephippiorhynchus asiaticus	Black-necked Stork	E			h	+	VH
Family Ardeidae							
Botaurus poiciloptilus	Australasian Bittern	E	*E*		h	+	VH
Ixobrychus dubius	Australasian Little Bittern				m		VH
Ixobrychus flavicollis	Black Bittern	V			l		N
Ardea pacifica	White-necked Heron				m	+	H
Ardea modesta	Eastern Great Egret		*M*	#	h	+	H
Ardea intermedia	Intermediate Egret			#	m	+	H
Ardea ibis	Cattle Egret		*M*	#	h	+	H
Butorides striata	Striated Heron				m	+	L
Egretta novaehollandiae	White-faced Heron				h	+	H
Egretta garzetta	Little Egret			#	h	+	H
Egretta sacra	Eastern Reef Egret		*M*	#	l		L
Nycticorax caledonicus	Nankeen Night-Heron			#	m	+	VH
Family Threskiornithidae							
Plegadis falcinellus	Glossy Ibis		*M*	#	m		VH
Threskiornis molucca	Australian White Ibis			#	h	+	M

Threskiornis spinicollis	Straw-necked Ibis			#	m	+	VH
Platalea regia	Royal Spoonbill				h	+	H
Platalea flavipes	Yellow-billed Spoonbill				m		VH
Family Gruidae							
Grus rubicunda	Brolga	V			l		VH
Family Accipitridae							
Pandion cristatus	Eastern Osprey	V		#	h	+	N
Haliastur indus	Brahminy Kite			#	m	+	L
Haliastur sphenurus	Whistling Kite			#	h	+	M
Haliaeetus leucogaster	White-bellied Sea-Eagle			#	h	+	M
Accipiter fasciatus	Brown Goshawk			#		+	M
Circus approximans	Swamp Harrier			#		+	VH
Falco cenchroides	Nankeen Kestrel			#		+	H
Family Rallidae							
Porphyrio porphyrio	Purple Swamphen			#	h	+	VH
Lewinia pectoralis	Lewin's Rail				h	+	VH
Gallirallus philippensis	Buff-banded Rail			#	h		M
Porzana pusilla	Baillon's Crake			#	h		H
Porzana fluminea	Australian Spotted Crake				h		M
Porzana tabuensis	Spotless Crake			#	h		M
Tribonyx ventralis	Black-tailed Native-hen				l		VH
Gallinula tenebrosa	Dusky Moorhen				h	+	VH
Fulica atra	Eurasian Coot				h	+	VH
Family Burhinidae							
Burhinus grallarius	Bush Stone-curlew	E			l		N
Esacus magnirostris	Beach Stone-curlew	C		#	l		L
Family Haematopodidae							
Haematopus finschi	South Island Pied Oystercatcher				l		L
Haematopus longirostris	Australian Pied Oystercatcher	E			m	+	L
Haematopus fuliginosus	Sooty Oystercatcher	V			l		L
Family Recurvirostridae							
Himantopus himantopus	Black-winged Stilt			#	h	+	H
Recurvirostra novaehollandiae	Red-necked Avocet			#	l		L
Cladorhynchus leucocephalus	Banded Stilt				l		L
Family Charadriidae							
Pluvialis fulva	Pacific Golden Plover		*M*	#	m	+	L
Pluvialis squatarola	Grey Plover		*M*	#	l		L
Charadrius alexandrinus	Kentish Plover				l		L
Charadrius hiaticula	Ringed Plover		*M*	#	l		L
Charadrius ruficapillus	Red-capped Plover			#	h	+	L
Charadrius bicinctus	Double-banded Plover		*M*	#	m	+	L
Charadrius mongolus	Lesser Sand Plover	V	*M*	#	l	+	L
Charadrius leschenaultii	Greater Sand Plover	V	*M*	#	l		L
Charadrius veredus	Oriental Plover		*M*	#	l		L
Elseyornis melanops	Black-fronted Dotterel				h		L
Erythrogonys cinctus	Red-kneed Dotterel				m		L
Vanellus tricolor	Banded Lapwing				l		N
Vanellus miles	Masked Lapwing				h	+	N
Family Jacanidae							
Irediparra gallinacea	Comb-crested Jacana	V			h	+	VH
Family Rostratulidae							
Rostratula australis	Australian Painted Snipe	E	*V / M*	#	m		VH
Family Scolopacidae							
Gallinago hardwickii	Latham's Snipe		*M*	#	h		VH
Limosa limosa	Black-tailed Godwit	V	*M*	#	l		H
Limosa haemastica	Hudsonian Godwit				l		L
Limosa lapponica	Bar-tailed Godwit		*M*	#	m	+	L
Numenius minutus	Little Curlew		*M*	#	l		H
Numenius phaeopus	Whimbrel		*M*	#	l	+	L
Numenius madagascariensis	Eastern Curlew		*M*	#	l	+	L
Xenus cinereus	Terek Sandpiper	V	*M*	#	l		L
Actitis hypoleucos	Common Sandpiper		*M*	#	l	+	N

Tringa brevipes	Grey-tailed Tattler		*M*	#	l	+	L
Tringa incana	Wandering Tattler		*M*	#	l		L
Tringa nebularia	Common Greenshank		*M*	#	h	+	M
Tringa flavipes	Lesser Yellowlegs				l		M
Tringa stagnatilis	Marsh Sandpiper		*M*	#	m	+	M
Tringa glareola	Wood Sandpiper		*M*	#	l		L
Arenaria interpres	Ruddy Turnstone		*M*	#	l	+	L
Limnodromus semipalmatus	Asian Dowitcher		*M*	#	l		L
Calidris tenuirostris	Great Knot	V	*M*	#	l		L
Calidris canutus	Red Knot		*M*	#	m	+	L
Calidris alba	Sanderling	V	*M*	#	l		L
Calidris ruficollis	Red-necked Stint		*M*	#	l	+	L
Calidris subminuta	Long-toed Stint		*M*	#	m		L
Calidris melanotos	Pectoral Sandpiper		*M*	#	l		L
Calidris acuminata	Sharp-tailed Sandpiper		*M*	#	h	+	M
Calidris ferruginea	Curlew Sandpiper	E	*M*	#	l	+	L
Tryngites subruficollis	Buff-breasted Sandpiper		*M*	#	l		L
Limicola falcinellus	Broad-billed Sandpiper	V	*M*	#	l		L
Philomachus pugnax	Ruff		*M*	#	l		L
Family Laridae							
Gygis alba	White Tern	V			l		L
Procelsterna cerulea	Grey Ternlet	V		#	l		L
Onychoprion fuscata	Sooty Tern	V		#	l		L
Sternula albifrons	Little Tern	E	*M*	#	m		L
Gelochelidon nilotica	Gull-billed Tern			#	m	+	L
Hydroprogne caspia	Caspian Tern		*M*	#	m	+	L
Chlidonias hybrida	Whiskered Tern			#	h	+	H
Chlidonias leucopterus	White-winged Black Tern		*M*	#	l		H
Chlidonias niger	Black Tern			#	l		H
Sterna striata	White-fronted Tern			#	l		L
Sterna hirundo	Common Tern		*M*	#	m	+	M
Sterna paradisaea	Arctic Tern			#	l		L
Sterna bergii	Crested Tern			#	m	+	L
Larus pacificus	Pacific Gull			#	l		L
Larus dominicanus	Kelp Gull			#	l		L
Chroicocephalus novaehollandiae	Silver Gull			#	h	+	M
Family Tytonidae							
Tyto longimembris	Eastern Grass Owl				m	+	H
Family Halcyonidae							
Cyex azureus	Azure Kingfisher				h	+	H
Todiramphus sanctus	Sacred Kingfisher			#	m		M
Family Meliphagidae							
Epthianura albifrons	White-fronted Chat				l	+	L
Family Hirundinidae							
Hirundo neoxena	Welcome Swallow			#	h	+	M
Petrochelidon nigricans	Tree Martin			#	h	+	H
Family Acrocephalidae							
Acrocephalus orientalis	Oriental Reed-warbler			#	l		VH
Acrocephalus australis	Australian Reed-warbler			#	h	+	VH
Family Cisticolidae							
Cisticola exilis	Golden-headed Cisticola				h	+	H
Family Megaluridae							
Megalurus timoriensis	Tawny Grassbird				m	+	VH
Megalurus gramineus	Little Grassbird				h	+	VH

TSC Act V = vulnerable, E = Endangered.
EPBC Act *V* = vulnerable *M* = migratory. Ma = marine (# = present)
Likelihood of occurrence l = low, m = moderate, h = high.
Benefit of closure VH = very high, H = high, M = moderate, L = low

Appendix A

Figures

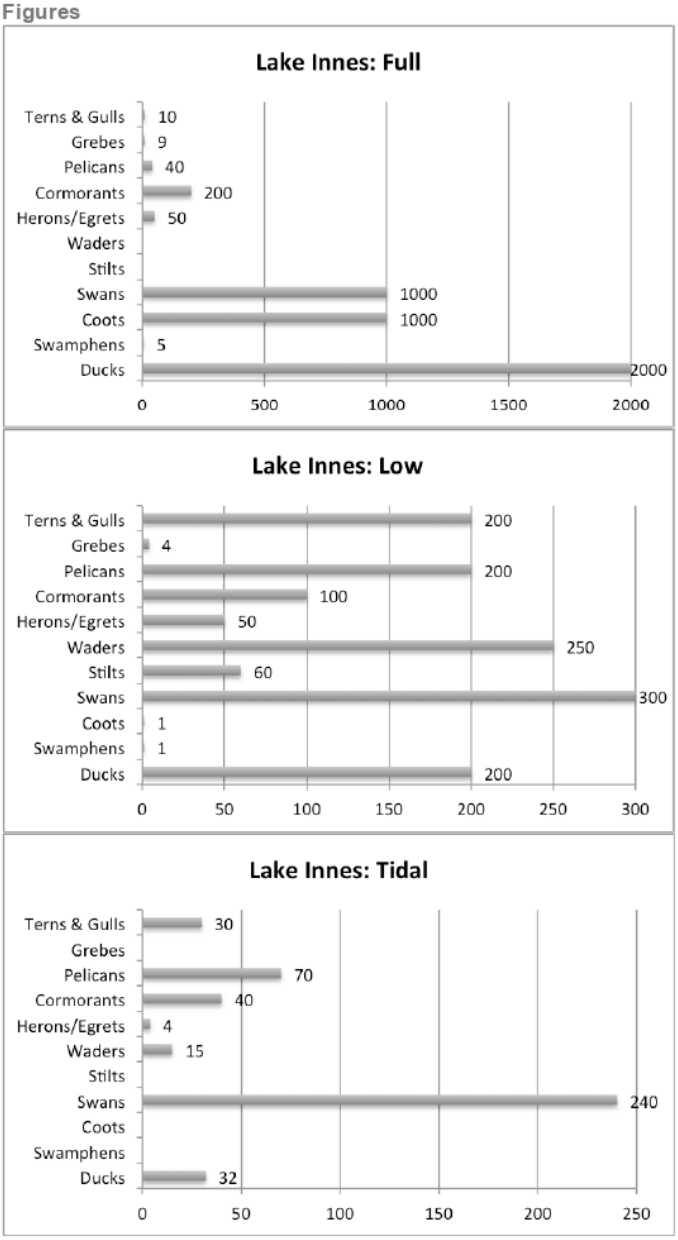

Figure 1 Maximum count of waterbirds at Lake Innes while a) Full b) Low and c) Tidal

NB:
Full: June 2001 – May 2002
Low: June 2002 – May 2003
Tidal: October 2004 – September 2005

Appendix B: Lake Innes – Seven-part test of significance

An assessment of significance was undertaken by identifying species known to occur in the area, as well as species that may occur in the area based on habitat use.

Making an assessment of significance

The threatened species assessment of significance should not be considered a 'pass or fail' test. Instead, consideration of the factors will inform the decision-making process of the likelihood of significant effect. Where necessary, the process will trigger further assessment in the form of a species impact statement.

All factors should be considered as well as any other information deemed relevant to the assessment. The assessment of significance should not be used as a substitute for a species impact statement. Application of the precautionary principle requires that a lack of scientific certainty about the potential impacts of an action does not itself justify a decision that the action is not likely to have a significant impact. If information is not available to conclusively determine that there will not be a significant impact on a threatened species, population or ecological community, or its habitat, then it should be assumed that a significant impact is likely and a species impact statement should be prepared.

Proposed measures that mitigate, improve or compensate for the action, development or activity should not be considered in determining the degree of the effect on threatened species, populations or ecological communities, unless the measure has been used successfully for that species in a similar situation.

In many cases where complex mitigating, ameliorative or compensatory measures are required, such as translocation, bush restoration or purchase of land, further assessment through the species impact statement process is likely to be required.

In determining the nature and magnitude of an impact, it is important to consider matters such as:

- Pre-construction, construction and occupation/maintenance phases
- All on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones
- All direct and indirect impacts
- The frequency and duration of each known or likely impact/action
- The total impact which can be attributed to that action over the entire geographic area affected, and over time
- The sensitivity of the receiving environment
- The degree of confidence with which the impacts of the action are known and understood

Recovery and threat abatement plans, priorities action statements, threatened species profiles and other fact sheets prepared by DECC and DPI may provide further guidance on whether an action or activity is likely to be significant.

Application of the precautionary principle requires that a lack of scientific certainty about the potential impacts of an action does not itself justify a decision that the action is not likely to have a significant impact. If information is not available to conclusively determine that there will not be a significant impact on a threatened species, population or ecological community, or its habitat, then it should be assumed that a significant impact is likely.

Threatened species impact assessment is an integral part of environmental impact assessment. The objective of s. 5A of the Environmental Planning and Assessment Act 1979 (EP&A Act), the assessment of significance, is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

The Threatened Species Conservation Amendment Act 2002 revised the factors that need to be considered when assessing whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats, previously known as the '8-part test.' The changes affect s. 5A EP&A Act, s. 94 Threatened Species Conservation Act 1995 (TSC Act) and s. 220ZZ Fisheries Management Act 1994 (FM Act).

These revised factors of assessment maintain the earlier intent of the legislation but focus particularly on likely impacts to the local rather than the regional environment. The reason for the shift to a local focus is that the long-term loss of biodiversity at all levels arises mainly from the accumulation of losses and depletions of populations at a local level. This is the broad principle underpinning the TSC Act, state and federal biodiversity strategies, and international agreements.

The consideration of impacts at a local level is also designed to make it easier for local government to assess, and easier for applicants and consultants to undertake the assessment of significance because there is no longer a need to research regional and statewide information.

The assessment of significance is the first step in considering potential impacts. When a significant effect is likely, further consideration is required and is more appropriately carried out when preparing a species impact statement.

Section 94A of the TSC Act and s. 220ZZA of the FM Act provides that the Minister for Climate Change, Environment and Water and the Minister for Primary Industries, with the concurrence of the Minister for Planning, may prepare assessment guidelines to assist in the interpretation and application of the factors of assessment.

These guidelines have been prepared to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment. The aim of the guidelines is to help ensure that a consistent and systematic approach is taken when determining whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats either directly or indirectly.

Making determinations requires technical expertise, and knowledge of species and their habitats. The guidelines assume that those undertaking an assessment of significance have sufficient knowledge and experience to do so.

These guidelines clarify the specific terminology of the relevant legislation and provide clear interpretations of the factors of assessment. Further guidance, including examples and case studies will be provided in a supplementary document.

The assessment of significance should not be considered a 'pass or fail' test but a system allowing applicants/proponents to undertake a qualitative analysis of the likely impacts, and ultimately, whether further assessment needs to be undertaken through a species impact statement. All factors must be considered and an overall conclusion must be drawn from all factors in combination. Where there is reasonable doubt regarding the likely impacts, or where detailed information is not available, a species impact statement should be prepared. Other issues not specifically addressed by the factors of assessment should be included and discussed in the broader impact assessment process, for example, in a review of environmental factors or an environmental impact statement.

Listed threatened species

The assessment of significance is applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A and 5 of the FM Act. The applicant/proponent should develop a list of threatened species, populations and ecological communities, which may be affected directly or indirectly by the proposed action, development or activity. Adequate reasons should be provided to show how the list was derived.

A species does not have to be considered as part of the assessment of significance if adequate surveys or studies have been carried out that clearly show that the species:

- does not occur in the study area, or
- will not use on-site habitats on occasion, or
- will not be influenced by off-site impacts of the proposal.

Otherwise all species likely to occur in the study area (based on general species distribution information), and known to use that type of habitat, should be considered in the rationale that determines the list of threatened species, populations and ecological communities for the assessment of significance.

Consultants for proponents/applicants need to be aware that any 'Final Determination' to list a species, population or ecological community as 'Critically Endangered' or 'Endangered' made after lodgement of a s. 91 TSC Act or s. 220ZW FM Act licence, development application or activity proposal needs to be included in the consideration of impacts and the application of the assessment of significance. Therefore applicants/proponents are advised to give due consideration to Preliminary Determinations made by the Scientific Committees. Vulnerable species listed after lodgement are not subject to impact assessment so long as the application is determined within 12 months of lodgement (s. 113C TSC Act, ss. 105A and. 110D EP&A Act). The NSW legislation website (www.legislation.nsw.gov.au/) provides the most up-to-date information on what is listed in the schedules.

To assist the assessment process, the Department of Environment and Climate Change NSW (DECC) and the NSW Department of Primary Industries (DPI) have prepared species profiles for a number of

threatened species. Consultants are advised to refer to these and other fact sheets for baseline information on species morphology, behaviour, habitat and threats.

Terminology
Throughout this guideline the terms subject site and study area are used. It is important to have a thorough understanding of these terms as they apply to the assessment.

Subject site means the area directly affected by the proposal.

Study area means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account.

Direct impacts are those that directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development.

Indirect impacts occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given, when applying each factor, to all of the likely indirect impacts of the proposed activity or development.

The factors of assessment
Seven-part tests for the following threatened biota in relation to the proposed works are included here:

Waterbird species
All waterbird species listed under the Threatened Species Act.

Waterbird species

In the case of – Magpie Goose (Anseranas semipalmata)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Magpie Goose is listed as a vulnerable species under the TSC Act. This waterbird species was once widespread throughout coastal northern and eastern Australia, found in freshwater wetlands, floodplains and wet grasslands. Habitat alteration since white settlement has caused a decline in this species, although this species has increased in NSW as a result of habitat enhancement.

There are no recorded observations of this species at Lake Innes, but would be highly advantaged by the reversion to a large well-vegetated freshwater lake.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Magpie Goose is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of the species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW (DECC) has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Fifteen current priority actions have been identified to help recover this species. The proposed restoration of Lake Innes to a freshwater lake is consistent with the priority action statement, particularly with one action classified as a high priority:

"To restore natural hydrological regimes to freshwater wetlands, and maintain existing hydrological regimes. Do not fill or drain wetlands. Retain and protect native vegetation in and around wetlands, and restore degraded wetlands."

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Magpie Goose is associated with freshwater wetlands, so would be highly advantaged by the reversion to a freshwater lake.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Magpie Goose.

In the case of – Freckled Duck (Stictonetta naevosa)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Freckled Duck is listed as a vulnerable species under the TSC Act. This species is relatively sedentary, found on the most permanent densely vegetated swamps and lakes. During severe droughts this bird is found on coastal wetlands, which form important drought refuges. The Freckled Duck was present at Lake Innes up until 1933/34. Ten birds were recorded by Dick in June 1929 and small numbers, up to six in July 1933 but no recorded observations since the lake was opened to tidal influence.

The result of the development is not likely to have an adverse effect on the life cycle of the Freckled Duck such that a viable local population is likely to be placed at risk of extinction, but will highly benefit this species particularly during severe drought periods.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Freckled Duck is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of the species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Ten current priority actions have been identified to help recover this species. The proposed restoration of Lake Innes to a freshwater lake is consistent with the priority action statement, with actions including the maintenance of freshwater flows and protection of key vegetation, including lignum and cumbungi.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Freckled Duck is associated with freshwater wetlands, so would be highly advantaged by the reversion to a freshwater lake.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Freckled Duck.

In the case of – Cotton Pygmy-goose (Nettapus coromandelianus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Although once widespread from the Hunter River to north Queensland, this species is now only a rare visitor to NSW. The Cotton Pygmy-goose is listed as endangered under the TSC Act. It inhabits deep, permanent coastal lagoons and large freshwater lakes with abundant aquatic vegetation.

The result of the development is not likely to have an adverse effect on the life cycle of the Cotton Pygmy-goose such that a viable local population is likely to be placed at risk of extinction, but will highly benefit this species as one that utilises permanent freshwater lakes.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Cotton Pygmy-goose is listed as an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of the species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Fourteen current priority actions have been identified to help recover this species, with key actions including the rehabilitation and preservation of Cotton Pygmy-goose habitat. Although Lake Innes is not an identified wetland for this species, the proposed reversion of Lake Innes to a freshwater lake is likely to highly benefit this species based on its preferred habitat usage.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Cotton Pygmy-goose is associated with freshwater wetlands, so would be highly advantaged by the reversion to a freshwater lake.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Cotton Pygmy-goose.

In the case of – Blue-billed Duck (Oxyura australis)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Blue-billed Duck is listed as vulnerable under the TSC Act. This species is almost exclusively aquatic, often found congregating in large flocks on large, deep open freshwater dams and lakes. The Blue-billed Duck is found in southeastern and southwestern Australia, usually found congregating along the lower Murray River during winter, and dispersing to breed in summer. Mostly recorded inland but utilises coastal sites at times of drought.

The result of the development is not likely to have an adverse effect on the life cycle of the Blue-billed Duck such that a viable local population is likely to be placed at risk of extinction, but would highly benefit this species as one that utilises permanent freshwater lakes.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Blue-billed Duck is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Nine current priority actions have been identified to help recover this species, with key actions being to protect important breeding wetlands, key vegetation and maintaining water flows. Although Lake Innes is not an identified wetland for this species, the proposed reversion of Lake Innes to a freshwater lake is likely to highly benefit this species based on its preferred habitat usage.
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Blue-billed Duck is associated with freshwater wetlands, so would be highly advantaged by the reversion to a freshwater lake.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Blue-billed Duck.

In the case of – Black-necked Stork (Ephippiorhynchus asiaticus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Black-necked Stork is listed as an endangered species under the TSC Act. The only stork in Australia, this species is found along the northern and eastern coasts from the Kimberley to the Bega district in NSW but is nowhere common. The Black-necked Stork is usually seen wading in shallows of wetlands, including floodplains of rivers and deeper permanent bodies of water; occasionally found in open grass, woodland or flooded paddocks. Breeding in solitary pairs, this species requires large areas of freshwater swamps to maintain even one pair. This species has been recorded as breeding at Lake Innes both in the pre-conversion freshwater period as well as the salt-water period.

The result of the development is not likely to have an adverse effect on the life cycle of the Black-necked Stork such that a viable local population is likely to be placed at risk of extinction, but would highly benefit this species as one that utilises permanent freshwater wetlands.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Black-necked Stork is listed as an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Fourteen current priority actions have been identified to help recover this species, with one of the key actions being to:
"Identify sites for rehabilitation or construction in the Northern Rivers catchment, having due consideration for water regime, existing or potential habitat, predators, other threatening processes & monitoring activities."

As this species is associated with freshwater systems, and has been recorded in Lake Innes, within the Northern Rivers catchment, it is considered this species will be advantaged.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Black-necked Stork has been recorded breeding on Lake Innes, and as a species that prefers freshwater systems; it would be advantaged by the reversion to a freshwater system.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Black-necked Stork.

In the case of – Australasian Bittern (Botaurus poiciloptilus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Australasian Bittern is listed as an endangered species under the TSC Act. Australasian Bitterns are widespread but uncommon over southeastern Australia. In NSW they may be found over most of the state except for the far northwest. The species favours permanent freshwater wetlands with tall, dense vegetation, particularly Typha spp, Phragmites spp and Eleocharis spp. This shy and cryptic species forages amongst dense reeds or rushes feeding mainly on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird. Breeding occurs in summer from October to January.

No field surveys were undertaken to specifically target cryptic species such as the Australasian Bittern but one observation was made of this species in 1999 (Bischoff 2006). The result of the development is not likely to have an adverse effect on the life cycle of the Australasian Bittern such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Australasian Bittern is listed as endangered, not an endangered population,

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The Australasian Bittern is not part of an Endangered Ecological Community.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Eight current priority actions have been identified to help recover this species, with a key focus being to protect and rehabilitate breeding habitat.

As this species is associated with freshwater systems, it is considered this species will be advantaged.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Australasian Bittern has been recorded once at Lake Innes, and as a species that prefers freshwater systems; it would be advantaged by the reversion to a freshwater system.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Australasian Bittern.

In the case of – Black Bittern (Ixobrychus flavicollis)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Black Bittern is listed as a vulnerable species under the TSC Act. The Black Bittern is associated with mangrove-lined channels and mudflats associated with mangroves tidal mudflats of the central to northern coasts of Australia down as far as Sydney on the east coast, using both fresh and salt-water wetlands.

The result of the development is not likely to have an adverse effect on the life cycle of the Black Bittern such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Black Bittern is not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The Black Bittern is not part of an Endangered Ecological Community.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Two current priority actions have been identified to help recover this species, with a key focus being to enhance the knowledge of the breeding locations of this species, and in areas of suitable breeding habitat, seek to retain and manage riparian vegetation.

As this species is associated with both freshwater and saline systems, it is considered the proposed works will have a neutral impact on this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

As this species is associated with both freshwater and saline systems, it is considered the proposed works will have a neutral impact on this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Black Bittern.

In the case of – Brolga (Grus rubicunda)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Brolga is listed as a vulnerable species under the TSC Act. This species prefers freshwater wetlands, including flood plains, grasslands, irrigated pastures and crops. During the wet season they are widespread over the plains but in the dry season they are usually concentrated in permanent coastal swamps.

The result of the development is not likely to have an adverse effect on the life cycle of the Brolga such that a viable local population is likely to be placed at risk of extinction, but would highly benefit this species as one that favours freshwater environments.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Brolga is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Nine current priority actions have been identified to help recover this species, with a key focus being to retain water flows and protect habitat in alliance with landowners.

As this species is associated with freshwater habitats, it is considered this species will be advantaged by the reversion to a freshwater system.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

As this species is associated with freshwater systems, it is considered the proposed works will be an advantage to this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Brolga.

In the case of – Eastern Osprey (Pandion haliaetus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Eastern Osprey is listed as a vulnerable species under the TSC Act. This solitary species can be seen around almost the entire coastline of Australia, favouring mouths of large rivers, lagoons and lakes. It is also sometimes found far inland on rivers and lakes, using both fresh and saltwater environments. The Eastern Osprey forages over estuarine and inshore waters, and nests in tall trees in coastal habitats from woodland to open forest, usually within one kilometre of the sea.

The result of the development is not likely to have an adverse effect on the life cycle of the Eastern Osprey such that a viable local population is likely to be placed at risk of extinction, but is considered to have a neutral effect, as it utilises both fresh and saltwater environments.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Eastern Osprey is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Nine current priority actions have been identified to help recover this species, with a key focus being to protect both feeding and breeding habitat.

As this species is associated with both fresh and saltwater habitats, it is considered the proposed works will have a neutral effect on the Eastern Osprey.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

As this species is associated with both fresh and saltwater habitats, it is considered the proposed works will have a neutral effect on the Eastern Osprey.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Eastern Osprey.

In the case of – Bush Stone-curlew (Burhinus grallarius)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Bush Stone-curlew is listed as an endangered species under the TSC Act. This species inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber and infrequently visit intertidal areas.

This species has a low likelihood of occurrence in the vicinity of Lake Innes, so the proposed action is not likely to have an adverse effect on the life cycle of the Bush Stone-curlew such that a viable local population is likely to be placed at risk of extinction. Based on habitat preference, this species would not be advantaged by the proposed works.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Bush Stone-curlew is listed as an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Thirty-nine current priority actions have been identified to help recover this species, with a key focus being to raise public awareness and to identify and protect Bush Stone-curlew habitat.

As this species has a low level of occurrence in the area, impacts of the proposed works on this species are not considered to be significant.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

As this species is unlikely to be currently using the area, and based on habitat preference, the impact of the proposed works on this species is considered to be minimal.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Bush Stone-curlew.

In the case of – Beach Stone-curlew (Esacus magnirostris)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Beach Stone-curlew is listed as a critically endangered species under the TSC Act. This species inhabits coastal undisturbed beaches, coral reefs, tidal mudflats and mangroves. The Beach Stone-curlew is found across northern and north-eastern Australia south to north-eastern NSW. It is extremely rare in NSW, with a minimum population of 13 adult birds recorded in 2000 (OEH 2012). Disturbance is a key threat to this species, particularly human recreational activities that can cause desertion of nests and make remaining habitat unsuitable.

Based on habitat preference, this species would not be advantaged by the proposed works. This species has a low likelihood of occurrence in the vicinity of Lake Innes, so the proposed action is not likely to have an adverse effect on the life cycle of the Beach Stone-curlew such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Beach Stone-curlew is listed as a critically endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Twenty-two current priority actions have been identified to help recover this species in NSW, with a key focus being to protect and monitor known foraging and roosting habitats.

This proposal does not conflict with these actions as the site at Lake Innes is not a known foraging or nesting site for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

As this species is unlikely to be currently using the area, and based on habitat preference, the impact of the proposed works on this species is considered to be minimal.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Beach Stone-curlew.

In the case of – Australian Pied Oystercatcher (Haematopus longirostris)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

In NSW the Pied Oystercatcher is listed as an endangered species under the TSC Act. The Pied Oystercatcher is associated with the intertidal zone of sandy beaches and tidal mudflats of Australia. Numbers have remained stable or even slightly increased in some areas of NSW. However the species has recently been listed as endangered in NSW, previously listed

as vulnerable. It is predicted this species will potentially be disadvantaged by the proposed works due to its preference for saltwater habitats such as beaches, tidal flats and estuaries. Having only been observed in small numbers occasionally near Lake Innes, the result of the development is not likely to have an adverse effect on the life cycle of the Pied Oystercatcher such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Pied Oystercatcher is an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for this species will be modified, with the reversion of the habitat from its current (ICOLL) condition to a freshwater system. However, as the bird is an irregular visitor to the area, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Fourteen current priority actions have been identified to help recover this species in NSW, with a key focus being to identify and protect nesting sites, and avoid disturbances during the nesting season.

The impact of the proposed works on this species is considered to be minimal due to the moderate use of this site.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an

important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

Because this species only occurs as an irregular visitor to the site, the impact of the proposed works on this species is considered to be minimal.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Pied Oystercatcher.

In the case of – Sooty Oystercatcher (Haematopus fuliginosus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

In NSW, the Sooty Oystercatcher is listed as a vulnerable species under the TSC Act. This species prefers rocky terrain, like exposed rock flats, reefs and tidal rock pools on the coasts of Australia. The nest is a small depression in sand, or a collection of small pebbles, nestled amongst rocks and sometimes lined with locally available vegetation.

There are 3 records of Sooty Oystercatcher within 5km of the site at Lake Innes. Given that this species is uncommon in the area and unlikely to use the habitat on site, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Sooty Oystercatcher such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Sooty Oystercatcher is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. As the bird is an irregular visitor to the area, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Seven current priority actions have been identified to help recover this species in NSW, with a key focus being to assess threats at key breeding sites, ensure minimum disturbance and implement predator control.

The study area is not a known breeding area for this species. The impact of the proposed works on this species is considered to be minimal due to the irregular use of this site.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

Because this species only occurs as an irregular visitor to the site, the impact of the proposed works on this species is considered to be insignificant.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Sooty Oystercatcher.

In the case of – Lesser Sand Plover (Charadrius mongolus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Lesser Sand Plover is listed as a vulnerable species under the TSC Act. This migratory shorebird breeds in central and northeastern Asia, migrating south for the southern summer. In Australia, it is most commonly found along the east coast of Queensland and northern NSW, favouring intertidal mudflats and sheltered bays, and occasionally sandy beaches, reefs and rock platforms.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Lesser Sand Plover has only been recorded once at the entrance of Lake Innes. Given that this species is an irregular visitor to the site, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Lesser Sand Plover such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Lesser Sand Plover is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Lesser Sand Plover will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Lesser Sand Plover is an irregular visitor to the area, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Four current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in

place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Lesser Sand Plover due to the inconsistent habitat usage for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Lesser Sand Plover.

In the case of – Greater Sand Plover (Charadrius leschenaultii)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Greater Sand Plover is listed as a vulnerable species under the TSC Act. The Greater Sand Plover is a migratory species, breeding in central Asia and migrating south for the southern summer. In Australia, it is found most commonly along coastal NSW, utilising sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Greater Sand Plover has not been recorded around Lake Innes, however it is possible that it may occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Greater Sand Plover such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Greater Sand Plover is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Greater Sand Plover will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Greater Sand Plover is unlikely to be using the site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Four current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Greater Sand Plover due to the inconsistent habitat availability for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Greater Sand Plover.

In the case of – Comb-crested Jacana (Irediparra gallinacea)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Comb-crested Jacana is listed as a vulnerable species under the TSC Act. This species spends its entire life on freshwater lagoons, using lakes, swamps and dams with waterlilies or other extensive floating vegetation, feeding and nesting on floating lily leaves.

The Comb-crested Jacana was recorded as breeding on Lake Innes in 1931 but disappeared after conversion to saltwater in 1933. This species returned after heavy rainfall in November 1933, after which time Albert Dick noted the water lilies looked sick, and by 1934 all Lotus birds and Swamphens had disappeared from the site.

The result of the development is not likely to have an adverse effect on the life cycle of the Comb-crested Jacana such that a viable local population is likely to be placed at risk of extinction, but will highly advantage this species as one that requires freshwater habitats.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Comb-crested Jacana is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of the species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Eight current priority actions have been identified to help recover this species. The proposed reversion of Lake Innes to a freshwater lake will highly benefit this species based on its feeding and breeding habitat requirements.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

Given this species is associated with freshwater habitats, it is predicted the proposed works will highly advantage this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Comb-crested Jacana.

In the case of – Australian Painted Snipe (Rostratula australis)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Australian Painted Snipe is listed as an endangered species under the TSC Act. This small freshwater species is found along the fringes of swamps, dams and marshy areas where there is cover of low vegetation, foraging on freshwater mudflats in shallow water.

The Painted Snipe has not been recorded at Lake Innes, however, targeted surveys have not been conducted along the mid-north coast of NSW. Preferring freshwater habitats, it is predicted that the proposed works will advantage this species.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Australian Painted Snipe is listed as an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of the species, population or ecological community in the locality. In fact the action will result in an enhancement of feeding and roosting habitat.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. One current priority action has been identified to help recover this species, by encouraging surveys in known and predicted habitats. The proposed reversion of Lake Innes to a freshwater lake is likely to highly benefit this species based on its preferred freshwater habitat usage.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The Australian Painted Snipe is associated with freshwater wetlands, so would be highly advantaged by the reversion to a freshwater lake.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Australian Painted Snipe.

In the case of – Black-tailed Godwit (Limosa limosa)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Black-tailed Godwit is listed as a vulnerable species under the TSC Act. The Black-tailed Godwit is a migratory species, breeding in Mongolia and Siberia then migrating south for the southern summer. It is found along coastal areas of NSW, most frequently recorded in the Hunter River estuary. This species is usually found on sandspits, lagoons and mudflats, but has also been recorded inland, utilising large lakes when muddy shores are exposed.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Black-tailed Godwit has not been recorded around Lake Innes, however it is possible that it may occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development

is not likely to have an adverse effect on the life cycle of the Black-tailed Godwit such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Black-tailed Godwit is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The Black-tailed Godwit is a vulnerable species, not part of an Endangered Ecological Community.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Black-tailed Godwit will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Black-tailed Godwit is unlikely to be using the site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key

threatening processes in New South Wales. Four current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Black-tailed Godwit due to the inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Black-tailed Godwit.

In the case of – Terek Sandpiper (Xenus cinereus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Terek Sandpiper is listed as a vulnerable species under the TSC Act. The Terek Sandpiper is a rare migrant to Australia, most common on the northern coast and extending south to the NSW east coast, occurring at two main sites, Richmond River estuary and the Hunter River Estuary. This species favours mudflats and sandbanks near mangroves, but may also occur on rocky pools and reefs.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Terek Sandpiper has not been recorded around Lake Innes, however it is possible that it may occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Terek Sandpiper such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Terek Sandpiper is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Terek Sandpiper will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Terek Sandpiper is unlikely to occur on site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Four current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Terek Sandpiper due to the unlikelihood of occurrence and inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Terek Sandpiper.

In the case of – Great Knot (Calidris tenuirostris)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Great Knot is listed as a vulnerable species under the TSC Act. This migratory species breeds in Siberia, migrating south for the southern summer. It is found scattered along coastal habitats of NSW, including inlets, bays, harbours, estuaries and lagoons. Few birds are recorded south of Sydney.
Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Great Knot has not been recorded around Lake Innes, although it is possible that it may occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Great Knot such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Great Knot is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Great Knot will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not

provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Great Knot is unlikely to occur on site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Five current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Great Knot due to the unlikelihood of occurrence and inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Great Knot.

In the case of – Sanderling (Calidris alba)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Sanderling is listed as a vulnerable species under the TSC Act. The Sanderling is a regular summer migrant from Arctic breeding grounds to most of the Australian coastline. This

species is almost always found on the coast, mostly on beaches exposed to open sea-swell; also on exposed sandbars and spits, shingle banks and rock platforms.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Sanderling has not been recorded around Lake Innes, although it is possible that it may occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Sanderling such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Sanderling is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Sanderling will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Sanderling is unlikely to occur on site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Five current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Sanderling due to the unlikelihood of occurrence and inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Sanderling.

In the case of – Curlew Sandpiper (Calidris ferruginea)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Curlew Sandpiper is associated with tidal mudflats of the coasts of Australia, found on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats. Numbers have declined throughout southeastern Australia and in particular NSW leading to its recent listing as endangered under the TSC Act.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Curlew Sandpiper is a rare visitor to Lake Innes, with three observations between 1981-2005 of 1-5 birds. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Curlew Sandpiper such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Curlew Sandpiper is an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The Curlew Sandpiper is an endangered species, not part of an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Curlew Sandpiper will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Curlew Sandpiper is unlikely to occur on site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for the Curlew Sandpiper.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and

Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Curlew Sandpiper due to the unlikelihood of occurrence and inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Curlew Sandpiper.

In the case of – Broad-billed Sandpiper (Limicola falcinellus)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Broad-billed Sandpiper is listed as a vulnerable species under the TSC Act. The Broad-billed Sandpiper is associated with the coasts of Australia generally, but is very scarce and irregular. This migratory species favours sheltered coastal areas such as estuarine sandflats and mudflats, harbours, bays, lagoons, saltmarshes and reefs.

Migratory shorebirds have been observed in relatively small numbers at Lake Innes during tidal and low water levels, taking advantage of the newly exposed mudflats resulting from the opening of the system. Such events only provide a temporary habitat, as the system is constantly changing in response to the opening and closing of the lake. The Broad-billed Sandpiper has not been recorded around Lake Innes, although it is possible that it could occur at times of low water levels. Given that this species is unlikely to be using the site due to inconsistent availability of suitable habitat, it is considered that the result of the development is not likely to have an adverse effect on the life cycle of the Broad-billed Sandpiper such that a viable local population is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Broad-billed Sandpiper is a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Occasionally available potential habitat for the Broad-billed Sandpiper will be modified, with the reversion of the habitat to a freshwater system. Since the alteration of the hydrology of the lake it has become an ICOLL where due to changing conditions, habitats adjust, suiting different bird species whether the lake is full of largely freshwater or periodically drained with similar characteristics of an estuary. At this time, the lake system may only provide a relatively short period of time for species such as shorebirds and is unlikely providing a reliable habitat for such species that tend to be site faithful. At low water level the lake entrance and Cathie Creek attract a variety shorebirds that visit the site opportunistically (as the site does not provide consistent quality habitat for these birds). Juvenile migratory shorebirds, which have not yet become site faithful, that are moving through on migration may stay in the area until conditions change and are forced to move elsewhere.

Most of these birds would have less extensive areas to forage if Lake Innes was closed to tidal flushing. For example the entrance to Lake Innes (the reverse delta) may be partially or totally lost as exposed mudflats when the system is open to the sea. This would restrict most migratory shorebirds to Cathie Creek and Lake Cathie.

The numbers of migratory shorebirds using the lake entrance to Cathie Creek are comparatively low and would not be classified as significant under the EPBC Act. As the Broad-billed Sandpiper is unlikely to occur on site, the extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Four current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is unlikely to be providing a consistent suitable foraging habitat for this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Broad-billed Sandpiper due to the unlikelihood of occurrence and inconsistency of suitable habitat for this species.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Broad-billed Sandpiper.

In the case of – White Tern (Gygis alba)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The White Tern is listed as a vulnerable species under the TSC Act. This oceanic species occurs widely in tropical and subtropical seas and islands, usually keeping far from land. Vagrant birds are known to occur around coastal NSW, particularly during storms. This species feeds over open seas, then while breeding forages over lagoons and island reefs. No recorded observations exist for the White Tern nearby Lake Innes. This species is unlikely to be impacted on by the proposed works due to its preference for offshore habitats.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The White Tern is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for the White Tern.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in

1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the White Tern due to the unlikelihood of occurrence.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the White Tern.

In the case of – Grey Ternlet (Procelsterna cerulea)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Grey Ternlet is listed as a vulnerable species under the TSC Act. This species is widely distributed in the southern Pacific Ocean, foraging over calm waters and breeding on offshore islands. Vagrant birds are known to occur around coastal NSW, particularly during storms. No recorded observations exist for the Grey Ternlet nearby Lake Innes. This species is unlikely to be impacted on by the proposed works due to its preference for offshore habitats.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Grey Ternlet is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for the Grey Ternlet.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Grey Ternlet due to the unlikelihood of occurrence.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Grey Ternlet.

In the case of – Sooty Tern (Onychoprion fuscata)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Sooty Tern is listed as a vulnerable species under the TSC Act. This species is found over tropical and subtropical seas and islands around northern Australia. In the breeding season, colonies of this species nest on coral cays, atolls, sandbanks, rock stacks, cliffs or other offshore islets. In NSW it is only known to breed at Lord Howe Island. Vagrant birds occasionally seen around coastal NSW, particularly after storms or cyclones. No recorded observations exist for the Sooty Tern nearby Lake Innes. This species is unlikely to be impacted on by the proposed works due to its preference for offshore habitats.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Sooty Tern is listed as a vulnerable species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for the Sooty Tern.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Sooty Tern due to the unlikelihood of occurrence.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Sooty Tern.

In the case of – Little Tern (Sternula albifrons)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Little Tern is listed as an endangered species under the TSC Act. Little Terns make their nests on ocean beaches, sand spits and sand islands near rivers, creeks and coastal lakes, feeding in shallow coastal waters by diving for fish. The Little Tern is an occasional visitor to Lake Innes, with records of up to twenty birds.

The result of the development is not likely to have an adverse effect on the life cycle of the Little Tern such that a viable local population is likely to be placed at risk of extinction due to its moderate usage of this site.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

The Little Tern is listed as an endangered species, not an endangered population.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

No endangered ecological population has been listed for the site.

d) in relation to the habitat of a threatened species, population or ecological community:
i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
iii) the importance of the habitat to be removed, modified, fragmented or isolated to the longterm survival of the species, population or ecological community in the locality

No habitat will be removed as part of the development. The extent to which any habitat is likely to be modified is not considered sufficient to have a significant negative impact on the long-term survival of this species, population or ecological community in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The habitat found in the study area or subject site is not listed as critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Department of Environment and Climate Change NSW has prepared a Priorities Action Statement (PAS) to promote the recovery of threatened species and the abatement of key threatening processes in New South Wales. Twenty-two current priority actions have been identified to help recover this species in NSW. This proposal does not conflict with these actions, as the site is only occasionally used by this species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. Thirteen current priority actions are in place for the abatement of this key threatening process (Department of Environment and Climate Change NSW); one of which is to identify rivers and wetlands of high conservation value for biodiversity. Lake Innes was once the largest freshwater lake on the NSW coast, providing a permanent freshwater habitat for safe nesting for a variety of waterbirds and an important drought refuge to species restricted to fresh water. Prior to the artificial opening in 1933, the lake was of State, if not national, significance as a coastal fresh water habitat (Clausen 1999).

The proposal is not likely to exacerbate any key threatening process relevant to the Little Tern based on habitat preference and occasional usage of the site.

Conclusion
Based on the above investigation, we do not consider it necessary to conduct further impact assessment on the impacts of the proposed development on the Little Tern.

References:

Clausen (1999) Lake Innes Nature Reserve Plan of Management. NSW National Parks and Wildlife Service.

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Webb, McKeown and Associates (1994) Lake Cathie/Lake Innes Estuary Management Plan, Hastings Shire Council, Port Macquarie, NSW.

Creighton C (1985). Wetlands of the Lakes Innes–Cathie catchment. *Wetlands (Australia)* 5: 20–30.

Appendix E - Biodiversity Conservation Act (2016) Five Part tests of significance and Fisheries Management Act (1994) Seven Part test of significance

1. Native Guava (*Rhodomyrtus psidioides)*

Item	The Biodiversity Conservation Act (2016) 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. No specimens were identified on site during a site visit on 19/04/20. The closest specimen of Native Guava (Rhodomyrtus psidioides) is approximately one kilometre to the south of the Study Area.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. The appropriate habitat of this species is littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines. The works and possible associated impacts of decreasing the water levels of Lake Cathie estuarine system will not impact on this habitat.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Work site As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with Native Guava.	☐ Yes ☑ No

2. Hawksbill Turtle

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. No specimens were identified on site during a site visit on 19/04/20. It is not well documented that the turtle would be found in and ICOLL as their natural habitat is tidal and sub-tidal coral and rocky reef habitats. Two records indicate that turtles have been seen both north of the worksite and within the lagoon system but both were suffering from health issues. Changes to the berm do not impact on this species natural habitat.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. The appropriate habitat of this species is tidal and sub-tidal coral and rocky reef habitats	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the Hawksbill Turtle	☐ Yes ☑ No

3. Koala

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. Based on location of works the koala will not be impacted by these works.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. The appropriate habitat of this species eucalypt forests which are not present on site.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the koala.	☐ Yes ☑ No

4. Grey Headed Flying-Fox

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. The species is transient in nature and has a wide home range. The flying-fox roosts during the day and will not be impacted by noise generated on site during the day as there are no roosting sites on or near the site. Changes to the berm do not impact on this species natural habitat.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. Although habitat choices are variable for the flying-fox they do require trees for roosting.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the Grey Headed flying-fox.	☐ Yes ☑ No

5. White-bellied Sea Eagle

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. The artificial opening of Lake Cathie mimics natural openings. As such, the changes brought about by this activity should not negatively impact the foraging habitat of the White-bellied Sea Eagle.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. The artificial opening of Lake Cathie mimics natural openings. As such, the changes brought about by this activity should not negatively impact the foraging habitat of the White-bellied Sea Eagle.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the White-bellied Sea Eagle.	☐ Yes ☑ No

6. Varied Sitella

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. This species is not affected by the works undertaken due to the work zone and the short timeframe of works.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, No habitat is to be altered, removed or isolated due to the works undertaken. The appropriate habitat of this species is eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the Varied Sitella.	☐ Yes ☑ No

7. Green and Golden Bell Frog

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The location of the project works is on the foreshore and berm of Lake Cathie. The breeding cycle of this species is summer and is in vegetated shallow marsh. The work zone will not directly impact on any part of lifecycle of this threatened species. The works may drain water from Lake Innes which may inadvertently impact on the frog but not to the extent of adversely impacting on a local population. Changes to the berm do not impact on this species natural habitat.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat downstream of the work zone may be impacted by a fluctuating water levels. The habitat of an ICOLL is variable and as such although the works may reduce water levels this is not permanent and is not unnatural.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the Green and Golden Bell Frog.	☐ Yes ☑ No

8. Black-necked Stork

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, ARS (2013) stated the following with regard to the Black-necked Stork: *Occurs in lagoons, swamps, estuarine mudflats, flood plains etc. It occurs irregularly, up to two or three times in some years at Lake Innes. Water levels do not appear to influence numbers as it feeds along lake margins feeding largely on fish and frogs, also crustaceans. Has been recorded as breeding at Lake Innes in both freshwater period as well as during saltwater periods, although largely associated with freshwater wetlands in mid to central coastal NSW.* *Based on the observations as stated in ARS (2013) the proposed activity is not likely to have an adverse effect on the life cycle of the Black-necked Stork such that a viable local population is likely to be placed at risk of extinction.*	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (iv) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (v) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Black-necked stork is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (vi) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

9. Pied Oystercatcher (Haematopus longirostris)

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, ARS (2013) stated the following with regard to the Pied Oystercatcher: *In NSW the Pied Oystercatcher is listed as an endangered species. The Pied Oystercatcher is associated with saltwater habitat within the intertidal zone of sandy beaches, estuaries and tidal mudflats of Australia.* *Having only been observed in small numbers occasionally near Lake Innes, the result of the proposed activity is not likely to have an adverse effect on the life cycle of the Pied Oystercatcher such that a viable local population is likely to be placed at risk of extinction.*	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (vii) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (viii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Pied Oystercatcher is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (ix) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

10. Eastern Osprey (Pandion cristatus)

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, ARS (2013) stated the following with regard to the Eastern Osprey: *This species occurs around almost the entire coastline of Australia, favouring mouths of large rivers, lagoons and lakes, but also occurs far inland on rivers and lakes, using both fresh and saltwater environments for foraging. Nests in trees in or close to rivers, but in coastal habitats from woodland to open forest, usually within one kilometre of the sea, sometimes in the ground on isolated islands. The proposed activity would have a neutral effect on this species and would most likely to continue to nest in or around the watercourse as it appears to have done for many years during high and low water levels.* *The result of the proposed activity is not likely to have an adverse effect on the life cycle of the Eastern Osprey such that a viable local population is likely to be placed at risk of extinction, as the species utilises both fresh and saltwater environments.*	☐ **Yes** ☑ **No**
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (x) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (xi) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Eastern Osprey is not an EEC.	☐ **Yes** ☑ **No**

S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (xii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No
S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure. As this species is associated with both fresh and saltwater habitats, it is considered the proposed works will have a negligible impact on the Eastern Osprey.	☐ Yes ☑ No

11. Beach Stone Curlew (Esacus magnirostris)

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, ARS (2013) stated the following with regard to the Beach Stone Curlew: *This critically endangered species inhabits coastal undisturbed beaches, coral reefs, tidal mudflats and mangroves. The Beach Stone-curlew is found across northern and north-eastern Australia south to northeastern NSW. It is extremely rare in NSW, with a minimum population of 13 adult birds recorded in 2000. Disturbance is a key threat to this species, particularly human recreational activities that can cause desertion of nests and make remaining habitat unsuitable.* *This species occurs around almost the entire coastline of Australia, favouring mouths of large rivers, lagoons and lakes, but also occurs far inland on rivers and lakes, using both fresh and saltwater environments for foraging. Nests in trees in or close to rivers, but in coastal habitats from woodland to open forest, usually within one kilometre of the sea, sometimes in the ground on isolated islands. The proposed activity would have a neutral effect on this species and would most likely to continue to nest in or around the watercourse as it appears to have done for many years during high and low water levels.* *The result of the proposed activity is not likely to have an adverse effect on the life cycle of the Eastern Osprey such that a viable local population is likely to be placed at risk of extinction, as the species utilises both fresh and saltwater environments.*	☐ **Yes** ☑ **No**
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (xiii) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (xiv) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Beach Stone Curlew is not an EEC.	☐ **Yes** ☑ **No**

S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (xv) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No
S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure. As this species is associated with saltwater habitats, it is considered the proposed works will have a negligible impact on the Beach Stone Curlew.	☐ Yes ☑ No

12. Australasian bittern (*Botaurus poiciloptilus*)

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, ARS (2013) stated the following with regard to the Australasian Bittern: *This endangered species is a very secretive bird and hard to locate. It prefers permanent heavily vegetated freshwater wetlands dominated by reedbeds for nesting and foraging. Very few observations recorded at Lake Innes, which is no indication, as presence is usually determined through dedicated surveys to flush birds from reeds or listening for 'booming' males during the breeding surveys.* *The result of the proposed activity is not likely to have an adverse effect on the life cycle of the Australasian Bittern such that a viable local population is likely to be placed at risk of extinction.*	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (xvi) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (xvii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Australasian Bittern is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (xviii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

13. Wallum Froglet

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The Wallum Froglet is listed as vulnerable in NSW. It is associated habitat is acidic swamps on coastal sand plains. They typically occur in sedgelands and wet heathlands. They can also be found along drainage lines within other vegetation communities and disturbed areas, and occasionally in swamp sclerophyll forests.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (xix) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (xx) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Wallum Froglet is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (xxi) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

14. Eastern Grass Owl

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The Eastern Grass Owl is listed as vulnerable in NSW. Eastern Grass Owls are found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Breeding season is highly variable and dependent on environmental conditions, but in NSW nesting most typically occurs in autumn or winter.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Eastern Grass Owl is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

15. Rose Crown Fruit Dove

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, The Rose-crowned Fruit-dove is listed as vulnerable in NSW. Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits.	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, The Rose-crowned Fruit-dove is not an EEC.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, Habitat will not be removed as a result of the proposed activity. The extent to which any habitat is likely to be modified (that is, saltwater content or water quantity) is not considered sufficient to have a significant negative impact on the long-term survival of this species in the locality.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  Not listed as declared area of outstanding biodiversity value.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The proposed works constitutes a key threatening process, that is, alteration to the natural flow regimes of rivers and streams and their wetlands. It is considered necessary to prevent another key threatening process of anthropogenic contamination and debris from entering the watercourse due to flooding of public (chiefly sewer) and private infrastructure.	☐ Yes ☑ No

16. Endangered Ecological Communities (EEC's)

Item	The Biodiversity Conservation Act 5 Part Test of Significance	Does the development trigger a significant impact ?
S7.3(1)a	in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, Not applicable	☐ Yes ☑ No
S7.3(1)b	in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No
S7.3(1)c	in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality, There are no EEC's on site or within close proximity to the works area.	☐ Yes ☑ No

S7.3(1)d	whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),  As shown below the works site is not in an area depicted on the BV map although drainage of the estuarine system will impact indirectly on the Lake Innes system to the North East of the work site which is mapped on the BV map. The nature of ICOLL's is depicted by changing water levels and fluctuations and as such it is difficult to assume that the change in water levels caused by the artificial opening will have negative impacts. Therefore, it is assumed that impacts are low.	☐ Yes ☑ No
S7.3(1)e	whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process. The impact of works will not be a key part and will not likely increase the impact on a key threatening process for associated with the EEC's.	☐ Yes ☑ No

Interim guidelines to assist in interpreting the test of significance can be found at:
http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf

17. Purple Spotted Gudgeon (*Mogurnda adspersa*) (Fisheries Management Act Test of Significance)

Item	The Fisheries Management Act 7 Part Test of Significance	Does the development trigger a significant impact ?
(a)	in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction, Applies as the species is listed in Part 1 of Schedule 4 of the FM Act.	☐ Yes ☑ No
(b)	in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction Not applicable as the species does not constitute an endangered population as listed in Part 2 of Schedule 4 of the FM Act.	☐ Yes ☑ No
(c)	in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction Not applicable as the species does not constitute an endangered population as listed in Part 3 of Schedule 4 or Part 2 of Schedule 4A of the FM Act.	☐ Yes ☑ No
(d)	in relation to the habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality The presence of the species within the Cowarra Creek would be indicative of its resilience of, or conditioning to, any potential for saltwater intrusion and modification of water levels that may be caused by the lake opening. The proposed activity is the replication of a natural lake opening, instigated so as to prevent flooding of infrastructure (and sewer infrastructure) which would likely have significant water quality impacts.	☐ Yes ☑ No
(e)	whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly) The Study Area is understood to not be critical habitat.	☐ Yes ☑ No

(f)	whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan The activity would not be consistent with the objectives or actions of a recovery plan or threat abatement plan, though would prevent potential impacts to water quality that would result from not preventing flooding of infrastructure. The presence of the species within the Cowarra Creek would be indicative of its resilience of, or conditioning to, any potential for saltwater intrusion and modification of water levels that may be caused by the lake opening.	☐ Yes ☑ No
(g)	whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process The proposed action would constitute a threatening process as the opening would potentially cause fluctuations in water levels and flow. However it is noted that this is the replication of a natural event that would, replicating the potential for water level fluctuations that would be caused by a natural opening. As previously stated the presence of the species within the Cowarra Creek would be indicative of its resilience of, or conditioning to, any potential for saltwater intrusion and modification of water levels that may be caused by the lake opening.	☐ Yes ☑ No

Appendix F - Water Quality Monitoring Results

Reference	Sample	Description	Sample		Time Sampled	Sampled By	Site Reference	Enterococci	True Colour	Turbidity	Ø pH	Ø Temperature	Ø Salinity	Ø Dissolved Oxygen	Ø Dissolved Oxygen	Ø Water Level
	No.		Description	Date												
Units								cfu 100mL^{-1}	CU (Pt-Co)	NTU	pH Units	°C	PPT	%	mg L^{-1}	Meters
Method								MET040	MET036	MET018	Field	Field	Field	Field	Field	Field
H18 1476	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	6/08/2018	12:15	B. Malcolm	CBW-02	3	16	2.3	8.0	17.2	28.2	91.9	7.39	0.1
H18 1677	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	3/09/2018	12:00	K. Archer	CBW-02	18	6	1.7	8.0	17.3	41.3	94.4	7.12	0.5
H18 1874	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	2/10/2018	12:15	K. Archer	CBW-02	11	<5	1.9	8.1	22.0	41.8	99.4	6.75	0.37
H18 2151	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	5/11/2018	10:55	M. Butt	CBW-02	1	22	1.9	7.7	26.8	31.3	85.4	5.67	0.5
H18 2355	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	11/12/2018	11:10	C. Menjivar	CBW-02	9	18	2	8.0	25.9	34.2	78.6	5.31	0.38
H19 0067	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	8/01/2019	10:50	M. Butt	CBW-02	4	27	3.7	8.3	27.7	40.9	117	7.37	0.275
H19 0231	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	5/02/2019	10:45	M. Butt	CBW-02	6	25	8.0	8.3	28.1	NR	NR	NR	0.062
H19 0418	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	5/03/2019	11:10	K. Archer	CBW-02	12	21	7.6	8.1	26.6	42.3	93.2	5.90	0.016
H19 0720	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	9/04/2019	11:10	M. Butt	CBW-02	19	25	8.5	8.2	25.3	41.9	94.0	6.09	0.047
H19 0923	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	7/05/2019	11:10	B. Malcolm	CBW-02	<10	19	5.5	8.1	18.8	41.1	103	7.51	0
H19 1126	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	4/06/2019	11:35	K. Archer	CBW-02	29	16	3.6	7.8	15.0	42.2	79.3	6.17	-0.1
H19 1337	1	Lake Cathie LOG Monthly	Lake Cathie: Ocean Drive Bridge -SW side	2/07/2019	11:20	C. Menjivar	CBW-02	3	23	3.6	8.0	15.6	39.4	38.0	2.98	0

Reference	Sample No.	Description	Sample Description	Sample Date	Time Sampled	Sampled By	Site Reference	Enterococci	pH	Electrical Conductivity @ 25°C	Ø Salinity	Ø Electrical Conductivity	Ø Dissolved Oxygen	Ø Dissolved Oxygen	Ø pH	Ø Temperature	Ø Water Level
Units								cfu 100mL^{-1}	pH Units	µS cm^{-1}	PPT	µS cm^{-1}	mg L^{-1}	%	pH Units	°C	Meters
Method								MET040	MET014	MET009	Field	Field	Field	Field	Field	Field	Internet Site 207441
H19 0197	1	Lake Cathie Weekly	Perch Hole Reserve	30/01/2019	11:35	G. Kaa		<1	8.1	64300	^ 42.9	72100	NR	NR	7.9	29.0	
H19 0197	2	Lake Cathie Weekly	Lake Cathie Playground	30/01/2019	11:15	G. Kaa		44	8.7	60700	^ 40.3	68500	NR	NR	8.6	29.1	
H19 0197	3	Lake Cathie Weekly	Lake Cathie Bridge	30/01/2019	10:50	G. Kaa	CBW-02	11	8.6	61700	^ 41.1	67900	NR	NR	8.5	28.1	0.1
H19 0232	1	Lake Cathie Weekly	Perch Hole Reserve	5/02/2019	11:15	M. Butt		67	8.0	65900	NR	72500	NR	NR	7.8	28.6	
H19 0232	2	Lake Cathie Weekly	Lake Cathie Playground	5/02/2019	10:55	M. Butt		16	8.5	62300	NR	68900	NR	NR	8.3	28.6	
H19 0232	3	Lake Cathie Weekly	Lake Cathie Bridge	5/02/2019	10:45	M. Butt	CBW-02	11	8.5	63000	NR	68800	NR	NR	8.3	28.1	0.062
H19 0255	1	Lake Cathie Weekly	Perch Hole Reserve	12/02/2019	7:50	C. Menyvar		<1	8.0	66100	NR	69800	NR	NR	7.7	24.2	
H19 0255	2	Lake Cathie Weekly	Lake Cathie Playground	12/02/2019	8:10	C. Menyvar		10	8.3	61400	NR	66100	NR	NR	8.2	26.1	
H19 0255	3	Lake Cathie Weekly	Lake Cathie Bridge	12/02/2019	8:25	C. Menyvar	CBW-02	10	8.3	62700	NR	67900	NR	NR	8.1	27.4	NR^
H19 0307	1	Lake Cathie Weekly	Perch Hole Reserve	19/02/2019	11:30	B. Malcolm		1	8.0	67200	46.0	67600	6.43	105	8.0	27.1	
H19 0307	2	Lake Cathie Weekly	Lake Cathie Playground	19/02/2019	11:15	B. Malcolm		8	8.3	62200	42.3	62900	7.13	115	8.2	27.7	
H19 0307	3	Lake Cathie Weekly	Lake Cathie Bridge	19/02/2019	10:55	B. Malcolm	CBW-02	10	8.3	63100	42.8	63500	6.20	98.2	8.0	26.7	0.02
H19 0368	1	Lake Cathie Weekly	Perch Hole Reserve	25/02/2019	12:45	K. Archer		5	8.3	65600	46.0	67500	7.78	117	8.2	22.0	
H19 0368	2	Lake Cathie Weekly	Lake Cathie Playground	25/02/2019	12:30	K. Archer		34	8.4	55400	36.8	55400	8.20	120	8.3	23.0	
H19 0368	3	Lake Cathie Weekly	Lake Cathie Bridge	25/02/2019	12:15	K. Archer	CBW-02	5	8.5	59400	40.4	60200	7.08	105	8.3	23.0	0.01
H19 0417	1	Lake Cathie Weekly	Perch Hole Reserve	5/03/2019	11:40	K. Archer		7	8.1	67900	47.3	69200	6.79	111	8.1	26.9	
H19 0417	2	Lake Cathie Weekly	Lake Cathie Playground	5/03/2019	11:25	K. Archer	2600	8.3	60100	40.9	61000	7.33	117	8.3	27.9		
H19 0417	3	Lake Cathie Weekly	Lake Cathie Bridge	5/03/2019	11:10	K. Archer	CBW-02	5	8.3	61800	42.3	62800	5.90	93.2	8.1	26.6	0.016
H19 0482	1	Lake Cathie Weekly	Perch Hole Reserve	12/03/2019	10:55	M. Butt		8	8.3	67100	45.3	66800	6.53	105	8.3	27.8	
H19 0482	2	Lake Cathie Weekly	Lake Cathie Playground	12/03/2019	10:40	M. Butt		760	8.5	56400	38.7	58300	7.32	116	8.4	28.6	
H19 0482	3	Lake Cathie Weekly	Lake Cathie Bridge	12/03/2019	10:30	M. Butt	CBW-02	3	8.5	62500	42.0	62400	7.32	115	8.2	27.1	0.032
H19 0536	1	Lake Cathie Weekly	Perch Hole Reserve	19/03/2019	11:40	B. Malcolm		29	8.4	64800	44.1	65100	7.42	119	8.3	25.5	
H19 0536	2	Lake Cathie Weekly	Lake Cathie Playground	19/03/2019	11:25	B. Malcolm		420	8.5	58100	34.8	58200	8.25	128	8.4	26.7	
H19 0536	3	Lake Cathie Weekly	Lake Cathie Bridge	19/03/2019	11:05	B. Malcolm	CBW-02	21	8.5	61000	41.2	61300	7.23	110	8.0	24.8	0
H19 0605	1	Lake Cathie Weekly	Perch Hole Reserve	26/03/2019	11:35	G. Kaa		1	8.2	66200	44.5	65700	6.08	98.6	8.1	27.5	
H19 0605	2	Lake Cathie Weekly	Lake Cathie Playground	26/03/2019	11:20	G. Kaa		37	8.4	57500	38.4	57700	6.86	106	8.4	26.8	
H19 0605	3	Lake Cathie Weekly	Lake Cathie Bridge	26/03/2019	11:05	G. Kaa	CBW-02	29	8.4	60700	40.5	60500	4.34	68.7	8.1	27.3	-0.048
H19 0605	4	Lake Cathie Weekly	Lake Cathie Bridge - 1m	26/03/2019	11:07	G. Kaa					40.7	60800	4.70	74.4	8.2	27.3	
H19 0658	1	Lake Cathie Weekly	Perch Hole Reserve	2/04/2019	10:50	K. Archer		3	8.2	65600	44.3	65300	6.22	91.1	8.1	21.5	
H19 0658	2	Lake Cathie Weekly	Lake Cathie Playground	2/04/2019	10:35	K. Archer		110	8.4	57700	38.4	57500	6.50	91.1	8.3	20.9	
H19 0658	3	Lake Cathie Weekly	Lake Cathie Bridge	2/04/2019	10:25	K. Archer	CBW-02	19	8.4	60600	41.3	61400	4.80	69.9	7.9	22.1	-0.05
H19 0719	1	Lake Cathie Weekly	Perch Hole Reserve	9/04/2019	11:30	M. Butt		<1	8.2	67600	46.4	68100	7.07	114	8.2	26.5	
H19 0719	2	Lake Cathie Weekly	Lake Cathie Playground	9/04/2019	11:20	M. Butt		26	8.4	61300	40.8	60800	7.08	110	8.3	26.3	
H19 0719	3	Lake Cathie Weekly	Lake Cathie Bridge	9/04/2019	11:10	M. Butt	CBW-02	20	8.4	62500	41.9	62200	6.09	94.0	8.2	25.0	0.047
H19 0785	1	Lake Cathie Weekly	Perch Hole Reserve	16/04/2019	11:05	C. Menyvar		1	8.1	66400	43.8	64700	6.60	97.3	8.0	22.0	
H19 0785	2	Lake Cathie Weekly	Lake Cathie Playground	16/04/2019	10:45	C. Menyvar		21	8.3	56300	37.4	56700	6.49	93.9	8.2	22.9	
H19 0785	3	Lake Cathie Weekly	Lake Cathie Bridge	16/04/2019	10:30	C. Menyvar	CBW-02	37	8.3	61500	41.5	61700	5.93	87.1	8.0	22.5	<0.00
H19 0825	1	Lake Cathie Weekly	Perch Hole Reserve	23/04/2019	8:55	M. Butt		1	8.0	63500	42.3	62800	6.02	89.1	7.5	22.7	
H19 0825	2	Lake Cathie Weekly	Lake Cathie Playground	23/04/2019	9:05	M. Butt		19	8.3	52200	38.3	57400	6.37	93.6	8.1	23.6	
H19 0825	3	Lake Cathie Weekly	Lake Cathie Bridge	23/04/2019	9:20	M. Butt	CBW-02	5	8.2	60400	40.7	60600	5.32	78.5	8.1	23.0	0.05
H19 0855	1	Lake Cathie Weekly	Perch Hole Reserve	30/04/2019	11:00	K. Archer		59	8.0	66000	45.2	66400	6.61	97.0	7.9	21.3	
H19 0855	2	Lake Cathie Weekly	Lake Cathie Playground	30/04/2019	10:50	K. Archer		2500	8.4	56900	39.4	58800	7.64	109	8.3	21.5	
H19 0855	3	Lake Cathie Weekly	Lake Cathie Bridge	30/04/2019	10:40	K. Archer	CBW-02	>1000	8.3	61200	41.5	61700	5.55	79.0	8.0	20.7	0
H19 0920	1	Lake Cathie Weekly	Perch Hole Reserve	7/05/2019	11:40	B. Malcolm		2	8.0	63800	41.8	62000	7.84	107	8.0	18.5	
H19 0920	2	Lake Cathie Weekly	Lake Cathie Playground	7/05/2019	11:25	B. Malcolm		<10	8.3	57000	39.1	59400	9.22	130	8.3	21.1	
H19 0920	3	Lake Cathie Weekly	Lake Cathie Bridge	7/05/2019	11:10	B. Malcolm	CBW-02	<10	8.3	59700	41.1	61100	7.51	103	8.1	18.8	0
H19 0973	1	Lake Cathie Weekly	Perch Hole Reserve	14/05/2019	11:00	C. Menyvar		2	8.0	67000	45.1	66300	7.32	105	8.0	20.2	
H19 0973	2	Lake Cathie Weekly	Lake Cathie Playground	14/05/2019	10:45	C. Menyvar		5	8.1	59000	39	58300	6.6	91.7	8.1	20.2	
H19 0973	3	Lake Cathie Weekly	Lake Cathie Bridge	14/05/2019	10:20	C. Menyvar	CBW-02	3	8.2	61900	41.2	61300	5.72	78.2	7.8	18.5	0
H19 1028	1	Lake Cathie Weekly	Perch Hole Reserve	21/05/2019	11:05	C. Menyvar	-	<1	8.0	68700	46.2	67700	6.81	96.9	7.9	19.2	
H19 1028	2	Lake Cathie Weekly	Lake Cathie Playground	21/05/2019	10:55	C. Menyvar	-	32	8.2	59500	38.2	57300	6.95	97.0	8.1	20.7	
H19 1028	3	Lake Cathie Weekly	Lake Cathie Bridge	21/05/2019	10:45	C. Menyvar	CBW-02	1	8.1	62900	41.6	61800	5.44	75.3	7.7	19.2	0
H19 1083	1	Lake Cathie Weekly	Perch Hole Reserve	28/05/2019	11:10	G. Kaa		<1	8.1	68000	46.2	67900	7.73	102	8.1	15.3	
H19 1083	2	Lake Cathie Weekly	Lake Cathie Playground	28/05/2019	11:00	G. Kaa		4	8.3	59900	38.9	58300	8.34	105	8.3	15.2	
H19 1083	3	Lake Cathie Weekly	Lake Cathie Bridge	28/05/2019	10:45	G. Kaa	CBW-02	1	8.3	62800	42.0	62300	7.42	96.8	8.0	15.9	0
H19 1124	1	Lake Cathie Weekly	Perch Hole Reserve	4/06/2019	12:00	K. Archer		5	8.1	66300	44.1	65100	7.89	102	8.1	14.9	
H19 1124	2	Lake Cathie Weekly	Lake Cathie Playground	4/06/2019	11:45	K. Archer		25	8.2	58100	37.4	56300	8.27	102	8.2	14.4	
H19 1124	3	Lake Cathie Weekly	Lake Cathie Bridge	4/06/2019	11:35	K. Archer	CBW-02	24	8.2	62600	42.2	62600	6.17	79.3	7.8	15.0	-0.1
H19 1161	1	Lake Cathie Weekly	Perch Hole Reserve	12/06/2019	9:40	G. Kaa		10	8.2	62100	41.7	62000	9.51	126	7.9	16.8	
H19 1161	2	Lake Cathie Weekly	Lake Cathie Playground	12/06/2019	9:55	G. Kaa		330	8.1	52900	35.3	53300	6.5	82.7	8.1	16.7	
H19 1161	3	Lake Cathie Weekly	Lake Cathie Bridge	12/06/2019	10:10	G. Kaa	CBW-02	23	8.0	56800	37.9	56900	5.64	72.8	8.0	16.6	0
H19 1226	1	Lake Cathie Weekly	Perch Hole Reserve	18/06/2019	9:05	M. Butt		4	8.1	62600	41.8		7.34	95.4		15.8	
H19 1226	2	Lake Cathie Weekly	Lake Cathie Playground	18/06/2019	9:15	M. Butt		12	8.2	54600	29.4		7.73	92.5		15.4	
H19 1226	3	Lake Cathie Weekly	Lake Cathie Bridge	18/06/2019	9:25	M. Butt	CBW-02	20	8.2	57900	38.6		7.88	100		15.7	0.17
H19 1273	1	Lake Cathie Weekly	Perch Hole Reserve	25/06/2019	9:15	M. Butt		56	8.2	54800	34.1	51800	8.00	94.9		13.7	
H19 1273	2	Lake Cathie Weekly	Lake Cathie Playground	25/06/2019	9:25	M. Butt		460	8.2	48300	31.4	48100	8.00	93.3		13.8	
H19 1273	3	Lake Cathie Weekly	Lake Cathie Bridge	25/06/2019	9:35	M. Butt	CBW-02	670	8.2	53200	35.9	54300	7.20	86.7		13.5	0.136
H19 1335	1	Lake Cathie Weekly	Perch Hole Reserve	2/07/2019	11:50	C. Menyvar		13	8.2	58900	^ 38.5	NR	NR	NR	8.2	NR	
H19 1335	2	Lake Cathie Weekly	Lake Cathie Playground	2/07/2019	11:35	C. Menyvar		5	8.3		35.1	53100	7.96	103	8.3	17.8	
H19 1335	3	Lake Cathie Weekly	Lake Cathie Bridge	2/07/2019	11:20	C. Menyvar	CBW-02	2	8.2		39.4	59900	2.98	38.0	8.0	15.6	0
H19 1383	1	Lake Cathie Weekly	Perch Hole Reserve	9/07/2019	11:40	B. Malcolm		6	8.0		39.1	58500	7.02	91.2	8.0	16.6	
H19 1383	2	Lake Cathie Weekly	Lake Cathie Playground	9/07/2019	11:20	B. Malcolm		14	8.2	50700	^ 39.6	NR	^ 8.01	^ 101	NR	NR	

H19 1383	3	Lake Cathie Weekly	Lake Cathie Bridge	9/07/2019	11:10	B. Malcolm	CBW-02	15	8.1	53800	^ 36.0	NR	^ 7.87	^ 99.9	NR	NR	0
H19 1436	1	Lake Cathie Weekly	Perch Hole Reserve	16/07/2019	11:30	K. Archer		2	8.0	59600	40.7	60800	8.09	98.1	8.1	12.6	
H19 1436	2	Lake Cathie Weekly	Lake Cathie Playground	16/07/2019	11:15	K. Archer		42	8.1	52200	35.2	53400	7.33	88.4	8.1	14.0	
H19 1436	3	Lake Cathie Weekly	Lake Cathie Bridge	16/07/2019	11:00	K. Archer	CBW-02	27	8.0	54700	36.7	55400	6.76	80.4	7.9	12.8	-0.1

^ HACH SenSion5

^ Performed in the Lab

Field

Appendix G - AHIMS Report

Office of Environment & Heritage
NSW GOVERNMENT

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : Lake Cathie

Client Service ID : 496776

Port Macquarie Hastings Council - NRM Team

17 Burrawan Street
Port Macquarie New South Wales 2444

Attention: Tim Haydon

Email: tim.haydon@pmhc.nsw.gov.au

Date: 09 April 2020

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -31.5518, 152.8504 - Lat, Long To : -31.545, 152.8613 with a Buffer of 50 meters, conducted by Tim Haydon on 09 April 2020.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

Appendix H - EPBC Protected Matters Search Report

Australian Government
Department of the Environment and Energy

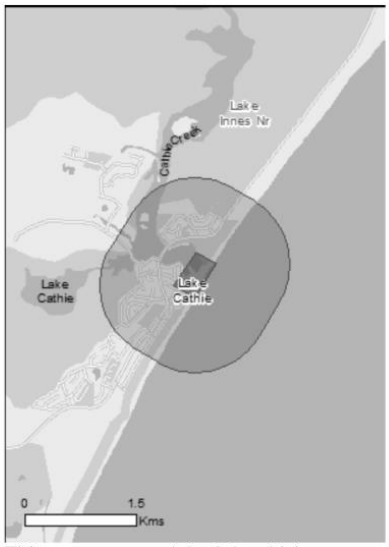
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 09/04/20 10:35:58



Coordinates
Buffer: 1.0Km

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	70
Listed Migratory Species:	58

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	79
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	1
Invasive Species:	32
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities		[Resource Information]
For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.		
Name	Status	Type of Presence
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or

Name	Status	Type of Presence
		related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species habitat may occur within area
Fish		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Insects		
Argynnis hyperbius inconstans Australian Fritillary [88056]	Critically Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Plants		
Acronychia littoralis		
Scented Acronychia [8582]	Endangered	Species or species habitat likely to occur within area
Allocasuarina defungens		
Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat likely to occur within area
Arthraxon hispidus		
Hairy-joint Grass [9338]	Vulnerable	Species or species habitat may occur within area
Asperula asthenes		
Trailing Woodruff [14004]	Vulnerable	Species or species habitat may occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Cynanchum elegans		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat known to occur within area
Euphrasia arguta		
[4325]	Critically Endangered	Species or species habitat may occur within area
Macadamia integrifolia		
Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat may occur within area
Melaleuca biconvexa		
Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area
Persicaria elatior		
Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area
Phaius australis		
Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
Syzygium paniculatum		
Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat may occur within area
Thesium australe		
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Saiphos reticulatus Three-toed Snake-tooth Skink [88328]	Vulnerable	Species or species habitat may occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Foraging, feeding or related behaviour may occur within area
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Foraging, feeding or related behaviour may occur within area
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat likely to occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs'		Species or species

Name	Threatened	Type of Presence
Pipefish [66242]		habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Solegnathus dunckeri		
Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus spinosissimus		
Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus		
Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus		
Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora nigra		
Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus		
Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus		
Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus		
Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon		
Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Lake Innes	NSW

Regional Forest Agreements	[Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area

Name	Status	Type of Presence
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla		
Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis		
Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.550747 152.855761,-31.55064 152.855869,-31.55064 152.855869,-31.547288 152.85839,-31.548553 152.86084,-31.552088 152.858354,-31.550747 152.855761

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix I - Correspondence to Stakeholders

From:	Blayne West
To:	Silas Sutherland; Jonathan Yantsch; Andrew.Marshall@environment.nsw.gov.au; John Schmidt
Cc:	Debbie Archer; Jack Hiscock; Melissa Watkins
Subject:	PMHC CMP - Roles and Responsibilities
Date:	Wednesday, 15 April 2020 4:40:00 PM
Attachments:	image001.jpg image002.jpg

Hi folks,

How is everyone keeping in these unprecedented times? Hope you all had a nice break over Easter. Apologies if you feel like you are being inundated with questions from the PMHC staff at the moment but we are in the final throws of writing our CMP also developing some much needed community education and engagement pieces.

Ideally this request would come out of a well written community engagement plan but as it stands the rate of information requested of all of us is happening faster than we can get the processes in place to assist with. As such, we are working on how to provide information more succinctly and consistently to the community. I think we are all aware of the issues that have arisen where we haven't done this well but unfortunately John Schmidt, sent me a news article link that shows me we are still not there.

Excerpt from John's email that sums it up nicely:

Just noticed this article in the Port News https://www.portnews.com.au/story/6719053/time-for-some-real-answers-on-management-of-our-lake/ which seems founded on some dubious information.
The last sentence certainly reinforces the merits of getting an engagement strategy kicked off in this community.

So, I think we can all agree we need to work on doing this better and as such PMHC is proposing that we need to have consistent messaging about what role each stakeholder has in managing not only Lake Cathie but estuaries, rivers and coastline. In order to provide this message we are suggesting:

1. Clear information in the CMP in a table format as shown below that outlines exactly what each of us does.
2. Video and live chat sessions on the topics listed in the table below.

Therefore it comes down to - we are in need of your help please. To help us out we are asking the following:

1. Please provide us with a few sentences to fill out the table below - What is the responsibility of your agency regarding managing estuaries, rivers and coastlines?

Potential CMP Governance and Management

Entity	Responsibility
Port Macquarie-Hastings Council	Lead agency, coordination and implementation.

State Agencies: Department of Planning Industry and Environment Department of Industry - Crown Lands and Water Department of Primary Industries - Fisheries National Parks and Wildlife Services NSW Environment Protection Authority Roads and Maritime Services Transport for NSW	Sign off on CMP, collaboration, action(s) and implementation (as defined).
Coast, Estuary & Floodplain Advisory Sub-Committee Port Macquarie-Hastings Council State Agencies Industry Representatives Community Representatives	Council adopted Sub-Committee, to assist Council in undertaking management and planning. To assist reviewing studies, plans and policies and to provide and receive feedback from the community.

2. Is anyone other than John and Danny (thank you both for already agreeing) to help us out with a video (filmed with only your voice even)? And also to partake in a live Q &A on some or all of the topics below? Again you can call in on the phone so you no hair and makeup required. The Q & A is moderated so it is very controlled and where possible most of the questions will be provided before the sessions. We need to solidify a message with our community and we need to rebuild trust and knowledge.

   Our first session is around mid-May and we would like to have as many panel experts as possible to answer questions on the CMP. Anyone available to help out?

Topic	Who?
Coastal Management Program: • What is a CMP • Why do we need one? • How will it benefit our LGA? • PMHC's role/responsiblity (Blayne West)	John Schmidt
Estuary Health Monitoring - water quality: • What is considered good water quality? • Diff between monitoring for ecosystem health and recreational purposes. • What are the main contributors to poor water quality? • Effects of artificial entrance openings on water quality? • PMHC's role/responsiblity (Blayne West)	Peter Scanes
ICOLL Entrance Management:	Angus Ferguson

• Artificial vs natural opening • Wet vs Dry weather opening • Channel formation • Closure processes • Frequency of openings • Natural water quality • PMHC's role/responsiblity (Blayne West)	

Permanent Openings - Entrance training walls:
• Pros vs Cons
• Impacts to fisheries
• Erosion
• Seagrass loss
• Marine sand transport
• Increased tidal velocities
  ○ Scouring issues
  ○ Loss of shallow water habitats, shorelines & wetlands
  ○ Damage to infrastructure
• PMHC's role/responsiblity (Blayne West)
	Danny Wiecek

Fisheries - implications of artificial entrance management: • Recruitment processes in ICOLL's • Species abundance and diversity • Effects of rainfall/drought in closed systems • Effects of artificial openings on fish stocks • Commercial fisheries in Lake Cathie/Innes - is it still viable? • Responsibilities under "Fisheries Act" • PMHC's role/responsiblity (Blayne West)	Jonathan Yantsch
Port Macquarie-Hastings Council's role: • Tenure / responsibilities / roles • Council as a link between community & NSW GOV owners/managers • Where we are with the CMP • Future opening strategy • Future management strategies	Blayne West
Crown Lands: (5 mins) • Roles & responsibilities	Silas Sutherland
NPWS: (5 - 10 mins) • Roles & responsibilities	Andy Marshall
Birpai: (5 - 10 mins) • Cultural values	David Carroll

• Traditional management / uses • Connection to country	

Many thanks,
Blayne

Blayne West
Natural Resources Manager
Development and Environment

p (02) 6581 8560

f (02) 6581 8123

cid:image001.jpg@01D601EC.56B63660

From: Blayne West
To: silas.sutherland@crownland.nsw.gov.au
Subject: FW: Lake Cathie - Seeking input and advice
Date: Tuesday, 11 February 2020 4:47:00 PM
Attachments: image001.jpg
image002.jpg
Letter - Request for Agency Input into Brief for EIS - Part 5 Assessment February 2020.DOCX
Lake Cathie Sand Removal & Opening - Request for Secretaries Environmental Assessment Requirements SEARs, February 2020.DOCX
Ordinary Council Meeting - Mayoral Minute - MINUTES - Lake Cathie Reverse Opening to Ocean, 20 November 2019.PDF
Ordinary Council Meeting LATE - Mayoral Minute - AGENDA - Lake Cathie Reverse Opening to Ocean, 20 November 2019.PDF
Concept Plans.jpg

Hi Silas,

This was sent to Tina last week but I just saw a bounced email. Not sure if anyone from Crown directly received this.

Cheers, Blayne

From: Blayne West
Sent: Friday, 7 February 2020 4:16 PM
To: Jonathan Yantsch (jonathan.yantsch@dpi.nsw.gov.au) <jonathan.yantsch@dpi.nsw.gov.au>; tina.clemens@lands.nsw.gov.au; Geoffrey James <Geoffrey.James@environment.nsw.gov.au>; John Schmidt <John.Schmidt@environment.nsw.gov.au>; Shane Robinson <Shane.Robinson@environment.nsw.gov.au>
Cc: Jesse Dick <Jesse.Dick@pmhc.nsw.gov.au>; Dan Croft <Dan.Croft@pmhc.nsw.gov.au>; Craig Swift-McNair <Craig.Swift-McNair@pmhc.nsw.gov.au>
Subject: Lake Cathie - Seeking input and advice

Hi all,

Please find attached a formal letter of request for your input into the opening (works and application undertaken by PMHC), of Lake Cathie under Part 5 of the EP&A Act. We will provide further detail on Monday regarding a diagrammatic scope of works but do feel that the information provided herein is a basis from which to comment from.

I understand we are asking a lot but based on everyone's intimate knowledge of this site we do ask for feedback and advice by COB Friday Feb.14th. Specifically, as outlined the attached letter we are requesting the following:

Council is requesting the following:

1. Specific matters that are require for consideration are requested from each NSW government agency in order to inform the brief to a consultant.

2. Specific tasks that must be considered are requested from each agency.

3. Specific advice regarding the Acid Sulphate studies. Is it the advice of key agencies that the ASS work needs to be completed to inform the EIS in the short term opening or in a long term opening strategy?

Please provide comments under separate cover or via an update to this document.

If you have any questions or concerns please contact me on 6581 - 8560.

Many thanks, Blayne

Blayne West
Natural Resources Manager
Development and Environment

p (02) 6581 8560

f (02) 6581 8123

PMHC Water Restrictions Notice_Level Three_Email Signature_0.2

From: Silas Sutherland
To: Blayne West
Subject: HPE CM: RE: Lake Cathie Opening
Date: Thursday, 13 February 2020 5:27:52 PM
Attachments: image004.jpg
image005.jpg
image001.jpg

Thanks Blayne,

Enjoy the rain!

Cheers

Silas

Silas Sutherland
Area Manager North Coast

Crown Lands I Department of Planning, Industry and Environment
Level 3 | 49-51 Victoria Street | Grafton | PO Box 2215 | DANGAR | NSW | 2309
P: (02) 6591 3580 | **M**: 0429 499 597 | **F**: (02) 6642 5375 | **E**: silas.sutherland@crownland.nsw.gov.au
W: www.crownland.nsw.gov.au | www.dpie.nsw.gov.au

The Department of Planning, Industry and Environment acknowledges that it stands on Aboriginal land. We acknowledge the traditional custodians of the land and we show our respect for elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

From: Blayne West <Blayne.West@pmhc.nsw.gov.au>
Sent: Thursday, 13 February 2020 4:07 PM
To: Silas Sutherland <silas.sutherland@crownland.nsw.gov.au>
Cc: Dan Croft (Port Macquarie-Hastings Council) <dan.croft@pmhc.nsw.gov.au>; Craig Swift-McNair (Port Macquarie-Hastings Council) <craig.swift-mcnair@pmhc.nsw.gov.au>; Tim Haydon <Tim.Haydon@pmhc.nsw.gov.au>; Jesse Dick <Jesse.Dick@pmhc.nsw.gov.au>; Jack Hiscock <Jack.Hiscock@pmhc.nsw.gov.au>
Subject: Lake Cathie Opening

Hi Silas,

As per our earlier conversation PMHC is currently watching the rising Lake Cathie water levels. At current, the level is at .863 AHD, the trigger level for opening the lake at the high level is 1.6mAHD. As such, Council would like to inform the Crown Lands office that Council will be enacting emergency powers under Section 191A of the Local Government Act to open the Lake if the trigger is met as per the Lake Cathie opening strategy to reduce the flood risk to our assets and community. I will do the courtesy of emailing in either the situation of opening or not over the next few days.

Regards, Blayne

Blayne West
Natural Resources Manager
Development and Environment

p (02) 6581 8560

f (02) 6581 8123

PMHC Water Restrictions Notice_Level Three_Email Signature_0.2

From: Blayne West
To: Silas Sutherland
Cc: Craig Swift-McNair; Dan Croft; Tina Clemens; Jesse Dick; Jack Hiscock
Subject: HPE CM: Urgent question - Lake Cathie
Date: Thursday, 13 February 2020 12:50:00 PM
Attachments: image001.jpg
image002.jpg

Hi Silas,

I am writing to seek clarification for opening Lake Cathie in a flooding situation. The lake as of 7.00am (13/02/20) the water level was at 0.813 AHD. Our trigger level is 1.6mAHD and with the rate of rise at the moment this may well be reached if the rains continue over the next few days.

As such, we will be applying for a new license from Crown and would like to use our current Opening Strategy and REF from 1995 to support this application. This email is a query as to whether or not it would be supported in principle.

If you are able to please provide me with an answer as soon as possible that would be very much appreciated,

Regards, Blayne

Blayne West
Natural Resources Manager
Development and Environment

p (02) 6581 8560

f (02) 6581 8123

PMHC Water Restrictions Notice_Level Three_Email Signature_0.2

From:	Jonathan Yantsch
To:	Blayne West; Jesse Dick
Cc:	Silas Sutherland; John Schmidt; Jack Hiscock; Dimitri Young; Geoffrey James; Shane Robinson
Subject:	Re: Lake Cathie - Cathie Creek, Lower Estuary Bulk Sand Removal, Excavation, Dredging Plans, February 2020
Date:	Friday, 14 February 2020 10:28:01 AM

Hi Blayne and Jesse

Thank you for providing DPI Fisheries with the opportunity to provide input into the environmental considerations for the preparation of an REF for the once-off mechanical opening of the Lake Cathie ICOLL to the ocean for ecological purposes.

As there have been very few well documented instances of ICOLL low water level openings for the purpose of ecological improvements in the past, the outcome of such an activity within Lake Cathie is unknown and there is a risk that such an activity may be also have unintended negative ecological outcomes such as impacts to fish and fish habitat.

DPI Fisheries' long standing policy position on ICOLL management, as stated within the DPI Fisheries *Policy and guidelines for fish habitat conservation and management (Update 2013)* (DPI Fisheries P&G), is for minimal interference with ICOLL barriers and for the allowance of natural processes to operate to the greatest extent possible. This remains the case for ICOLLs exhibiting low water levels due to drought conditions. Flooding and drying are natural components of the hydrological and ecological processes operating within ICOLLs. Coastal lakes and the life they support have evolved in response to these forces and to maintain a 'healthy' lake, ideally it should be left to operate as close to natural as possible

Where ICOLL entrance management is necessary, usually for reasons such as to mitigate nuisance flooding, the long term approach is to develop an Entrance Management Strategy (EMS) (under the umbrella of a Coastal Management Program) by using a range of relevant information (and by potentially undertaking further studies) and via consultation with relevant stakeholders. The EMS should align with relevant policy and legislation (e.g. minimal intervention), minimise the introduction of new or the exacerbation of existing threats and risks to the ICOLL, and set out to achieve the desired objectives.

In the absence of an EMS (or an up-to-date EMS) for problematic ICOLLs, in the short term, the DPI Fisheries P&G recommends the formulation of an interim strategy that provides clear guidance as to where, when and under what conditions would be required for an artificial opening of the ICOLL. An interim strategy for allows interim management whilst an EMS is being developed.

A once-off ad-hoc approach to entrance opening is the least preferred approach for various environmental, social and economic reasons. However, should Council proceed with a proposal for an imminent once-off opening for ecological purposes, the specific information required within an REF would include:

- General information as set out within Section 3.3.1 of the DPI Fisheries P&G.
- A clear objective for the project and justification for the need for a once-off event. In this instance, Council has stated that the opening is for ecological purposes. Therefore, the objective would need to provide specific details of the issue that is intended to be addressed and how the project would resolve the issue. The

intended outcome should relate specifically to the ecological benefits that would be sought from the opening (e.g. water quality improvements, water level, aquatic biota, etc.) and should be tied to quantitative data where possible. The information should also include details of the expected duration that the channel would need to remain open for to achieve these benefits.

- A discussion on the environmental and social risks associated with a once-off opening and how the benefits of a once-off opening would outweigh these risks, particularly in relation to the 'do-nothing' scenario.
- Specific details of the opening works (i.e. location; depth and width; method and duration; spoil placement location; timing of opening with tides, swell and forecast rain; etc) and details of the expected longevity of the excavated channel.
- Details (how, what, when, where) of a monitoring program that would collect, analyse and report on quantitative data collected pre- and post-opening to determine if the opening is meeting/deviating from the objective (e.g. water levels; extent of tidal connectivity; water quality - DO, pH, nutrient and bacteria levels, etc; aquatic health; berm and channel profile; etc).
- A contingency plan for if the objective of the once-off opening is not met (e.g. retry or abort) that provides clear guidance to all stakeholders.
- Information on the status of more formal arrangements for entrance management of the Lake Cathie ICOLL.

It is understood that a Crown Land licence will be required for the dredging and reclamation component of the works (i.e. excavation of the channel). Therefore, there will be no requirement to obtain a dredging and reclamation permit from DPI Fisheries; rather, Crown Lands will consult with DPI Fisheries in accordance with s199 of the FM Act upon receipt of the licence application which will include referral of all submitted application materials.

It should be noted that provided the proposed entrance opening works will not impact marine vegetation (e.g. seagrass, mangroves, saltmarsh), there will be no requirement for a harm marine vegetation permit under the *Fisheries Management Act 1994* (FM Act). If the proposed entrance opening works will involve direct harm to marine vegetation, then a permit for harm to marine vegetation would be required prior to undertaking the works.

Please contact me on the details below if you require any further information.

Regards

Jonathan

Jonathan Yantsch | Senior Fisheries Manager - Coastal Systems (North Coast)
Aquatic Environment
NSW Department of Primary Industries | Fisheries
1243 Bruxner Hwy | Wollongbar | NSW 2477
T: 02 6626 1375 | M: 0447 537 168 | E: jonathan.yantsch@dpi.nsw.gov.au

-----Original Message-----
From: Blayne West <Blayne.West@pmhc.nsw.gov.au>
Sent: Wednesday, 12 February 2020 1:18 PM
To: John Schmidt <John.Schmidt@environment.nsw.gov.au>; Jonathan Yantsch <jonathan.yantsch@dpi.nsw.gov.au>; Geoffrey James <Geoffrey.James@environment.nsw.gov.au>; Shane Robinson <Shane.Robinson@environment.nsw.gov.au>; Silas Sutherland <silas.sutherland@crownland.nsw.gov.au>
Cc: Jesse Dick <Jesse.Dick@pmhc.nsw.gov.au>; Dimitri Young <Dimitri.Young@environment.nsw.gov.au>; Jack Hiscock <Jack.Hiscock@pmhc.nsw.gov.au>
Subject: RE: Lake Cathie - Cathie Creek, Lower Estuary Bulk Sand Removal, Excavation, Dredging Plans, February 2020

Hello again,

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Also, please note the confusion regarding the discussion of ecological versus recreational purpose for opening the lake. It has been decided by Council to now open the lake for ecological purposes, I know this discussion has been a moving feast. I would greatly appreciate a statement from each stakeholder group as to whether or not they support this type of purpose for opening.

Many thanks, Blayne

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Sent: Wednesday, 12 February 2020 11:28 AM
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PERMIT APPLICATION FORMS & FISH HABITAT POLICIES:
www.dpi.nsw.gov.au/fishing/habitat/protecting-habitats/toolkit
Submit permit applications via email to ahp.central@dpi.nsw.gov.au
NB: From date of receipt of application, please allow:
- 28 days for Permits, Consultations and Land Owner's Consent responses
- 40 days for Integrated Development Applications

KNOWN & EXPECTED DISTRIBUTION OF THREATENED FISH SPECIES:
www.dpi.nsw.gov.au/fishing/threatened-species/threatened-species-distributions-in-nsw

---

From: Jesse Dick <Jesse.Dick@pmhc.nsw.gov.au>
Sent: Wednesday, 12 February 2020 1:53 PM
To: John Schmidt <John.Schmidt@environment.nsw.gov.au>; Jonathan Yantsch <jonathan.yantsch@dpi.nsw.gov.au>; Geoffrey James <Geoffrey.James@environment.nsw.gov.au>; Shane Robinson <Shane.Robinson@environment.nsw.gov.au>; Silas Sutherland <silas.sutherland@crownland.nsw.gov.au>; Dimitri Young <Dimitri.Young@environment.nsw.gov.au>
Cc: Jack Hiscock <Jack.Hiscock@pmhc.nsw.gov.au>; Blayne West <Blayne.West@pmhc.nsw.gov.au>
Subject: FW: Lake Cathie - Cathie Creek, Lower Estuary Bulk Sand Removal, Excavation, Dredging Plans, February 2020

Dear All,

Again, apologies for the extra email.

Please ignore the SEARs form and Council's consideration of this project as being a Part 5 EIS. This information was provided Blayne's email from the 7th February. I have jumped the gun here and have proceed to determine that the impact on the environment would be 'significant', however I now realise that I have made a mistake in doing this. The REF process needs to run it's course and by doing so will inform us whether the impact is indeed significant, and therefore trigger a Part 5 EIS.

We request that you consider the project objectively and provide information on the project proceeding as an REF for a waterway or foreshore management activity for ecological purposes.

Please accept my sincerest apologies for this oversight.

Jesse Dick
Environmental Projects Officer
Development & Environment

p (02) 6581 8629

confusion on the drawings, I should have clarified these before I sent them along, but the works will be the berm and dredging of waterway area downstream of the bridge. This was decided through a meeting held on the 31st of January where the bulk sand excavation was a direct request of Minister Leslie Williams.

Additionally, in the meeting on the 31st of January, Jane Gibbs requested clarification on the short and long term actions required to manage the system. It was her request that we clarify directly whether or not we required the full suite of Acid Sulphate Studies to be completed as per the REF process for the short term opening.

Hence Council has found themselves in a peculiar position which is requesting permission to open an asset that is not owned or directly managed by us but is a localized issue of our community. Therefore we are seeking formal advice from all relevant stakeholders on what should be included in the scope of an REF to undertake bulk excavation works and an opening of the lagoon in the "current' (slightly past) drought conditions. We have been given conflicting information and guidance in meetings and I need to clarify this once and for all in one written forum.

I do hope answers some questions for people but please seek clarification if required,

Regards, Blayne

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From: John Schmidt <John.Schmidt@environment.nsw.gov.au>
Sent: Wednesday, 12 February 2020 9:05 AM
To: Blayne West <Blayne.West@pmhc.nsw.gov.au>; Jonathan Yantsch <jonathan.yantsch@dpi.nsw.gov.au>; Geoffrey James <Geoffrey.James@environment.nsw.gov.au>; Shane Robinson <Shane.Robinson@environment.nsw.gov.au>; Silas Sutherland <silas.sutherland@crownland.nsw.gov.au>; Tina Clemens <tina.clemens@crownland.nsw.gov.au>
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Subsequent emails are indicating a more traditional channel through berm and dredging of waterway area downstream of the bridge.
You will appreciate there is a large difference in scale of project.
Are you able to provide background on any subsequent discussions as some of what is proposed seems at odds with what was discussed at the last interagency meeting held 16 Dec 2019.

Sincerely

John Schmidt
Coast and Estuaries
Biodiversity and Conservation Division
Water, Floodplains & Coast (North East)
Department of Planning, Industry and Environment

247 Old Station Road
VERGES CREEK NSW 2440
T 02 65616726
M 0417428571
https://clicktime.symantec.com/3RUbc2trXCVPNU78T6bBUbD7Vc?u=www.dpie.nsw.gov.au

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Hi,

The last of the information for Lake Cathie.

Regards, Blayne

attached to this email is not waived, lost or destroyed by reasons of a mistaken delivery to you. The information contained in this email transmission may also be subject to the Government Information (Public Access) Act, 2009.

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From:	Silas Sutherland
To:	Blayne West; John Schmidt; Jonathan Yantsch; Geoffrey James; Shane Robinson
Cc:	Jesse Dick; Dimitri Young; Jack Hiscock; Tina Clemens
Subject:	RE: Lake Cathie - Cathie Creek, Lower Estuary Bulk Sand Removal, Excavation, Dredging Plans, February 2020
Date:	Thursday, 20 February 2020 12:35:45 PM
Attachments:	image002.jpg

Hi Blayne,

1. Any opening proposal must be underpinned by current science and evidence, and be supported by any future Coastal Management Program.
2. Whilst water level and water quality criteria are recognised criteria in proposing Lake openings, these triggers must not act in isolation and therefore proposals for opening Lake Cathie should refer to specific and ideal hydrological, ecological, geomorphological conditions, which minimise environmental, cultural, social and economic impacts to Crown land assets.
3. Crown Lands requires a clear description of the planning pathway for the proposed works
4. EIA must address factors of consideration per clause 228 of the EPA Regulation 2000 if carried out under Part 5
5. Mitigating factors included in any EIA will inform the Crown Lands assessment of any Licence application and the conditions for any potential Licence determination.

Please let me know if you have any questions or require additional information.

Regards,

Silas

Silas Sutherland
Area Manager North Coast

Crown Lands I Department of Planning, Industry and Environment
Level 3 | 49-51 Victoria Street | Grafton | PO Box 2215 | DANGAR | NSW | 2309
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_____

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If you are not the intended recipient, please notify the sender and then delete it immediately. Any views expressed in this email are those of the individual sender except where the sender expressly and with authority states them to be the views of the NSW Office of Environment and Heritage.

PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING THIS EMAIL

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This message is intended for the addressee named and may contain confidential information. If you are not the intended recipient, please delete it and notify the sender. Views expressed in this message are those of the individual sender, and are not necessarily the views of their organisation.

From: Jesse Dick
To: Samantha Johnsen; dcarroll.birpai@gmail.com; birpailalc@midcoast.com.au; admin@bunyah.com.au
Cc: Blayne West
Subject: RE: Coast Estuary and Floodplain Committee - LALC"s Interest for Membership
Date: Wednesday, 4 March 2020 11:06:00 AM
Attachments: image001.jpg
image002.jpg
image003.jpg
image004.jpg
image005.jpg

Dear Birpai & Bunyah LALCs,

Am just seeking a response to the below email from 11 Feb.

I note that the below email did not specify a date for providing a response to Council, however in order to provide the committee with an update on the committee composition, and to update Council on the committee charter, I will need a response from each LALC asap.

As such, if you could please provide a response to me by COB next Friday 13 March that would be greatly appreciated.

If you have any questions in relation to this email please don't hesitate to contact me.

cheers

Jesse Dick
Environmental Projects Officer
Development & Environment

p (02) 6581 8629

cid:image017.jpg@01D5D5C6.7B586850

From: Samantha Johnsen <Samantha.Johnsen@pmhc.nsw.gov.au>
Sent: Tuesday, 11 February 2020 5:37 PM
To: dcarroll.birpai@gmail.com; birpailalc@midcoast.com.au; admin@bunyah.com.au
Cc: Jesse Dick <Jesse.Dick@pmhc.nsw.gov.au>; Blayne West <Blayne.West@pmhc.nsw.gov.au>
Subject: Coast Estuary and Floodplain Committee - LALC's Interest for Membership

Hello David and Bunyah LALC,

I refer to Birpai Local Aboriginal Land Council's (LALC) interest in the discussion regarding

management options for Lake Cathie / Lake Innes Estuarine System. A Lake Cathie/Lake Innes Estuarine System Community Stakeholder meeting was held on 16 December 2020 and attendees agreed that on-going representation for all stakeholders would be via the Coast, Estuary and Floodplain Sub-Committee (CEF) which is a formal committee of Council who consider coast, estuary and flood matters for the entire local government area ie. not just Lake Cathie. A copy of the CEF Committee's current Charter is attached for your reference.

The CEF met on 30 January 2020 and resolved to seek both Birpai and Bunyah LALC's interest in membership to the CEF Committee. In that regard, Council would appreciate your consideration and response to this invitation to represent the interests of the LALC's.

I have attached copies of the minutes for the meetings referred to above and advise the next meetings are:

20 February 2020 - Steering Group to focus on the North Brother Local Catchments Flood Study referred to in Item 8 of CEF Minutes 30 January 2020.
Existing CEF representatives have been invited to attend based on their interest and you are welcome to attend also.

27 May 2020 - CEF Committee meeting

If you would like to discuss your interest or otherwise please contact Environmental Projects Officer, Jesse Dick via email at jesse.dick@pmhc.nsw.gov.au or telephone 6581 8629.

Kind regards,

Samantha Johnsen
Executive Assistant to the Director
Development & Environment

p (02) 6581 8626

NSW GOVERNMENT | Planning, Industry & Environment

Our Ref: DOC20/108471
Your Ref: SF20/387

Mr Craig Swift-McNair
Port Macquarie-Hastings Council
PO Box 84
Port Macquarie NSW 2444

Attention: Ms Blayne West

Dear Craig

Re: Request for Biodiversity and Conservation Division's Review of Environmental Factors Environmental Assessment Requirements – Lake Cathie Entrance Sand Removal and Opening to the Ocean

Thank you for your e-mail dated 7 February 2020 about the proposed removal of sand from the entrance to Lake Cathie and opening of the lake system to the ocean, seeking Environmental Assessment Requirements (EARs) from the Biodiversity and Conservation Division (BCD) of the Environment, Energy and Science Group in the Department of Planning, Industry and Environment. I appreciate the opportunity to provide input.

The BCD was formerly part of the Office of Environment and Heritage, but now forms part of a Group that has responsibilities relating to biodiversity (including threatened species and ecological communities, or their habitats), Aboriginal cultural heritage, National Parks and Wildlife Service estate, climate change, sustainability, flooding, coastal and estuary matters.

We note that the project will be assessed in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Review of Environmental Factors (REF) EARs provided by the BCD are limited to Aboriginal cultural heritage, biodiversity, NPWS estate, acid sulphate soils, flooding, stormwater and coastal erosion. We have reviewed the documentation supplied with the proposal and issues are apparent in regards to Aboriginal cultural heritage, biodiversity, National Parks and Wildlife Service estate, climate change and coast and estuary matters.

Our preference for the management of the Lake Cathie entrance is for minimal interference, but where such management is necessary, the careful preparation of an appropriate entrance management strategy would be desirable. The proposal by the Port Macquarie Hastings Council for the Lake Cathie entrance opening in the absence of a strategy, is our least preferred approach due to uncertainty about the potential for unforeseen environmental impacts.

However, should the council wish to proceed with a proposal for an imminent once-off opening for ecological purposes, the proponent should ensure that the REF will be sufficiently comprehensive to enable unambiguous assessment of all direct and indirect impacts of the proposed activity. In particular, the REF should address the following matters:

1. Aboriginal Cultural Heritage

   The BCD acknowledges the significance of the environment to the local Aboriginal community and the existence of many registered Aboriginal sites in the Port Macquarie Hastings local government

Level 8, 24 Moonee Street, Coffs Harbour, NSW 2450 | Locked Bag 914, Coffs Harbour Ph (02) 6659 8200| dpie.nsw.gov.au |

area. These include scarred and carved trees, shelters with art, middens, quarries, stone arrangements, mythological and ceremonial sites, grinding groves, artefact scatters, camp sites, isolated finds and burial sites. There is also a possibility that currently undetected Aboriginal objects may be present within the project area in those areas where Aboriginal objects have not been previously identified. The BCD therefore expects that the applicant would undertake an appropriate assessment strategy to address the above matters as per the requirements of the *National Parks and Wildlife Act 1974* (NPW Act).

2. Biodiversity

   a. Particular focus needs to be given to assessing:

      i. the potential impacts of the proposed activity on threatened shorebirds recorded within the area including *Haliaeetus leucogaster* (white-bellied sea-eagle), *Haematopus longirostris* (pied oystercatcher), *Pandion cristatus* (eastern osprey), *Esacus magnirostris* (Beach stone-curlew) and *Ptilinopus regina* (rose-crowned fruit-dove).

      ii. The impacts of saline incursion on endangered ecological communities (EECs) within the Lake Innes Nature Reserve.

      iii. The impacts to koala habitat within the Lake Innes Nature Reserve through raised salinity levels within the waterbody.

3. National Parks Estate

The Lake Innes Nature Reserve is west of the Ocean Drive Bridge and no actual earthworks are proposed within the Nature Reserve. However, the REF must consider the possible indirect impacts to the Nature Reserve due to changed water levels, flow and water quality. The REF must consider the following:

a. Clarification of whether the REF is for a one-off opening or an REF to cover all openings under the opening strategy e.g. low water (<0.2m) and high-water triggers (>1.6m) or at any time.

b. The impacts to the specific values of the Nature Reserve such as:
   - Breeding waterbirds
   - Coastal Saltmarsh EEC
   - Swamp oak EEC
   - Swamp Sclerophyll EEC
   - Threatened species (focussed on wetland species)
     - Black-necked Stork
     - Australasian Bittern
     - Eastern Osprey
     - Eastern Grass Owl
     - Wallum Froglet
     - Green and Golden Bell Frog
   - Listed migratory species under the EPBC Act e.g. CAMBA, JAMBA, ROKAMBA species.
   - Public appreciation, enjoyment and understanding of the nature reserve's natural values i.e. how the works will impact the use and related value of the reserve to the community.
   - Consistency with the objects of the NPW Act, including the management principles for nature reserves (Section 30J of the NPW Act), and the public interest in the conservation of the nature reserve's values.

c. An accurate prediction of habitat and biodiversity loss or change within the nature reserve.

d. Cumulative impacts of sand accretion west of the bridge on Ocean Drive impacting public use of the waterway and further impacting waterway hydrology, i.e. increasing the reverse delta in Lake Innes and reducing hydrological connection.

e. Possible impacts of Acid Sulfate Soils (ASS) to the Nature Reserve such as:
   - Hydraulic pumping of acid through tides.
   - Re-exposing ASS (currently ASS have water cover, due to rain) and opening Lake Cathie will result in water draining out of Lake Innes and potentially exposing ASS without sufficient time to neutralise in the water body.
   - Possible impacts of surficial monosulfidic black ooze, which is highly volatile and rapidly oxidises following lake openings (refer to ASS report of 2019).

4. Coastal Processes

It is our understanding that State Agencies involved in permitting works to mechanically open the entrance of Lake Cathie/ Lake Innes to the ocean are requiring the council to update their REF to reflect current best practice environmental assessment. Lake Cathie / Lake Innes is part of NSW intermittently closed and open lakes and lagoons known as ICOLLs. Around 70 of the 184 estuaries in NSW are ICOLLS. Each of these lake systems are unique but all have entrances that periodically close and become isolated from the ocean for extended periods due to sand and sediment build-up of the lower estuary and beach berm. When closed, these lake bodies during normal years can be fresh to brackish, but during extended dry periods can be become hypersaline. The ecology of ICOLLs is designed to tolerate highly variable salinity conditions.

The REF must address the following:

a. The scope of the REF must assess and evaluate the consequences of mechanically opening the entrance for a range of conditions. We recommend that at least three scenarios be considered;
   - a wetter than average year,
   - normal conditions, and
   - drier than average conditions.

   The normal and wetter years will typically have foreshore inundation and flooding issues, however extended dry periods can result in issues such as reduced water quality, fish kills, ASS soil leachate contamination and issues to public health.

b. A full description of the ICOLL catchment and respective sub catchments, highlighting population, numbers of houses, land use, physical attributes, number of onsite waste water systems, sewerage treatment plant and stormwater management discharge points. Using the Department's Estuary health risk modelling, the REF must identify those sub catchments posing a risk to lake health and consider the interplay of catchment conditions to ICOLL condition given these lake systems are highly sensitive to any inputs when closed.

c. Document the social, economic, environmental and cultural values acknowledging that much of the community debate over lake management is strongly linked to social perceptions of what constitutes a healthy lake.

d. Describe the hydrology of the lake system when closed and when open.

f. Describe the ecology of the wetted perimeter of the lake's foreshore including the extent and quality of saltmarsh community present, and the implications of changed hydrology to this wetted perimeter from different entrance management regimes during a range of climate conditions on saltmarsh communities.

g. Describe the extent of ASS soil within the wetted perimeter of the lake system and that hydrologically interacts with lake water levels, as well as how entrance management and changed hydrology interacts with these soils.

h. Describe how the system operates when open to tidal processes, including residence times and circulation of salinity regimes, as well as what happens when the entrance is opened after a prolonged dry period, describing the circulation and interactions that will occur with each tidal cycle.

i. Clearly describe the objectives for each scenario when a mechanical opening is deemed necessary. The recent lake opening at the beginning of an extended dry period exacerbated exposed foreshore ASS contamination issues and highlights the need for additional criteria to be considered in the decision making process flow chart for entrance opening. Additional criteria may include;
   - Bureau of Meteorology long range drought forecast.
   - Consideration of an "ecological calendar" that highlights critical months for breeding, feeding, germination, migration patterns of birds, aquatic and terrestrial species for which the lakes provide habitat.

   The REF will need to link to an amended opening strategy that specifically addresses the contingencies of the lake opening in a drought and extended dry forecast/ENSO event.

j. The REF is to highlight and describe the likely implications and risks of climate change factors such as sea level rise and changed weather patterns to preferred entrance management strategies.

We consider that this information is necessary for a comprehensive REF for the proposed activity.

The full list of our requirements that may need to be addressed in the REF is provided in **Attachment 1**. In preparing the REF, the proponent should refer to the relevant guidance material listed in **Attachment 2.**

If you have any further questions about this advice, please do not hesitate to contact Mr Bill Larkin, Senior Conservation Planning Officer, at bill.larkin@environment.nsw.gov.au or 6659 8216.

Yours sincerely

Dimitri Young 14 February 2020

DIMITRI YOUNG
Senior Team Leader Planning, North East Branch
Biodiversity and Conservation

Enclosures:
Attachment 1 - BCD Recommended Environmental Assessment Requirements for REF – Lake Cathie sand removal and opening to the ocean
Attachment 2 - REF Guidance Material

Attachment 1

Biodiversity and Conservation Division's Recommended Environmental Assessment Requirements (EARs)

Review of Environmental Factors

Lake Cathie Sand Removal and Opening to the Ocean

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TABLE OF CONTENTS

1. The Proposed Activity

The Review of Environmental Factors (REF) should fully and clearly describe the proposed activity, including any environmental impact mitigation measures, and identify all the processes and activities intended for the site during the life of the proposed activity.

The description of the proposed activity in the REF should, where relevant, include:

1. the location of the proposed activity and details of the surrounding environment;
2. appropriate land use zoning;
3. the size and type of the proposed activity and its operation;
4. the proposed layout of the site;
5. the staging and timing of the proposed activity;
6. the proposed activity's relationship to any other proposal.
7. all equipment proposed for use at the site;
8. chemicals, including fuel, used on the site and proposed methods for the transportation, storage, use and emergency management;
9. waste generation, storage and disposal;
10. the anticipated environment impacts of the proposed activity, both direct and indirect,
11. a plan showing the distribution of any threatened flora or fauna species and the vegetation communities on or adjacent to the subject site, and the extent of vegetation proposed to be cleared;
12. ownership details of any residence and/or land likely to be affected by the proposed activity;
13. maps/diagrams showing the location of residences and properties likely to be affected and other industrial developments, conservation areas, wetlands, etc. in the locality that may be affected by the proposed activity;
14. methods to mitigate any expected environmental impacts of the proposed activity; and
15. the anticipated level of performance in meeting required environmental standards.

2. Environmental Impacts of the Proposed Activity

Impacts related to the following environmental issues should be assessed, quantified and reported:

- Aboriginal cultural heritage
- Biodiversity
- NPWS Estate (land reserved or acquired under the *National Parks and Wildlife Act 1974*)
- Acid Sulfate Soils
- Flooding, Stormwater and Coastal Erosion
- Cumulative Impacts

The REF should address the specific requirements outlined under each heading below and assess impacts in accordance with the relevant guidelines mentioned. A full list of guidelines is at **Attachment 2**.

3. Aboriginal Cultural Heritage

The REF should contain:

1. A description of the Aboriginal objects and declared Aboriginal places located within the area of the proposed activity.
2. A description of the cultural heritage values, including the significance of any Aboriginal objects and/or declared Aboriginal places, that exist across the whole area that will be affected by the proposed activity, and the significance of these values for the Aboriginal people who have a cultural association with the land.
3. A description of any consultation with Aboriginal people on the proposed activity and the significance of any Aboriginal cultural heritage values identified through that consultation. The Biodiversity and Conservation Division advises that the proponent may utilise the former OEH's *Aboriginal Consultation Requirements for Proponents 2010* as best practice guidelines for such consultation (these requirements for consultation must be followed if the proposed activity requires an Aboriginal Heritage Impact Permit or the Aboriginal heritage assessment requires archaeological testing).
4. The views of those Aboriginal people regarding the likely impact of the proposed activity on their cultural heritage. If any submissions have been received as a part of the consultation requirements, then the report must include a copy of each submission and the proponent's response.
5. A description of the actual or likely harm posed to the Aboriginal objects and/or declared Aboriginal places from the proposed activity, with reference to the cultural heritage values identified.
6. A description of any practical measures that may be taken to protect and conserve those Aboriginal objects and/or declared Aboriginal places.
7. A description of any practical measures that may be taken to avoid or mitigate any actual or likely harm, alternatives to harm or, if this is not possible, to manage (minimise) harm, to those Aboriginal objects and/or declared Aboriginal places.

In addressing these requirements, the proponent may refer to the following documents:

a) *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (OEH, 2010) - www.environment.nsw.gov.au/resources/cultureheritage/ddcop/10798ddcop.pdf. These guidelines identify a process that could be used to prepare Aboriginal cultural heritage assessments for activities assessed under Part 5 of the *Environmental Planning and Assessment Act 1979*.

b) *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH, 2010) - www.environment.nsw.gov.au/licences/consultation.htm. This document further explains the consultation requirements that are set out in clause 80C of the National Parks and Wildlife Regulation 2009. The process set out in this document must be followed and documented in the REF if the proposed activity requires an Aboriginal Heritage Impact Permit or the Aboriginal heritage assessment requires archaeological testing.

c) *Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH, 2010) - www.environment.nsw.gov.au/licences/archinvestigations.htm. The process

described in this Code should be followed and documented where the assessment of Aboriginal cultural heritage requires archaeological testing to be undertaken.

Notes:

- An Aboriginal Site Impact Recording Form (http://www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm) must be completed and submitted to the Aboriginal Heritage Information Management System (AHIMS) Registrar, for each AHIMS site that is harmed through archaeological investigations required or permitted through these environmental assessment requirements.
- Under section 89A of the *National Parks and Wildlife Act* 1974, it is an offence for a person not to notify the Biodiversity and Conservation Division of the location of any Aboriginal object the person becomes aware of, not already recorded on the Aboriginal Heritage Information Management System (AHIMS). An AHIMS Site Recording Form should be completed and submitted to the AHIMS Registrar (http://www.environment.nsw.gov.au/contact/AHIMSRegistrar.htm), for each Aboriginal site found during investigations.

D. Biodiversity

1. The REF must assess the impacts of the proposed activity on biodiversity values to determine if the proposed activity is "likely to significantly affect threatened species" for the purposes of Section 7.8 of the *Biodiversity Conservation Act 2016* (BC Act) as follows:

   A. The REF must demonstrate whether the proposed activity is to be carried out in a declared area of outstanding biodiversity value.

   B. If the proposed activity is not carried out in a declared area of outstanding biodiversity value, then the REF must document *the test for determining whether proposed development or activity is likely to significantly affect threatened species or ecological communities* as outlined in Section 7.3 of the BC Act, by preparing an ecological assessment that:

      I. Should include a field survey of the site of the proposed activity conducted and documented in accordance with relevant guidelines, including:

         a. *Field survey methods for environmental consultants and surveyors when assessing proposed developments or other activities on sites containing threatened species* https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/field-survey-method-guidelines.pdf

         b. *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna -Amphibians* (DECC, 2009) http://www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf

         c. *NSW Guide to Surveying Threatened Plants* (OEH 2016) https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/guide-surveying-threatened-plants-160129.pdf

         d. *"Species credit' threatened bats and their habitats https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/species-credit-threatened-bats-survey-guide-180466.pdf*

         e. *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004), https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/draft-threatened-biodiversity-survey-guide.pdf

      If a proposed field survey methodology is likely to vary significantly from the methods in the guidelines above, then the proponent should discuss the proposed methodology with the Biodiversity and Conservation Division prior to undertaking surveys for the REF, to determine whether the Biodiversity and Conservation Division considers the proposed methodology appropriate.

The results of recent (less than five years old) field surveys may be used. However, the results of previous field surveys should not be used if they have:

- been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are unlikely to be detected or present, or
- utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species,

unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the field surveys.

If the results of previous field surveys are used, then field surveys for any additional threatened entities listed under the BC Act since the previous field surveys took place, must be undertaken and documented.

The list of potential threatened species, populations, ecological communities, or their habitats for the site should be determined in accordance with:

- the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004), and
- the Department's Threatened Species website http://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species ,and
- the *Bionet Atlas of NSW* http://www.environment.nsw.gov.au/wildlifeatlas/about.htm , and
- the Vegetation Information System (BioNet Vegetation Classification) http://www.environment.nsw.gov.au/research/Visclassification.htm , and
- other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http://www.ozcam.org/), previous or nearby surveys etc.) may also be used to compile the list.

II. Should include the following information as a minimum:

a. A description, spatial data files, and geo-referenced mapping of the study area, (overlays on topographic maps, satellite images and /or aerial photos, including details of map datum, projection and zone), showing all field survey locations, vegetation communities classified in accordance with the BioNet Vegetation Classification (http://www.environment.nsw.gov.au/research/Visclassification.htm), key habitat features and reported locations of threatened species and ecological communities present in the subject site and study area.

b. A description of survey methodologies used, including timing, location and weather conditions.

c. Details, including qualifications and experience, of all staff undertaking the surveys, mapping and assessment of impacts as part of the EIS.

d. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status.

e. A description of the likely impacts of the proposed activity on biodiversity values, including direct and indirect impacts and construction and operation impacts, with impacts quantified, wherever possible, such as the amount of each vegetation community or species habitat to be cleared or impacted, and/or the degree of fragmentation of a habitat connectivity.

f. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposed activity to avoid or minimise biodiversity impacts, including details about alternative options considered and how long-term management arrangements will be guaranteed.

g. A description of the residual impacts of the proposed activity.

III. Must include the '*test for determining whether proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats*' as outlined in Section 7.3 of the BC Act undertaken in accordance with the gazetted *Threatened Species Test of Significance Guidelines* (OEH 2018) available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/threatened-species-test-significance-guidelines-170634.pdf

2. If the REF determines under 1 above that the proposed activity is likely to significantly affect threatened species, then in accordance with Section 7.8 of the BC Act, an Environmental Impact Statement must be prepared that is accompanied by a Species Impact Statement prepared in accordance with Part 7, Division 5 of the BC Act, or, if the proponent so elects, a Biodiversity Development Assessment Report prepared in accordance with Part 6, Division 3 of the BC Act.

3. If the REF determines under 1 above that the proposed activity is unlikely to significantly affect threatened species, then the proposed activity should:

   a. be designed to avoid and minimise impacts on biodiversity values to the fullest extent possible, and

   b. include a biodiversity offset package to offset remaining direct and indirect impacts on biodiversity values, prepared in accordance with the Department's 13 offsetting principles available at http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm:

Note:

For the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the REF should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.

E. NPWS Estate

The REF should address the following with respect to land reserved under the *National Parks and Wildlife Act 1974*.

1. Where appropriate, likely impacts (both direct and indirect) of the proposed activity on any adjoining and/or nearby NPWS estate reserved under the *National Parks and Wildlife Act 1974* should be considered, with reference to the *Guidelines for developments adjoining land managed by the Office of Environment and Heritage* (OEH, 2013) available at:

   http://www.environment.nsw.gov.au/resources/protectedareas/development-land-adjoining-130122.pdf

2. The NPWS has clear guidelines for assessing the environmental impact of developments and activities proposed within NPWS managed lands. These include guidelines for the preparation of a REF for activities proposed on land reserved under the *National Parks and Wildlife Act 1974*, including national parks and nature reserves. The *Guidelines for preparing a Review of Environmental Factors* provides information on how to determine whether certain activities are permissible, as well as specific information on matters for consideration during the preparation of an REF. The guidelines can be found at

   http://www.environment.nsw.gov.au/research-and-publications/publications-search/guidelines-for-preparing-a-review-of-environmental-factors

3. For those proposals within NPWS managed areas that seek a lease or licence under Section 151 of the *National Parks and Wildlife Act 1974*, in addition to an REF, applications must also be accompanied by a sustainability assessment. The assessment must address the criteria adopted by the Chief Executive of the former Office of Environment and Heritage. Templates for completing a Sustainability Assessment can be found at:

   http://www.environment.nsw.gov.au/protectedareas/sustainabilityassessments.htm

Note: Proposals which may impact marine protected areas should be referred to the Regions, Industry, Agriculture and Resources Group in the Department of Planning, Industry and Environment to determine the assessment and approval requirements.

F. Acid Sulfate Soils

The REF should address the following:

1. The potential impacts of the proposed activity on acid sulfate soils must be assessed in accordance with the relevant guidelines in the *Acid Sulphate Soils Manual* (Stone et al. 1998) and the *Acid Sulphate Soils Laboratory Methods Guidelines* (Ahern et al. 2004).
2. The mitigation and management options that will be used to prevent, control, abate or minimise potential impacts from the disturbance of acid sulfate soils associated with the proposed activity, and to reduce risks to human health and prevent the degradation of the environment, must be described, including an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

G. Flooding, Stormwater and Coastal Processes

The REF should include an assessment of the following referring to the relevant guidelines in Attachment 2:

1. The potential effect of coastal processes and coastal hazards including potential impacts of sea level rise:
   a. on the proposed activity; and
   b. arising from the proposed activity.
2. Whether the proposed activity is consistent with any coastal zone management plans.
3. Whether the proposed activity is consistent with any floodplain risk management plans.
4. Whether the proposed activity is compatible with the flood hazard of the land.
5. Whether the proposed activity will significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other proposals or properties.
6. Whether the proposed activity will significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.
7. Whether the proposed activity incorporates appropriate measures to manage risk to life from flood.
8. Whether the proposed activity is likely to result in unsustainable social and economic costs to the community as a consequence of flooding.
9. The implications of flooding over the full range of potential flooding, including the probable maximum flood, should be considered as set out in the NSW Government Floodplain Development Manual. This should include the provision of:
   a. Full details of the flood assessment and modelling undertaken in determining any design flood levels (if applicable), including the 1 in 100 year flood levels.
   b. A sensitivity assessment of the potential impacts of an increase in rainfall intensity and runoff (10%, 20% and 30%) and sea level rise on the flood behaviour for the 1 in 100 year design flood if applicable.
10. All site drainage, stormwater quality devices and erosion / sedimentation control measures should be identified and the onsite treatment of stormwater and effluent runoff and predicted stormwater discharge quality from the proposed activity should be detailed.

H. Cumulative Impacts

The REF should include an assessment of the following:

1. The cumulative impacts, including both construction and operational impacts, from all clearing activities and operations, associated edge effects and other indirect impacts on cultural heritage, biodiversity and NPWS Estate in accordance with the *Environmental Planning and Assessment Act 1979*.
2. The cumulative impacts, including both construction and operational impacts, of the proponent's existing proposals and other proposals and associated infrastructure (such as access tracks etc.), as well as the cumulative impact of the proposed activity in the context of other proposals located in the vicinity.

Attachment 2 – REF Guidance Material

Title	Web address
Relevant Legislation	
Coastal Protection Act 1979	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+13+1979+cd+0+N
Commonwealth Environment Protection and Biodiversity Conservation Act 1999	http://www.austlii.edu.au/au/legis/cth/consol_act/epabca1999588/
Floodplain Development Manual	http://www.environment.nsw.gov.au/floodplains/manual.htm
Environmental Planning and Assessment Act 1979	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+203+1979+cd+0+N
Fisheries Management Act 1994	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+38+1994+cd+0+N
Marine Parks Act 1997	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+64+1997+cd+0+N
National Parks and Wildlife Act 1974	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+80+1974+cd+0+N
Protection of the Environment Operations Act 1997	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
Biodiversity Conservation Act 2016	https://www.legislation.nsw.gov.au/~/view/act/2016/63
Biodiversity Conservation Regulation 2017	https://www.legislation.nsw.gov.au/~/view/regulation/2017/432
Biodiversity Conservation (Savings and Transitional) Regulation 2017	https://www.legislation.nsw.gov.au/~/view/regulation/2017/433
Water Management Act 2000	http://www.legislation.nsw.gov.au/maintop/view/inforce/act+92+2000+cd+0+N
Aboriginal Cultural Heritage	
Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010)	http://www.environment.nsw.gov.au/licences/consultation.htm
Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010)	http://www.environment.nsw.gov.au/licences/archinvestigations.htm
Aboriginal Site Impact Recording Form	http://www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm
Aboriginal Heritage Information Management System (AHIMS) Registrar	http://www.environment.nsw.gov.au/contact/AHIMSRegistrar.htm

Biodiversity

Biodiversity Assessment Method (OEH 2017)	http://www.environment.nsw.gov.au/resources/bcact/biodiversity-assessment-method-170206.pdf
Biodiversity Assessment Calculator	https://www.lmbc.nsw.gov.au/bamcalc
Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna -Amphibians (DECCW, 2009)	http://www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf
Species credit threatened bats and their habitat – NSW survey guide for the Biodiversity Assessment Method (OEH 2018).	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/species-credit-threatened-bats-survey-guide-180466.pdf
NSW Guide to Surveying Threatened Plants (OEH 2016)	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/guide-surveying-threatened-plants-160129.pdf
Field Survey Methods	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/field-survey-method-guidelines.pdf
Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004)	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/draft-threatened-biodiversity-survey-guide.pdf
Department of Planning, Industry and Environment's Threatened Species website	http://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species
Atlas of NSW Wildlife	http://www.environment.nsw.gov.au/wildlifeatlas/about.htm
BioNet Vegetation Classification (NSW Vegetation Classification System)	http://www.environment.nsw.gov.au/research/Visclassification.htm
PlantNET	http://plantnet.rbgsyd.nsw.gov.au/
Online Zoological Collections of Australian Museums	http://www.ozcam.org/
Threatened Species Assessment Guidelines: the Assessment of Significance (DECC 2007)	http://www.environment.nsw.gov.au/research-and-publications/publications-search/threatened-species-assessment-guidelines
Principles for the use of biodiversity offsets in NSW	http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm

NPWS Estate

Land reserved or acquired under the NPW Act

List of national parks	http://www.environment.nsw.gov.au/NationalParks/parksearchatoz.aspx

NPWS Revocation of Land Policy	http://www.environment.nsw.gov.au/policies/RevocationOfLandPolicy.htm
Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECCW, 2010)	http://www.environment.nsw.gov.au/resources/protectedareas/10509devadjdeccw.pdf

Water and Soils

Acid sulphate soils

Acid Sulfate Soils Planning Maps	http://canri.nsw.gov.au/download/
Acid Sulfate Soils Manual (Stone et al. 1998)	Manual available for purchase from: http://www.landcom.com.au/whats-new/the-blue-book.aspx Chapters 1 and 2 are on DPI's Guidelines Register at: Chapter 1 Acid Sulfate Soils Planning Guidelines: http://www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Acid%20Sulfate%20Soils%20Planning%20Guidelines.pdf Chapter 2 Acid Sulfate Soils Assessment Guidelines: http://www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Acid%20Sulfate%20Soils%20Assessment%20Guidelines.pdf
Acid Sulfate Soils Laboratory Methods Guidelines (Ahern et al. 2004)	http://www.derm.qld.gov.au/land/ass/pdfs/lmg.pdf This replaces Chapter 4 of the Acid Sulfate Soils Manual above.

Flooding and Coastal Erosion

Reforms to coastal erosion management	http://www.environment.nsw.gov.au/coasts/coastalerosionmgmt.htm
Floodplain development manual	http://www.dnr.nsw.gov.au/floodplains/manual.shtml
Guidelines for Preparing Coastal Zone Management Plans	http://www.environment.nsw.gov.au/resources/coasts/130224CZMPGuide.pdf
Climate Change Impacts and Risk Management	http://www.environment.gov.au/climate-change
Best practice ICOLL management State of Science and guideline for assessment Climate Change in estuaries	http://estuaries.wrl.unsw.edu.au/index.php/climate-change/risk-assessment-guide/
Management of Coastal Lakes and Lagoons in NSW, www.dpi.nsw.gov.au NSW Coastal Management Manual Tool Kit	https://www.environment.nsw.gov.au/resources/coasts/150808-estuary-health-guide.pdf
P., Haines 2008, ICOLL Management: Strategies for a Sustainable Future, BMT WBM Pty Ltd, Broadmeadow NSW.	https://www.yumpu.com/en/document/read/22745192/icoll-management-bmt-group
K. Stephens & J. Murtagh, 2012, The Risky Business of ICOLL Entrance	https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/634558/HRC_Coastal-Lakes_2002.pdf

Management, Floodplain Management Australia Conference Independent Inquiry into Coastal Lakes Healthy Rivers Commission 2002	

Water

Water Quality Objectives	http://www.environment.nsw.gov.au/ieo/index.htm
ANZECC (2000) Guidelines for Fresh and Marine Water Quality	http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality
Applying Goals for Ambient Water Quality Guidance for Operations Officers – Mixing Zones	http://deccnet/water/resources/AWQGuidance7.pdf
Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (2004)	http://www.environment.nsw.gov.au/resources/legislation/approvedmethods-water.pdf

Form A

Request for the Planning Secretary's Requirements
for the preparation of an Environmental Impact Statement

Please provide the following information so that we can advise you promptly.

1. Provide details of the applicant

Applicant name	Port Macquarie-Hastings Council
Postal Address	Corner Burrawan & Lord Streets, Port Macquarie
	State NSW Postcode 2444
Contact name	Jesse Dick
Contact number	65818629 Email jesse.dick@pmhc.nsw.gov.au
ABN	11236901601

2. Describe the subject site

Street address	Corner Lord & Burrawan Streets
Suburb, town or locality	Lake Cathie
Local government area	Port Macquarie-Hastings
Real property description (eg. lot, DP/ MPS, vol/ fol, parish, portion)	Unidentified Crown Waterway, Unidentified Crown Land and Unidentified Crown Road Reserve, Lot 7023 DP 1025315, Reserve 754444

As part of your completed Form A, you must attach a locality map which clearly highlights the location and boundary of the site, as well as any key identifying features in the locality (eg. roads, towns, waterbodies, etc.).

3. Briefly describe the proposal

	Waterway or Foreshore Management Activity involving bulk earthworks for the purpose of opening the Lake Cathie/Lake Innes estuarine system entrance to the Ocean. The works are defined as Environmental Protection Works under PMH LEP 2011.
Components	The works involve bulk relocation of sand from lake mouth (area defined as being from Ocean Drive Bridge downstream to the Tasman Sea). Construction methodology TBA (dozers, graders, scrapers, excavators, dump trucks, floating dredge or any combination of). This will allow an influx of ocean water into the estuary and ongoing tidal exchange to combat the effects of the ongoing drought and to rehabilitate aquatic habitat.
	The works consist of the removal of approximately 120,000m3 of marine sands from the lake mouth and relocation of this material to the adjacent beach, both north and south of the lake mouth. No works will occur within mapped Coastal SEPP Littoral Rainforest or Coastal Wetlands areas.
	Works may occur in varying lake conditions and varying lake levels (i.e. works could be undertaken during extremely low water levels or more 'normal' water levels).
	A channel may be maintained for some time after an opening is initiated to ensure that tidal flushing of the upper catchment occurs.
Size	Approximately 10ha of excavation area and 4.5ha of disposal area north of lake mouth and 2ha south of lake mouth.
Employment	Unknown at this stage.

NSW GOVERNMENT Planning & Environment

Capital Investment Value	$700,000 - $1,000,000 (estimate)
Other Details	Refer to attached plans.

4. The proposed development is (please tick one):

☐	Permissible with development consent	*Go to Question 5*
X	Permissible without development consent	*Go to Question 8*
☐	Prohibited development	*Go to Question 8*
☐	State significant development *Refer to Schedule 1 and 2 of State Environmental Planning Policy (State and Regional Development) 2011*	*This form SHOULD NOT be used and you should contact the Department*

DEVELOPMENT WITH CONSENT

5. a) Which environmental planning instrument(s) apply to the proposal?
(ie. Council local environmental plan, regional environmental plan, State environmental planning policy, etc.)

b) Who is the consent authority?
(ie. the local council, the Joint Regional Planning Panel, etc.)

c) Is the proposal 'designated development'?

☐ No — *This form SHOULD NOT be used and you should contact the local council*

☐ Yes

If yes, what is the basis for designation?
(Refer to Schedule 3 of the Environmental Planning and Assessment Regulation 2000, or the relevant environmental planning instrument)

What is the category of designated development?
(eg. concrete works, waste management facilities or works, etc.)

You should check this with the local council.

6. Is the proposal 'Crown development'?

☐	No	*Go to Question 7*
☐	Yes *If yes, the proposal is not integrated development.*	*Go to Question 8*

7. Tick the relevant boxes next to the approvals which may be required to carry out the proposal.

If any box is ticked, the proposal would also be considered 'integrated development'.

☐ *Roads Act 1993* s. 138 (Council, Land & Property Information or Roads and Maritime Services (RMS))	Consent to: a) erect a structure or carry out a work in, on or over a publicroad b) dig up or disturb the surface of a public road c) remove or interfere with a structure, work or tree on a public road d) pump water into a public road from any land adjoining the road e) connect a road (whether public or private) to a classified road	☐ *Protection of the Environment Operations Act 1997* s. 43, 47, 48, 55, 122 (NSW Environment Protection Authority)	Environment Protection Licence to: *a)* authorise the carrying out of scheduled development work at any premises (scheduled development work is listed in Schedule 1 of the *POEO Act 1997* b) authorise the carrying out of scheduled activities at any premises (excluding an activity described as a 'waste activity' but including any activity described as 'waste facility') c) control carrying out of non-scheduled activities for the purposes of regulating water pollution from the activity
Tick the relevant approval body for the Roads Act: ☐ the road works affect a freeway or tollway = RMS ☐ the road works affect a Crown road = Lands Department ☐ other road works = Council ☐ the road works affect a classified road = Council with RMS concurrence *Note: If an approval is required from the Council under the Roads Act, the proposal is not considered 'integrated development' if Council is also the consent authority.*		☐ *Rural Fires Act 1997* s. 100B (NSW Rural Fire Service)	Bushfire Safety Authority for the: a) subdivision of bushfire prone land* that could lawfully be used for residential or rural residential purposes *b)* development of bushfire prone land* for a special fire protection purpose as defined in s. 100B of the *Rural Fires Act 1997* ** bushfire prone land is identified by a 'Bushfire Prone Land Map' prepared under s.146 of the Environmental Planning and Assessment Act 1979.*
☐ *Water Management Act 2000* s. 89, 90, 91 (Department of Primary Industries (DPI) Water)	Water use approval, water management work approval or activity approval under Part 3 of Chapter 3	☐ *Fisheries Management Act 1994* s. 144 (DPI Fisheries NSW)	Aquaculture permit
☐ *Heritage Act 1977* s. 58 (Office of Environment and Heritage)	Approval in respect of the doing or carrying out of an act, matter or thing referred to in s.57(1) of the *Heritage Act 1977*	☐ *Fisheries Management Act 1994* s. 201 (DPI Fisheries NSW)	Permit to carry out dredging or reclamation work
☐ Coal *Mine Subsidence Compensation Act 2017* s. 21 (Mine Subsidence Board)	Approval to alter or erect improvements or to subdivide land within a Mine Subsidence District	☐ *Fisheries Management Act 1994* s. 205 (DPI Fisheries NSW)	Permit to cut, remove, damage or destroy marine vegetation on public water, land, an aquaculture lease, or on the foreshore of any such land or lease
☐ *Mining Act 1992* s. 63, 64 (Department of Planning and Environment (DPE) Resources & Geoscience)	Grant of mining lease	☐ *Fisheries Management Act 1994* s. 219 (DPI Fisheries NSW)	Permit to: a) set a net, netting or other material b) construct or alter a dam, floodgate, causeway or weir c) otherwise create an obstruction, across or within a bay, inlet, river or creek, or across or around a flat
☐ *National Parks and Wildlife Act 1974* s. 90 (Office of Environment and Heritage)	Grant of Aboriginal heritage impact permit	☐ *Petroleum (Onshore) Act 1991* s. 9, 42 (DPE Resources & Geoscience)	Grant of production lease

8. In your opinion, is the proposed development a 'potentially hazardous industry' or a 'potentially offensive industry'?

(Refer to the Department's guideline Applying SEPP 33)

Yes X No

DEVELOPMENT WITHOUT CONSENT

Only answer the following question if you answered 'permissible WITHOUT development consent' to Question 4.

9. Does the proposal include an 'activity' (as defined under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act))?

X Yes No

If yes, what is the basis of this proposal being an 'activity'? *Waterway or foreshore management activities*

The predominant reason for undertaking the proposed works is for waterway or foreshore management activities, specifically, instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes.

Name all determining authorities, as defined under section 110B of the EP&A Act.

To be determined by the minister in accordance with section 5.3 (1) (b).

ALL DEVELOPMENT - Provide the following information for all proposals.

10. Provide details of the person requesting the Planning Secretary's requirements, if it is not the applicant.

Name

Postal Address

State Postcode

Contact name

Contact number Email

ABN

11. Signature of person requesting the Planning Secretary's requirements

Name Jesse Dick

Signature Date 05/02/2020

12. Submitting your completed Form A

All enquiries should be directed to 1300 305 695.

BY EMAIL **BY POST**

NSW GOVERNMENT Planning & Environment

Please email a scanned copy of the completed form to: information@planning.nsw.gov.au Attention: Director, Industry Assessments	The Executive Director, Key Sites and Industry Assessments Department of Planning and Environment GPO Box 39 SYDNEY NSW 2001 Attention: Director, Industry Assessments

Port Macquarie-Hastings Council
PO Box 84
Port Macquarie
NSW Australia 2444
DX 7415
e council@pmhc.nsw.gov.au

ABN 11 236 901 601

PORT MACQUARIE HASTINGS COUNCIL

05 January 2020 Ref: SF20/387

Dear NSW Government Agencies

LAKE CATHIE ENTRANCE SAND REMOVAL AND OPENING TO OCEAN - REQUEST FOR AGENCY INPUT INTO PART 5 EIS SEARS APPLICATION

Port Macquarie-Hastings Council (PMHC) requests input and advice from NSW State Government agencies for the preparation of a Part 5 EIS for the removal of sand from the entrance to Lake Cathie and opening the lake system to the ocean. The works will be undertaken as a one off opening of the lake for the reasons of ecological restoration of the lake system.

A Scope of Works is attached that details the project.

Please provide your comments no later than **COB on Friday 14th January 2020**.

Should you have any queries regarding this matter, please contact me on 02 6581 8629.

Yours sincerely

Jesse Dick
Environmental Projects Officer

Cc:
NPWS,
DPI Fisheries,
Crown Lands,
NSW Water,
DPIE,

PORT MACQUARIE OFFICE
17 Burrawan Street, Port Macquarie NSW 2444
t 02 6581 8111 f 02 6581 8123

WAUCHOPE OFFICE
49 High Street, Wauchope NSW 2446
t 02 6589 6500

LAURIETON OFFICE
9 Laurie Street, Laurieton NSW 2443
t 02 6559 9958

1 Council Resolution

At the November Meeting Council resolved to initiate an opening of Lake Cathie to the ocean, noting that the Opening Strategy trigger conditions had been met.

Council proceeded to submit a Short Term Licence (STL) application with Crown Lands for the purpose of opening Lake Cathie to the ocean.

A Crown Land licence application was submitted in late November but was not granted citing shortfalls in the Environmental Approval documents which date from 1995. Additional information was requested by Crown Lands.

As a result of the advice from Crown Lands the following documents are no longer valid:
• 1994 Estuary Management Plan (EMP)
• 1994 Opening Strategy
• 1995 Environmental Review

The above 3 documents were the main reports that contained Council's key management responsibilities and approval to undertake works within the lake system. The Crown Lands advice now renders these documents obsolete.

As a result, in order to undertake the opening to help manage ecological issues that are present in the lagoon PMHC purposes to undertake a significant environmental assessment as part of their Part 5 REF application. Due to the complexity of the issue including the multitude of stakeholders involved in this estuarine system we are seeking preliminary advice from all stakeholders before initiating studies.

Council staff have undertaken initial investigations into the environmental approval pathway and a new Part 5 EIS will need to be prepared to undertake opening works.

A copy of the Council Agenda and Minutes are attached.

2 Background

In early 2019, Port Macquarie-Hastings Council (PMHC) and NSW National Parks (NPWS) engaged the NSW Soil Conservation Service (SCS) to undertake an assessment of the current and potential Acid Sulfate Soil (ASS) risk of the Lake Cathie and Lake Innes estuary system.

The *Lake Cathie and Lake Innes Acid Sulfate Soil Risk Assessment (2019)* identified a significant ASS risk in Lake Innes.

In September 2019, government agencies agreed on a way to progress the situation, and on 16 October 2019, PMHC approved 50% funding for the following.

- A digestion model of the acid sulphate soil within Lake Innes as a result of the recent ASS study undertaken by SCS.
- A review of the *Lake Innes Environmental Assessment* (2013) (*the reversion study*)

- An ecological condition assessment of the saltmarsh community within Lake Innes.
- A review of possible emergency ASS containment works.

Notification on our funding application is yet to be received from DPIE Grants Unit.

3 Scope of works

The works will be to undertake a one off opening of Lake Cathie lagoon to the ocean to achieve reduced ecological pressures on the current lagoon system.

The project will consist of a detailed EIS undertaken as a Part 5 assessment pursuant to Clause 5.7 of the EP&A Act.

Due to the varying nature of the lake system a detailed construction/works methodology is not able to be provided at this time. Similarly, the conditions that may prevail at the time of works could range from extreme dry conditions (i.e. -0.5m AHD) to wetter conditions (i.e. up to 0.2m AHD) or any level in between. Likewise, the volume of sand that may require removal could vary significantly. Approx 120,000m3 has been identified for removal at this time with a maximum excavation depth of -0.5m AHD. This is the typical dredge depth that has been used for all previous dredging efforts in the past 20- 25 years.

Due to the volume of sand that may require excavation, spoil areas have been identified as the beach areas adjacent to the lake mouth. This includes a significant area to the north of the lake mouth (approx. 4.5ha). This area extends from the lake mouth north to the 4wd beach access track that is approximately 180m north of Dirah Street. An area to the south of the lake mouth will also be required for the disposal of sand. This area (adjacent to Illaroo Road) is the typical beach nourishment area which has been used in 2014 & 2018 during previous lake dredging efforts.

The EIS is for Environmental Protection Works which aim to reduce the impacts of drought conditions and low water quality within the lake system (which the former Opening Strategy identified as being when the lake level was 0.2m AHD or less and salinity over 40ppt).

4 Concept Plans

PMHC has prepared plans showing the proposed works. The extent of works will be limited to areas outside mapped SEPP Coastal Wetlands and Littoral Rainforest.

Works will include:

- Bulk removal of sand from Lake Mouth (area defined from Ocean Drive Bridge to Ocean) - construction methodology TBA (may consist of dozers, graders, scrapers, excavators, moxies, floating dredge or any combination of).
- Approx 120,000 m3 of sand to be removed from the lake mouth. Excavation works area will be approx. 10ha.
- Disposal of all sand to beach/ocean. Works extents include southern end of Illaroo Road and 4wd access track around 180m north of Dirah Street. Sand disposal

area will be around 2ha for southern disposal area and 4.5ha for northern disposal area.

5 Government Agency Input

Council is requesting the following:

1. Specific matters that are require for consideration are requested from each NSW government agency in order to inform the brief to a consultant.
2. Specific tasks that must be considered are requested from each agency.
3. Specific advice regarding the Acid Sulphate studies. Is it the advice of key agencies that the ASS work needs to be completed to inform the EIS in the short term opening or in a long term opening strategy?

Please provide comments under separate cover or via an update to this document.

End

06.01 MAYORAL MINUTE - LAKE CATHIE OPENING

RESOLVED: Pinson/Intemann

That Council:
1. Note the current Lake Cathie Opening Strategy.
2. Note the Opening Strategy conditions have been met with salinity in the Lake being greater than 40ppt and the water level currently recorded at 11.00 am on 19 November 2019 as -0.443m AHD with water quality being reported as poor.
3. Request the General Manager immediately prepare, lodge and apply for a Short Term Licence (STL) with Crown Lands for the purpose of opening Lake Cathie.
4. Request the General Manager write to the State Member for Oxley, the Hon Melinda Pavey MP and State Member for Port Macquarie, the Hon Leslie Williams MP, seeking their support to fast track Council's Short Term License application due to the abovementioned extreme environmental factors.
5. Request the General Manager, upon approval of the Licence by Crown Lands, engage a contractor to undertake the process of opening the entrance to the lagoon at the appropriate tides.
6. Request the General Manager to prepare a Communications Strategy to inform the community of the decision of Council and any possible consequences due to the opening.

CARRIED: 6/2
FOR: Dixon, Griffiths, Hawkins, Intemann, Pinson and Turner
AGAINST: Alley and Levido

Ordinary Council

MAYORAL MINUTE

Business Paper

date of meeting: Wednesday 20 November 2019

location: Council Chambers
17 Burrawan Street
Port Macquarie

time: 5.30pm

Note: *Council is distributing this agenda on the strict understanding that the publication and/or announcement of any material from the Paper before the meeting not be such as to presume the outcome of consideration of the matters thereon.*

Community Vision	A sustainable high quality of life for all
Community Mission	Building the future together People Place Health Education Technology
Council's Corporate Values	★ Sustainability ★ Excellence in Service Delivery ★ Consultation and Communication ★ Openness and Accountability ★ Community Advocacy
Community Themes	★ Leadership and Governance ★ Your Community Life ★ Your Business and Industry ★ Your Natural and Built Environment

PORT MACQUARIE HASTINGS COUNCIL

Ordinary Council Meeting
Wednesday, 20 November 2019

MAYORAL MINUTE

Items of Business

PORT MACQUARIE HASTINGS COUNCIL

Item: 06.01

Subject: MAYORAL MINUTE - LAKE CATHIE OPENING

Mayor, Peta Pinson

RECOMMENDATION

That Council:

1. **Note the current Lake Cathie Opening Strategy.**
2. **Note the Opening Strategy conditions have been met with salinity in the Lake being greater than 40ppt and the water level currently recorded at 11.00 am on 19 November 2019 as -0.443m AHD with water quality being reported as poor.**
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6. **Request the General Manager to prepare a Communications Strategy to inform the community of the decision of Council and any possible consequences due to the opening.**

Comments by Mayor Pinson

Lake Cathie is integral to the identity of the local community who, along with visitors to the area, enjoy all the recreational activities that Lake Cathie has to offer.

Whilst the management of the Lake Cathie estuarine system is the responsibility of a number of government stakeholders, Council holds the primary responsibility for areas downstream of the Ocean Drive bridge, including the lagoon.

The Lake Cathie Opening Strategy is a plan of action that determines when it is best to open the lake.

This Strategy aims to minimise adverse effects on the ecology of the wider area, minimise build-up of sand in the lake entrance, and reduce impacts of flooding, while providing residents and visitors with opportunities for recreational activities.

Now is the time to take action on behalf of our environment and community through a co-ordinated and sensible approach to the lagoon system which is in the care of Council.

Attachments

1View. Item 09.01 - Ordinary Council Meeting 2019 05 15 - NOM - Submission from Revive Lake Cathie on 2019-20 Operational Plan
2View. Item 10.04 - Ordinary Council Meeting 2019 06 19 - Integrated Planning and Reporting IPR Documents - Council Resolution
3View. Item 13.09 - Ordinary Council Meeting 2019 10 16 - Lake Innes-Lake Cathie Estuary System Update - Council Report and Resolution

Lake Cathie and Lake Innes Acid Sulfate Soil Risk Assessment

NSW GOVERNMENT Local Land Services

www.scs.nsw.gov.au

Lake Cathie and Lake Innes Acid Sulfate Soil Risk Assessment

Published by
Soil Conservation Service July 2019.

More information
Thor Aaso
Soil Conservation Service, 21-27 Grant Street Port Macquarie NSW 2444. p: 0419611831 | e: thor.aaso@scs.nsw.gov.au]

Acknowledgments
Analysis and interpretation of laboratory results was undertaken with the assistance of Professor Scott Johnston from the Southern Cross GeoScience Unit, Southern Cross University, Lismore NSW.

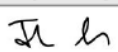
Field work as assisted by PMHC staff member, Jack Hiscok.

Cover Photo: Northern shoreline of Lake Innes, during extreme low water level conditions (-0.1m AHD) May 2019.

Document build:

Version	Date	Author	Details	Sections modified
0.1	24/6/19	Thor Aaso	First draft	
0.2	26/6/19	Clayton Colmer	Internal review	various
0.3	20/7/19	State agencies and PMHC	External review	various
1.0	25/7/19	Thor Aaso	Final draft	various

External distribution:

Version	Date	Prepared by (sign)	Approved by (sign)	Released to
1.0	25/7/19			PMHC, NPWS

Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing, July 2019. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of Soil Conservation Service or the user's independent adviser.

Contents

Figures

1. Introduction

Port Macquarie – Hastings Council (PMHC) and NSW National Parks has engaged the NSW Soil Conservation Service (SCS) to undertake an assessment of the current and potential Acid Sulfate Soil (ASS) risk of the Lake Cathie and Innes Lake system under a scenario of protracted drought. This report summarises the methodology, findings and conclusions of undertaking this assessment.

The Lake Cathie and Innes Lake system runs from Port Macquarie, south to the NSW coastal town of Lake Cathie as shown in Figure 1. Both lakes are located within National Park estate, namely the Lake Innes Nature Reserve.

Figure 1: Location of Lake Cathie / Innes

1.1. A short history of Lake Innes / Cathie system

During the last phase of the Holocene marine transgression, ~7900-2000 years BP, sea levels were some ~2m above current levels (Sloss *et. al.,* 2007). During this sea level phase, the Lake Innes / Cathie system was a connected brackish / saline coastal embayment (Creighton, 1983; Umwelt, 2003). During this period, inputs of organic matter, marine sulfate, and a low oxygen (anoxic) environment provided the conditions for Potential Acid Sulfate Soil (PASS) material to form (Dent, 1986; see Figure 2).

Since the last Holocene marine transgression (approximately the last 2000 yrs), sea levels dropped, and have remained relatively stable at today's levels. Lake Innes would have been separated from the estuary system of Cathie Creek and Lake Cathie under most conditions by way of a naturally formed berm of elevation estimated at 1.7m AHD (Armstrong, 2002). It is likely that Lake Innes was almost always fresh, with perhaps periods of brackish conditions (Hale, 2013). Only during extreme flood events would the Lake Innes / Cathie system naturally open to the sea (Umwelt, 2003; Creighton, 1983)

In 1933, Lake Innes was drained via an artificial channel to Lake Cathie (Hale, 2013). Both lakes now operate as a combined Intermittently Closed and Open Lake and Lagoons (ICOLL) regulated by the Lake Cathie Combined Entrance Opening Strategy (LCCEOS) by Port Macquarie Hastings Council (PMHC) as summarised in Appendix A).

With the combination of the artificial connection to Lake Cathie and the frequent regulated openings under the LCCEOS since 1994 (Umwelt, 2003), the geochemical conditions similar to that of the Holocene marine transgression period have been artificially re-established, resulting in the formation of PASS materials within the recent bed sediments and potentially in the pore water of older sediments at depth in Lake Innes.

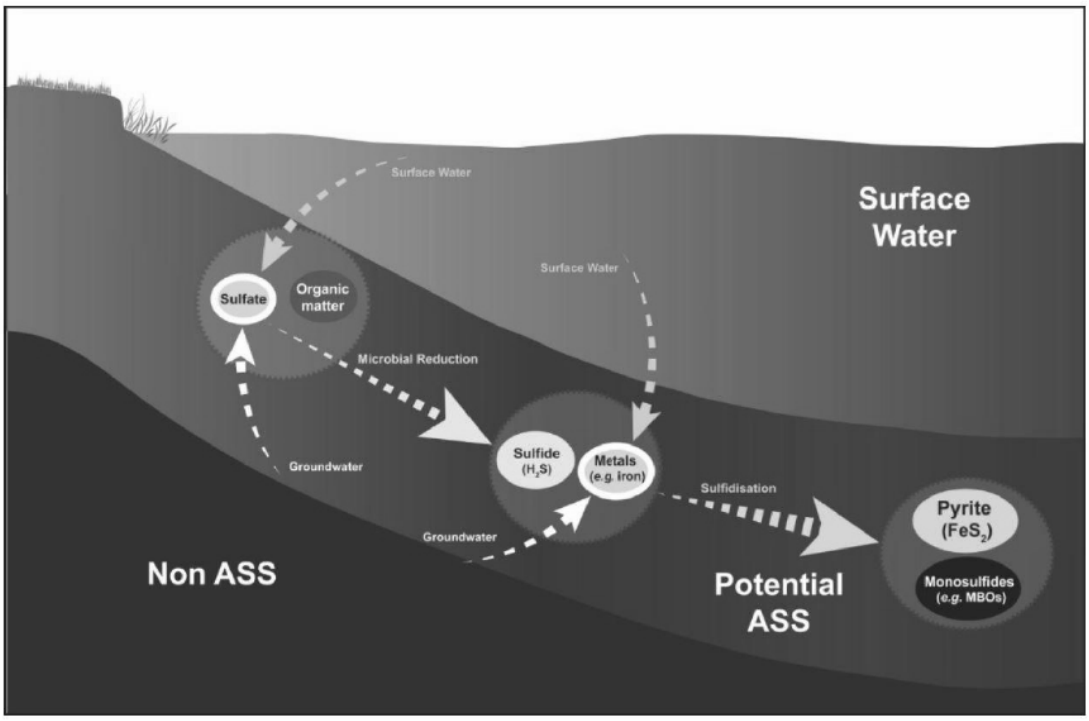


Figure 2: Conceptual model of the formation of Acid Sulfate Soil material within lake bed sediments

Source: Sullivan (*et. al.,* 2018)

Poor water quality has been documented in the form of elevated dissolved aluminium, and low pH associated with exposure of these PASS sediments during lake entrance opening events (Ryder *et. al,* 2012; 2017). The recent drying of lake beds after the 2018 lake opening event, has raised concerns on the ASS risk if the lake levels were to fall further.

1.2. Lake condition phases driven by entrance opening events

The physiochemical conditions of both Lake Cathie and Innes are governed by the interplay of rainfall, seasons, and the timing of lake opening events (Creighton, 1983). In times of high rainfall, the lake system fills up to a maximum level of 1.6m AHD before being artificially opened to the sea to drain. During a lake filling stage, both lakes transition from saline to brackish / freshwater conditions. When drought conditions proceed a lake opening event, ingressesed seawater into the lakes evaporate, forming hypersaline conditions and often elevated water temperatures.

During these periods of low water levels, Lake Innes experiences elevated levels of turbidity from the churning up of bed sediments associated with wind / wave action. In extreme cases, as in the case of the post July 2018 lake opening event, water levels can drop below - 0.1m AHD resulting in the complete desiccation Lake Cathie west of Kenwood Drive Bridge and water depths dropping to 0.1 to 0.5m deep in Lake Innes. Figure 5 and Figure 6 provide a visual comparison of conditions between wet and dry phases of the lakes.

1.2.1. The current 2018-2019 drying event

The latest artificial opening of Lake Cathie occurred in mid July 2018 as water levels reached the upper threshold of 1.6m AHD under the LCCEOS. The draining of the lake system followed a similar pattern to other lake full opening events whereby the initial discharge of lake water scours the beach berm down to meet the prevailing low tide mark, or indurated sand beds. For the July 2018 opening event, this level was approximately -0.1m AHD and was reached approximately 2 weeks after the initial opening of the lake (Figure 3). The duration of lake opening is governed by the interplay of prevailing wave / storm events and catchment inflows. The 2018 lake opening event was sustained to October 2018.

As water level recedes and flow rates dissipate, the beach profile is restored with the gradual build-up of the berm, raising the invert of the lake entrance to ~0.5m AHD. In the absence of major flood events, the beach berm continues to build under successive flood tides. Under average climatic conditions, the lake system proceeds to fill up with successive rainfall events.

However the ongoing drought conditions on the east coast of Australia has produced one of the lowest annual rainfall totals since 1885 in the last 12 months. A total of 760mm of rain fell since the Lake was last drained, compared to a long term average of 1529mm, see Figure 4. This has resulted in lake water levels to continue to fall. In June water levels were at -0.194m AHD, falling on an average rate of approximately 3cm per month since 1st March 2019. During May and June this rate of water level fall increased to 6cm per month. A total of 131mm of rain was received in late June, early July, which has temporarily stablised water lake water levels at approximately -0.15m AHD.

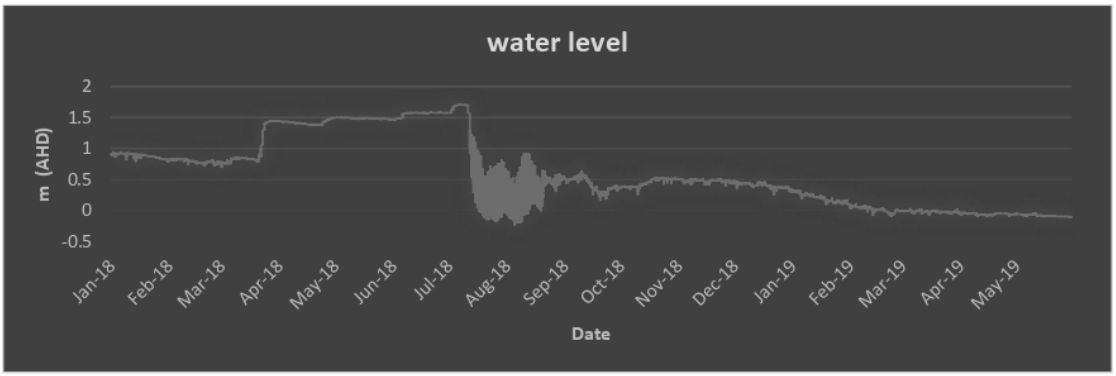
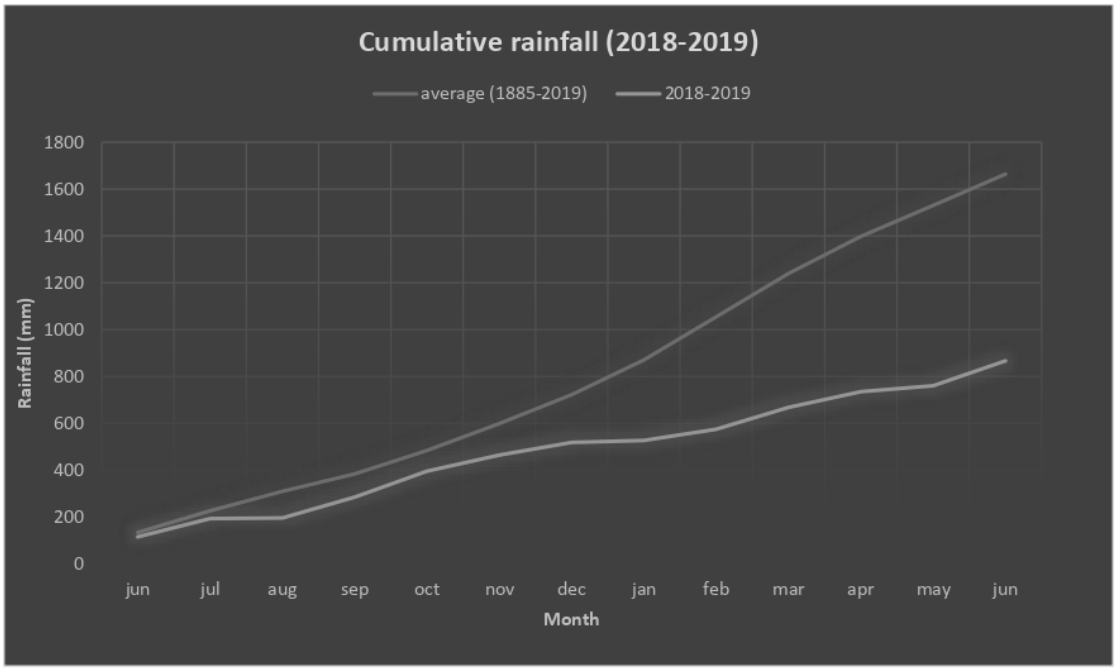


Figure 3: Lake Cathie water levels 2018-2019, MHL AWS 207441



Source: OEH (2019)

Figure 4: Cumulative rainfall (mm) 2018-2019 Laurieton (ELOUERA ST) (060022)

Source: BoM (2019)

This reduction in water levels has resulted in the exposure of approximately 900ha and 170ha of lake bed sediments in Lake Innes and Lake Cathie respectively (Figure 7). These exposed lake beds contain varying concentrations of Acid Sulfate Soil (ASS) materials. When exposed to oxygen, these ASS materials have the potential to generate sulfuric acid and metal leachate by-products within the pore waters of the lake bed sediments. This acidic water can impact on fish and benthic lake organisms through the directly toxicity of aluminium-rich, acid waters (Sammut, *et al.,* 1996) and the smothering of lake bed sediments with ferrous oxides (Johnston, *et al.,* 2016).

Immediately after the opening of the lake, an acid discharge event occurred, associated with the exposure of large areas of organic rich bed sediments containing surficial Monosulfidic Black Oozes (MBOs), principally in Lake Innes. Nearmap imagery taken on the 23rd of July 2018 documents the oxidation of MBOs and production of iron-rich acidic discharge as shown in Figure 8 and Figure 9. This oxidation event coincides with the rapid drop in water levels in the 2 weeks following the opening of the lake in mid-July as shown in Figure 3 and Figure 9. This rapid acidification of MBOs is likely to occur after every lake opening event.

Based on bathymetric surveys and stage volume calculations undertaken by Rayner and Galmore (2012) it is estimated lake volumes within Lake Innes fluctuate between 23,468 ML at 1.6m AHD to 2,291ML at -0.1m AHD.

Figure 5: Lake Cathie / Innes during high water levels (1.5m AHD)

Figure 6: Lake Cathie / Innes during low water levels (-0.1m AHD)

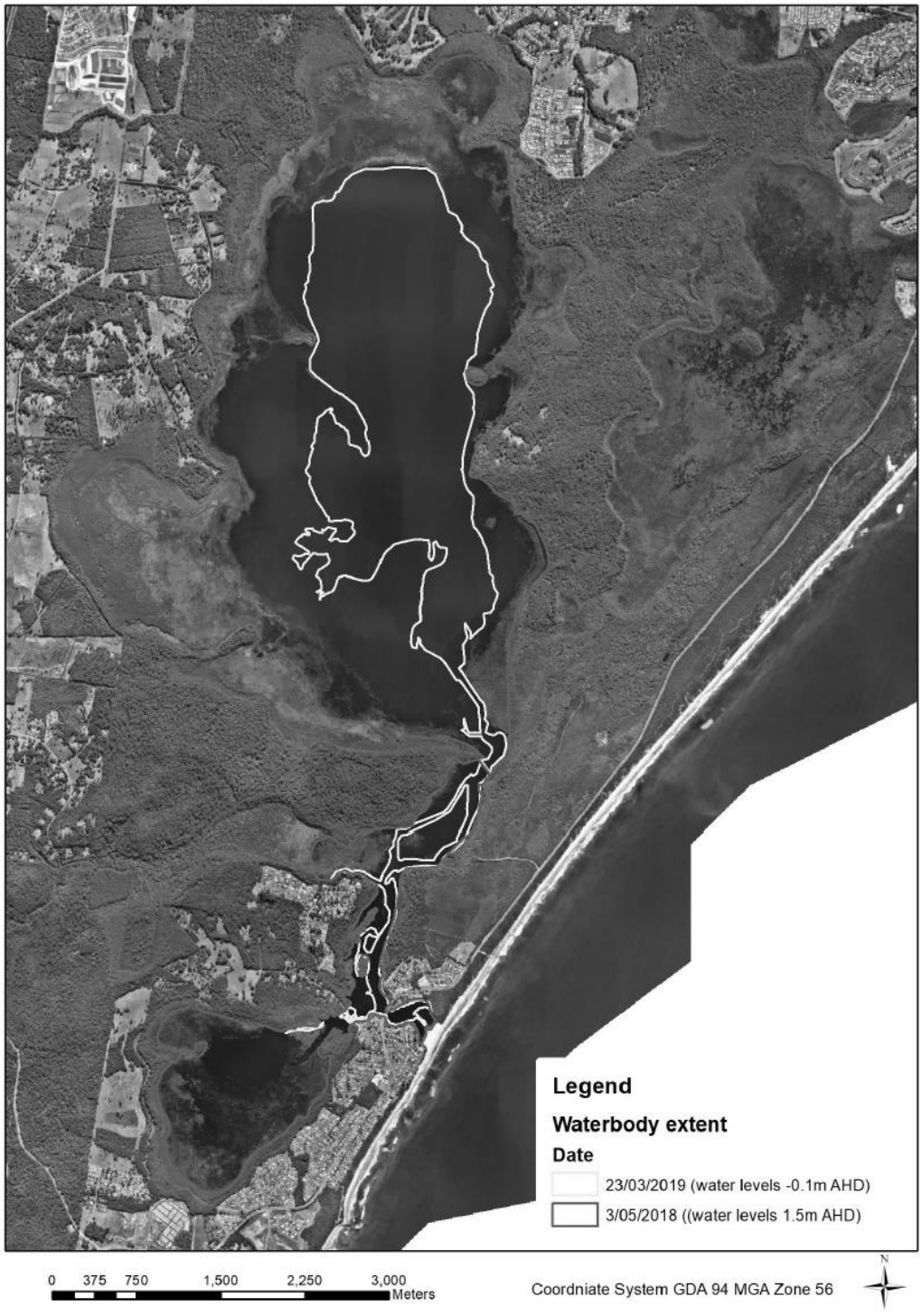


Figure 7: Waterbody extent comparison between 1.5m and -0.1m AHD levels.

Figure 8: Oxidation of MBOs in Lake Innes immediately after lake opening, July 2018.

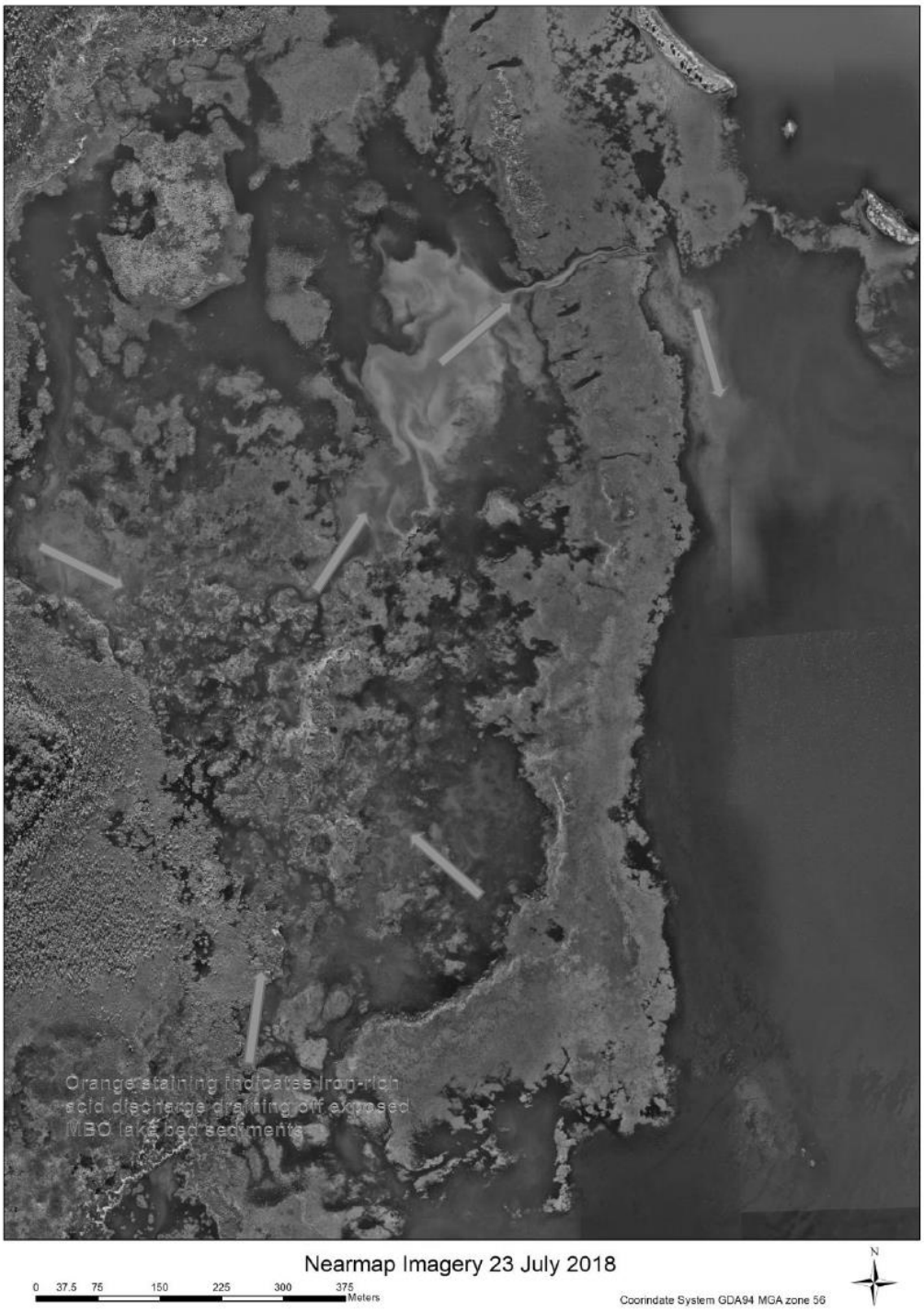


Figure 9: Central western margin of Lake Innes detailing iron-rich acid discharge, 2 weeks after lake opening.

2. Acid Sulfate Soil Risk Assessment

The following chapter provides a summary of the methods of sampling, analysis and discussion on the current and future acid sulfate soil risk if lake water levels were to continue to fall to -0.5m AHD. -0.5m AHD was chosen as this level is considered to have a high probability of being reached on the basis that under current drought conditions and the observed trajectory of lake water level lowering.

2.1. Method

Soils were sampled from each lake (Lake Innes, 11 sites; Lake Cathie, 4 sites) on the 8th and 10th of May 2018 as shown in Figure 10. Soil sample locations were selected to provide represented samples of the various landforms observed from aerial imagery and to provide an ability to assess any spatial variability of lake bed sediments. The location of each soil sample site was recorded using a Garmin GPS. Soil and lake bed sediments were sampled using a shovel or a tapered gouge auger to a maximum depth of 0.6m below natural surface levels. Cores were sectioned in 0.1m increments. A representative sample was taken from each layer at each site (with a maximum of three samples per site). Samples were placed in 70ml plastic vials and temporarily stored in an esky with ice bricks. Samples were transferred to a freezer and kept frozen until laboratory analysis was undertaken. Appendix B provides a summary of the field notes taken for each soil sample.

Soil sampling and handling was undertaken in accordance with the National Acid Sulfate Soil Guidance: National Acid Sulfate Soils Sampling and Identification Methods Manual (Sulivan *et. al*, 2018a) with the exception of a reduced spatial frequency of sampling to meet budgetary constraints.

Soil samples were analysed for Acid Sulfate Soil Net Acidity and Acid Volatile Sulfides (AVS) by Southern Cross University Environmental Analysis Laboratory in accordance with the National Acid Sulfate Soils Guidance: Identification and Laboratory Methods Manual (Sullivan *et. al.,* 2018b). Results are provided in Appendix C.

3 water samples from Lake Innes were also collected within the middle of the lake on the 10th of May 2019 (Appendix B). Samples were collected in 1L plastic bottles and analysed by PMHC Environmental Laboratory for Alkalinity (to pH 4.5) as per laboratory method METH042.

Photos 1 to 6 in Section 2.2 provide indicative site conditions of both lakes at the time of sampling

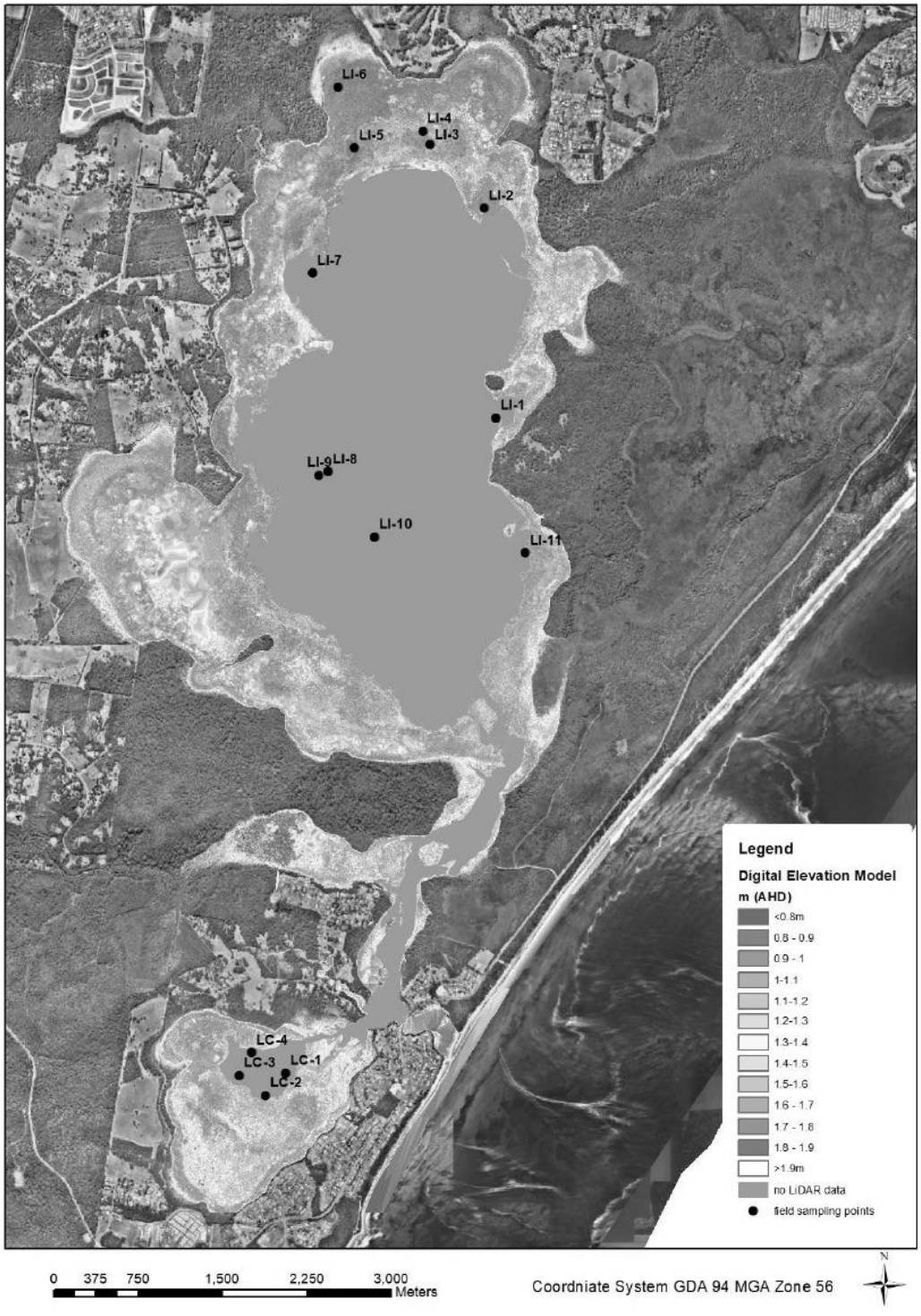


Figure 10: Sampling locations and Digital Elevation Model

Source: DFSI Spatial Services (2012)

2.2. Results

2.2.1. Actual and potential stores of Acid Sulfate Soil

There were three forms of ASS identified in the Lake Cathie / Innes system, namely;

- Holocene-aged Actual Acid Sulfate Soils (AASS) clays at depth
- Partially oxidised Potential Acid Sulfate material (PASS) in the form of pyrite–rich decomposed organic matter layers
- Recent surficial deposits of partially oxidised MBOs in Lake Innes, associated with the wetting and drying cycles driven by lake openings.

These stores of acidity behave quite differently during rapid lake level fluctuations and thus represent three distinct acid discharge risk management challenges.

2.2.2. Holocene-aged Actual Acid Sulfate Soil

Holocene-aged AASS occurs as traditional ASS clays, formed during the last interglacial sea level rise when the Lake Innes / Cathie system was a connected shallow estuarine embayment. These clays are most likely restricted to the outer margins of the northern and western shorelines of Lake Innes, these ASS clays have already oxidised at depth, producing a highly acidic landscape (pH 3.5 to 4.7) that presents a current risk to the Lake (Photo 1 & 2).

Photo 1: Highly acidic, iron rich lake bed sediments on the northern margin of Lake Innes, Site LI-6

These ASS clays are at least 80cm deep, ranging in elevation estimated at 0.9m to 0m AHD. Interestingly a charcoal layer was observed in sample site LI-6 (northern shoreline of Lake Innes) at 22cm depth ~0.7m AHD), indicating an extreme drying event of Lake Innes, estimated to have occurred during the late Holocene. This charcoal layer may be associated with Aboriginal fire management regimes during this period. During colonial explorations, both Oxley, (1820) and Hodgkinson (1845) document Aboriginal mosaic burning practices in the Hastings Valley.

Sullivan (*et. al.,* 2018b) provides a national framework for the management of ASS to assist with identifying and gauging ASS risk. Management action triggers for PASS are set at ≥ 0.03% Sulfur equivalent (oven dried basis) and for AASS ≥ 18 mol H^+/t titratable acidity (oven dried basis). The titratable actual acidity recorded at the surface and at depth in these AASS clays northern shoreline of Lake Innes (Sites LI6 and LI7) are extreme, up to 381 mol H^+/t (Appendix C).The presence of Jarosite deposits throughout the soil profile at LI-6 (Photo 2) also indicates extreme acidity.

These Holocene-aged AASS represents a significant long-term ASS store and risk to Lake Innes. Whilst these AASS stores have no rapid and direct means of discharging into the lake (such as from artificial drainage), frequent water level oscillations driven by the lake openings provides the significant hydraulic pumping action to recharge and draw down surface and groundwater out of these ASS stores. During field sampling it was observed iron-rich ASS seeps discharging from the northern margins of Lake Innes (Photo 3). Thus these soil represent a significant slow release source of highly acidic groundwater during protracted drought conditions.

Photo 2: Yellow mottling indicating the presence of jarosite in actual acid sulfate soils clays. Site LI-6.

Within these AASS clays, mainly in the deeper profile, there are still stores of unoxidised pyrite (concentrations between 0.04 and 1.25 % Sulfur, measured as $\%S_{cr}$) that are at levels well above the national trigger value of 0.03%. Thus these clays have the potential to acidify further and liberate more acid with further lowering of the ground water table.

Photo 3: Iron-rich acid discharge at the northern margin of Lake Innes.

2.2.3. Pyrite-rich organic lake bed deposits.

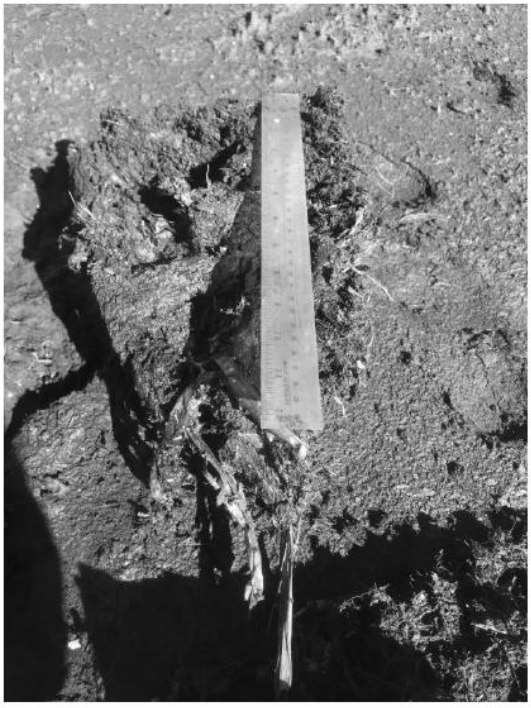
Generally speaking at 5-50cm below bed level throughout both lakes, there is a recent deposit of organic rich sediment that has extremely high levels of unoxidised stores of PASS, principally in the form of pyrite and some traces of the more highly volatile Monosulfidic Black Ooze (MBO). Whilst these layers are still currently at or just above groundwater levels at the time of sampling, they still have high moisture contents (>70%). However potential acid stores within these layers are significant, with sulfur concentrations ranging from 0.450% to 4.346 % for Lake Innes and 0.261% to 1.440% at Lake Cathie, measured as $\%S_{cr}$. The prevalence of higher pyrite concentrations in Lake Innes is most likely due to the input of significant quantities of organic matter into the lake during the death of freshwater macrophyte vegetation when the lake was initially drained in 1933. The conversion from a fresh to saline lake and the impacts on the vegetation and bird life is recorded in Albert Dick's Journal 1929

to 1974 (HDHS, 1973, *in* Creighton, 1983). The presence of preserved coarse fibrous root mats throughout the margins of Lake Innes at depth of 30-50cm (Appendix B) supports this theory.

Lake Cathie, being an ICOLL, with fringing vegetation already adapted to alternating salinity and water levels, would not have suffered the similar ecosystem crash, and thus would not have had the similar input of decaying organic matter from dying vegetating to fuel the formation of pyrite in the sediments, at concentrations to that of Lake Innes.

These pyrite- rich organic lake bed deposits, sitting at or above groundwater levels represent at the time of sampling, the most significant ASS risk to the Lake system if they were to dry out and oxidise. This layer contains the highest concentrations of sulfur and are ubiquitous throughout both lake systems.

Photo 4: Spongy pyrite-rich organic bed sediments, Lake Innes.



Moreover these bed sediments are almost completely made of fine decayed organic matter, which has little to no acid neutralising capacity to buffer any acid produced if they were to dry out (Appendix C).

Being close to the surface and having little structure, if these layers were to dry out, the resultant acidic pore waters would rapidly discharge into the lake after a moderate rainfall event. At water levels of -0.1m AHD, approximately 900ha of these sediments are exposed. If water levels were to drop a further 20-40cm these layers containing the largest stores of acidity, would likely oxidise and generate an unprecedented acid discharge event in both lakes.

At depths of generally >30cm, a layer of coarse preserved fibrous root matter is encountered as show in Photo 5.

This layer most likely represents the lake bed when Lake Innes was freshwater, dominated by macrophyte vegetation. Generally speaking unoxidised sulfur concentrations at ~50cm depth are slightly lower than that encountered in the layer above (0.450 – 2.434 %S_{cr}). However these reduced sulfur stores are still at concentrations well above the national guideline of 0.03% S_{cr} (Sullivan *et. al.,* 2018b), and represent significant ASS risk if they were to oxidise.

Photo 5: Typical soil profile of lake bed sediments on the eastern and western margins of Lake Innes. Note preserved fibrous root mat encountered at >30cm, ruler is 30cm)

2.2.4. Surficial Monosulfidic Black Ooze.

MBO deposits are formed under anoxic conditions, during periods of high lake water levels. These MBOs represent the third store / source of acid in the Lake Innes / Cathie system. These MBOs are highly volatile and rapidly oxidise and mobilise into the water column during the weeks post opening as depicted in Figure 8 and Figure 9. They represent the first source of acid following the opening of the lake entrance.

During the time of sampling, most of these MBO stores had already oxidised, leaving a thin iron-stained veneer on the surface of exposed lake bed sediments as show in Photo 6 and Figure 8 & 9. This is reflected in the relatively low levels of Acid Volatile Sulfur (AVS; <0.001 to 0.180 % S_{av} DW) recorded in the upper surface samples (Appendix C). Sites LI-8 and LI-10 were taken on the margin of the water body in Lake Innes and would give a reasonable indication of the concentrations of MBOs likely to occur throughout the lake bed prior to draining and subsequent oxidation. AVS concentrations at these two sites range between 0.063 and 0.354 %S_{av} DW (Appendix C). Once again, reduced sulfur concentrations are well above national guidelines (0.03%, Sullivan, *et al.,* 2018b) and have the potential to cause significant acid discharge if exposed from lake opening or drought events. At the time of sampling there were little or no evidence of MBOs within Lake Cathie. The bed of Lake Cathie is higher than Lake Innes (~0.6-0.9m AHD), thus any MBOs present on the surface would have oxidised early on during the lake opening event, preventing the detection during sampling. However due to the presence of marine sands associated with the reworking of the beach berm during lake opening events (reducing the conditions favourable MBO formation) and the lack of evidence of iron staining associated with MBO oxidation, it is considered that Lake Cathie has a much reduced MBO risk to that of Lake Innes.

Photo 6: Recently oxidised surficial layer of MBO, northern margin of Lake Innes.

2.2.5. Spatial variability of current and potential ASS Risk

There is no clear spatial trend in the stores of current and potential ASS risk other than acidity, MBOs and pyrite concentrations levels are generally more elevated in Lake Innes than in Lake Cathie. Low surface pH and high titratable acidity in the northern and western shorelines of Lake Innes correspond to the oxidation of Holocene-aged ASS clays and surficial MBOs. Low subsurface pH is restricted to Lake Innes and corresponds to the partial oxidation of Holocene-aged ASS clays and pyrite rich-organic layers.

The measured Net Acidity for each sample as detailed in Appendix C provides an idea of the theoretical ASS risk if all actual and potential acid stores were to oxidise and produce acid. Measured as Net Acidity mol H^+/t, any inherent acid neutralising capacity within the sediments (such as from carbonates and clay minerals) are measured and accounted for. Figure 12Figure 13 provide a summary of these net acidity levels across both lakes, at surface and at depth. Throughout the soil profiles and within both lakes, net acidity levels are extreme, and are up to 2 orders of magnitude above the national trigger value of $\geq$18 mol H^+/t (Sullivan *et. al.,* 2018b).

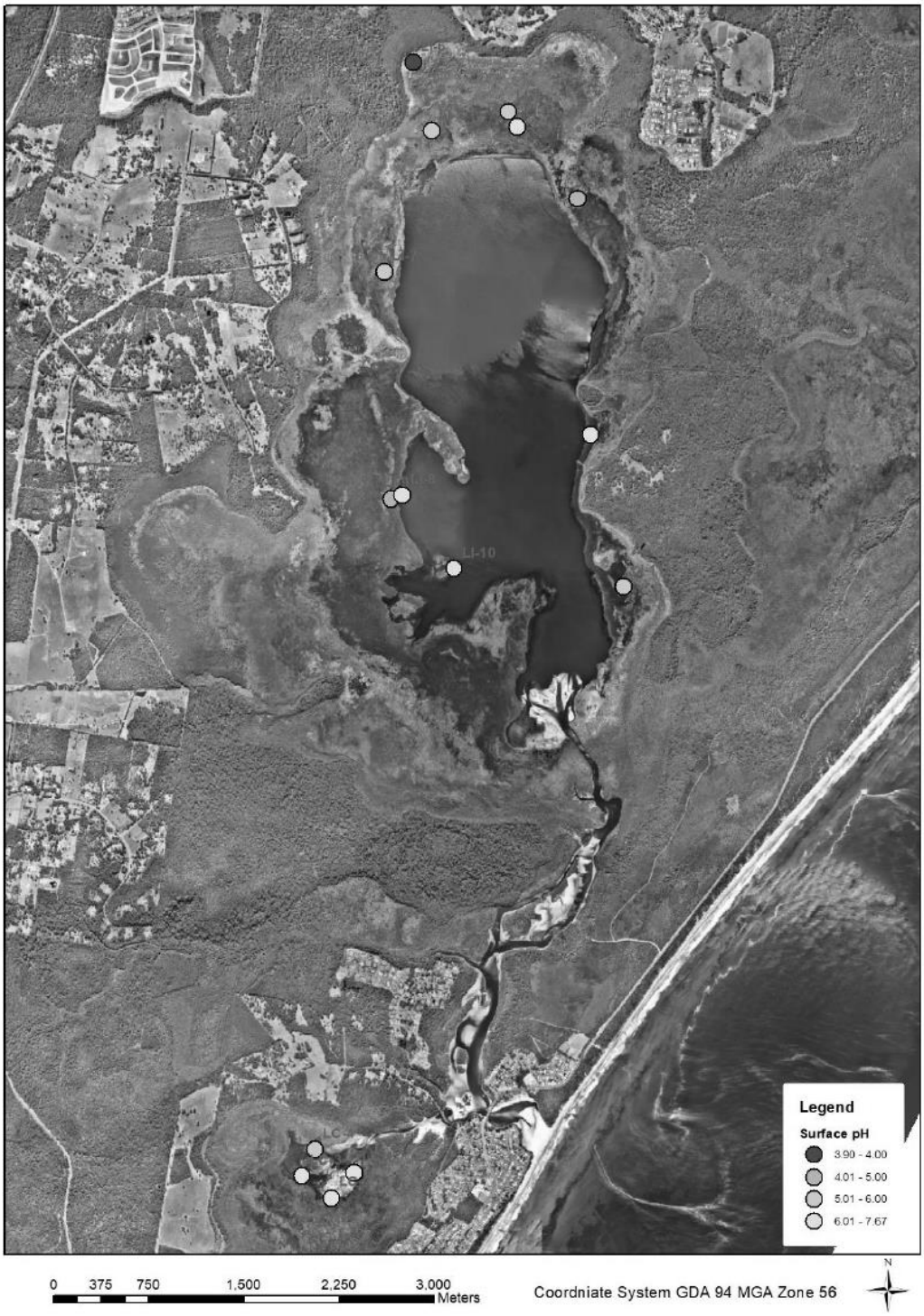


Figure 11: Surface actual acidity (measured as pH)

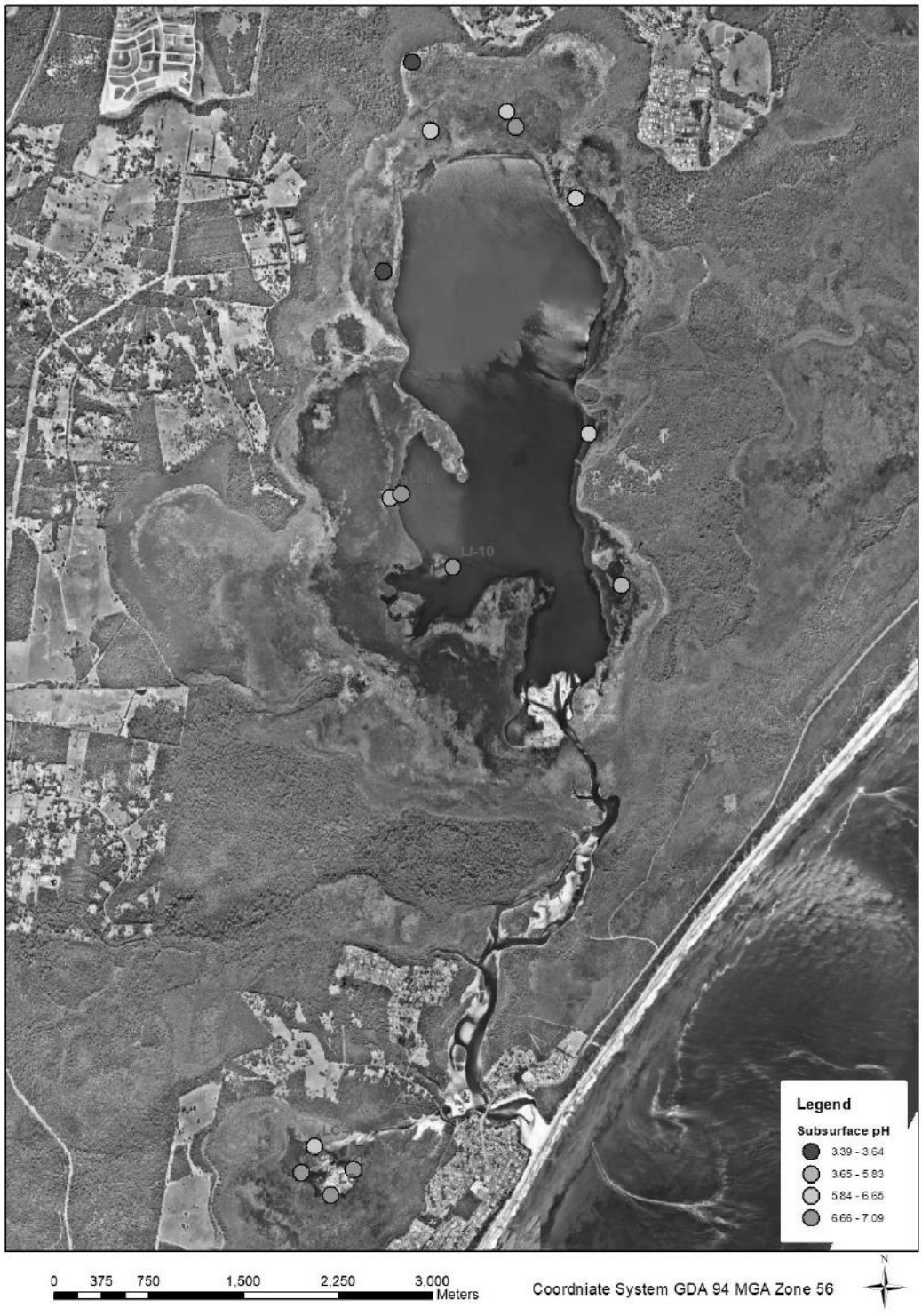


Figure 12: Subsurface actual acidity (measured as pH)

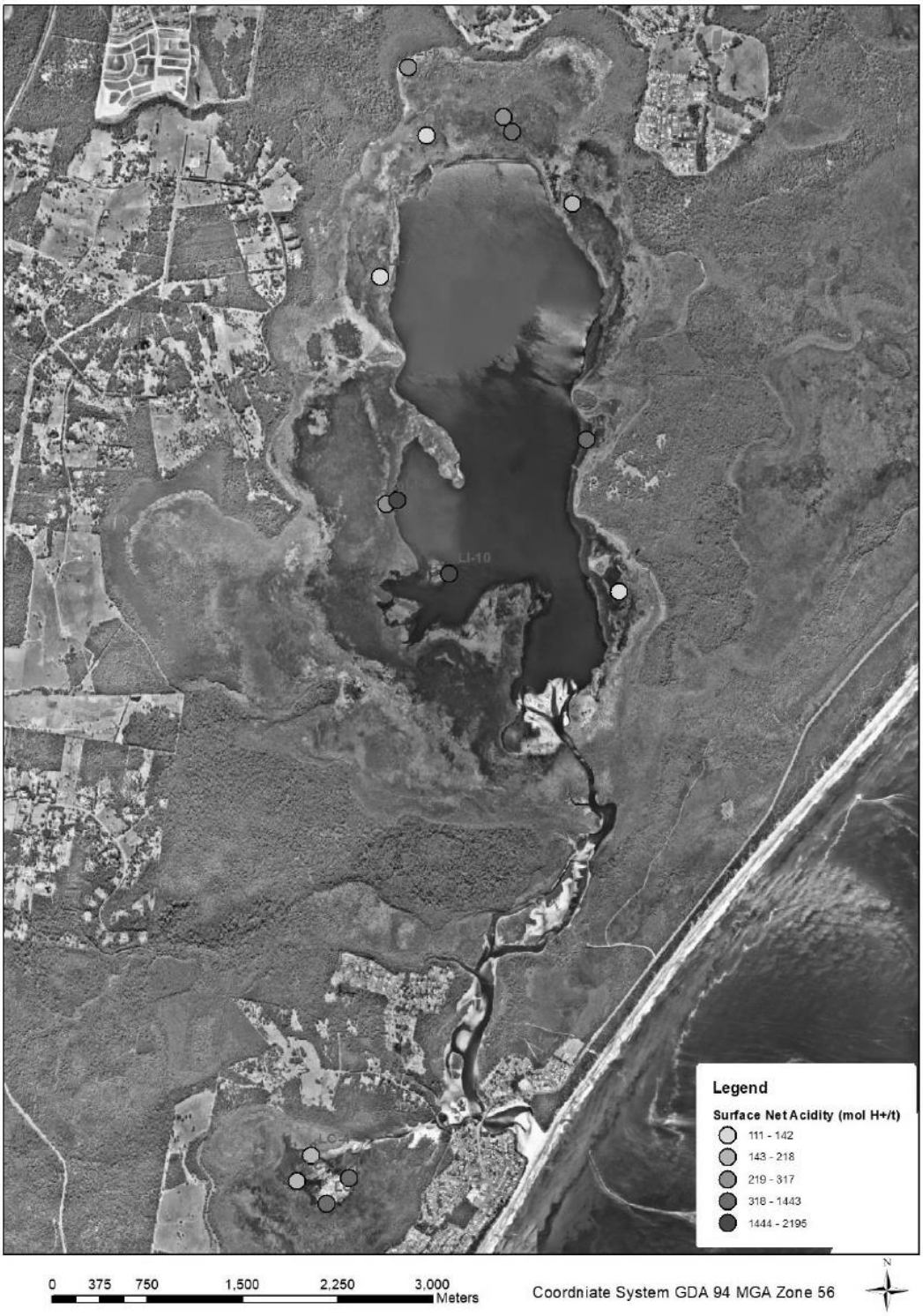


Figure 13: Surface Acid Risk (measured as net acidity)

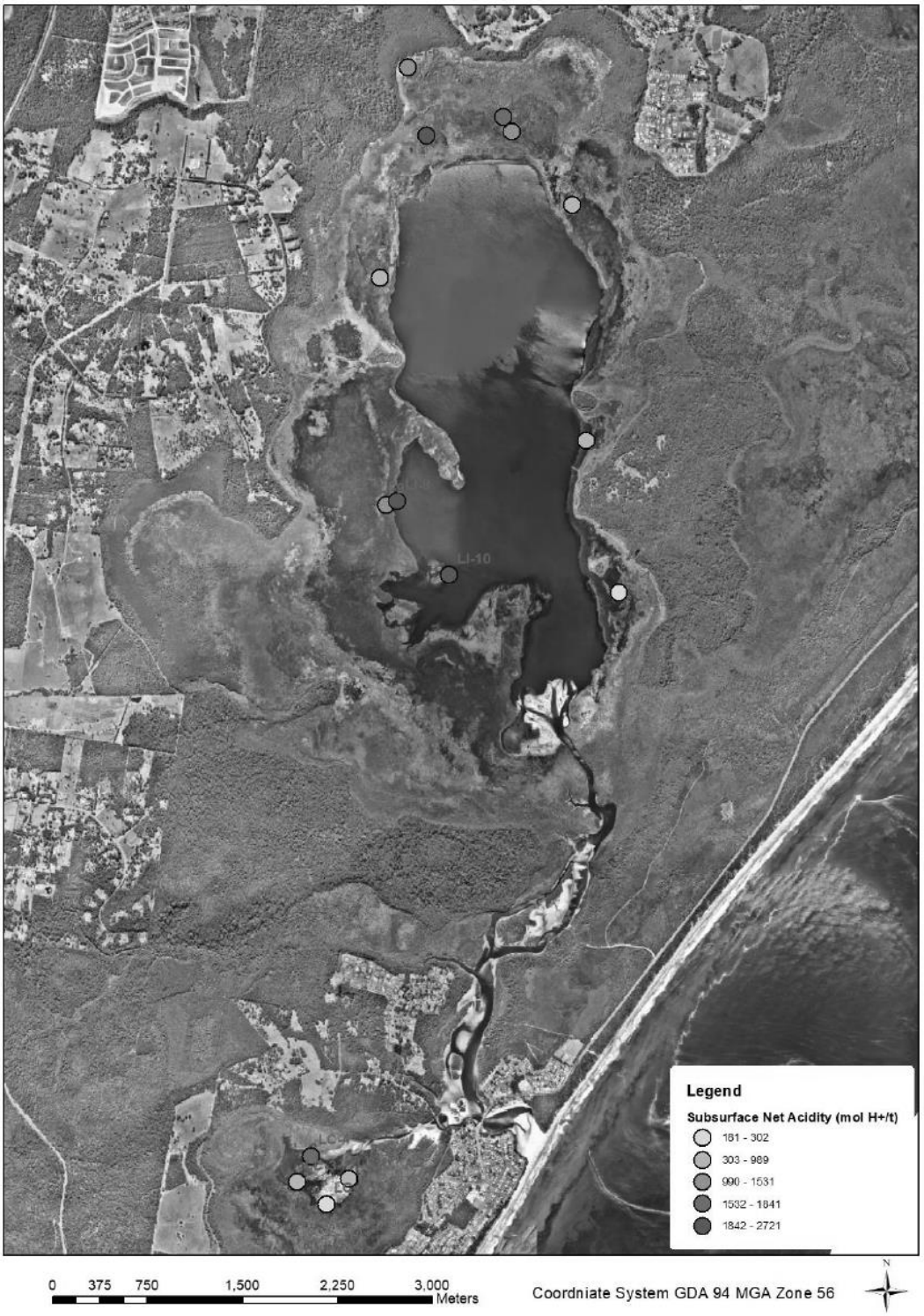


Figure 14: Subsurface ASS Risk (measured as net acidity)

3. Discussion

3.1. Impact of current actual acid stores to Lake Innes / Cathie.

The risk of ASS to the Lake Innes / Cathie system is best described when considering the 3 forms of ASS present as they chemically behave differently and their risk varies with varying lake water levels.

MBOs are the most recent deposits laid down as a thin veneer on the lake bed sediments and are the first to acidify as water levels fall. It is suspected that during a normal lake opening and refilling cycle, where water levels gradually restore with follow-up rainfall over weeks to months, the oxidation of MBOs is most likely to be the principle source of acid impacting the lake. This is due to the fact that the pyrite-rich organic deposits occur slightly deeper in the lake bed profiles and seem to retain sufficient pore water to prevent the full oxidation of pyrite for several weeks to months during suppressed water levels down to ~0m AHD. Moreover reduced sulfur in the form of pyrite is slower to oxidise compared to MBOs (Sullivan *et. al.,* 2002).

MBO-derived acidity is readily neutralised in the water body as carbonate levels increase with the ingress of seawater on flood tides during lake entrance opening periods. Thus these acid discharge events are likely to be relatively benign, short lived and restricted close to source discharge points. This may be the reason that historical water quality monitoring (MHL, 1995) failed to detect ASS impacts, compared to more recent monitoring programmes with finer temporal sampling fidelity (Ryder et. al, 2012; 2017).

Of note, under pH- neutral or alkaline conditions, recorded levels of dissolved aluminium in Lake Innes (Ryder *et. al*, 2012; 2017) are at levels known to affect the development of embryonic oysters, (Wilson and Hyne, 1997). Thus short-term acidification events associated with MBO oxidisation immediately after a lake opening event, is likely to have secondary long-lasting effects to the lake aquatic ecosystem, long after pH levels recover.

Whilst the other sources of actual acidity associated with Holocene-aged ASS clays and pyrite-rich organic deposits represent a far larger store of actual acidity within the system, the release of these stores is delayed and tempered by the lack of rapid transport pathways (such as artificial drainage) to the lakes. As such, in their current state, these actual acid stores are more likely to provide a gradual seep of acidic groundwater into the lake during extended periods of consistently low lake water levels at or below 0.0m AHD. The full impact of the actual and potential acid stores would be realised under ongoing protected drought, lowering lake water levels to -0.5m AHD or below.

With the lake bed of Lake Cathie is positioned higher than Lake Innes, one would assume that there is a higher risk of acidification of Lake Cathie to that of Lake Innes during lake opening events or drought. However it would appear the bed sediments in Lake Cathie, west of Kenwood Drive Bridge, are kept moist from a possible perched water table associated with sandy flood tide delta immediately west of Kenwood Drive Bridge. Moreover the immediate surrounding catchment of Lake Cathie is developed with hardened surfaces, increasing the rate and volume of surface runoff as urban stormwater, feeding groundwater of the lake.

3.2. Worst case scenario assessment

The vast majority of ASS stores in the Lake Cathie / Innes system are still in an inert PASS form, either as MBOs on lake bed sediments still underwater, or as reduced pyrite in the partial oxidised ASS clays and organic bed sediments.

If current low rainfall trends continue into the 2019-20 summer, there is a significant chance that lake water levels would continue to fall to or below -0.5m AHD. This is assuming there is insufficient groundwater input into the lake water budget, or that there is little aquifer connectivity to the lake.

At the time of writing, lake water levels were falling at an average rate of 6cm per month (May-June). If dry conditions persist leading up to summer, this rate would increase with increasing evapotranspiration rates. Under this scenario, the largest stores of PASS would oxidise producing vast quantities of acidic groundwater and stored pore water in the lake bed profile.

A series of small rainfall top-up events following this extended drying event would result in the discharge of acidic, aluminium-rich groundwater into the lake. Any inherent acid neutralising capacity within the waterbody would rapidly be exhausted, resulting in the likely formation of an acidic water body, toxic to most, if not all fish and benthic biota.

Under current climate change projections OEH, (2014) predicts the North Coast NSW will experience more variable weather, driven by more extreme flooding and drought events and an overall warming of 0.7 to 2ºC by 2080. Such predicted climate is likely to see the 2018-19 drought event to become more common and extreme,

potentially establishing these worst case scenario conditions for lake water levels to fall well below the current recorded sustained minimum.

3.3. Conclusion and recommendations

ASS driven poor water quality events in the Lake Cathie Innes system are inherently driven by the timing of the lake openings and any subsequent significant rainfall event during periods of extremely low lake levels.

Historically, the combination of lake opening events and weather events have only produced minor acidification events as reported in Ryder *et. al.,* (2012, 2017). However if current protracted drought conditions continue, there is a significant chance that current inert PASS will be oxidised. Resulting in a large-scale significant acidification event. Significant acid discharges in estuaries on the NSW north coast are known to cause mass fish kill events (Sammut *et. al.,* 1996).

Lake Innes is much more prone to acidification than Lake Cathie due to the larger volume and concentrations of acidity in the system, the relatively poor flushing capacity, and the possible influence of a perched water table in Lake Cathie west of Kenwood Drive Bridge.

With no trends in abating greenhouse gas emissions (IPPC, 2018) the likelihood of more extreme weather and projected droughts on the NSW north coast is high, making the aforementioned worst case scenario mush more probable in the near future. Thus preventing further oxidation of potential ASS stores in Lake Innes and Cathie should be considered as a priority.

The findings of this report sheds new light on the ASS risk of the Lake Innes / Lake Cathie system to wetting and drying cycles driven by the Lake Cathie opening strategy, which in hindsight, was underestimated in the Lake Innes Environmental Assessment (Hale, 2013). Furthermore Hale (2013) did not have the benefit of recent research documenting the reformation of pyrite and iron speciation under reduced (anoxic) conditions in re-flooded remediated ASS wetlands, assisting in the recovery of acidified wetlands (Johnston *et. al.,* 2014, Karimain *et. al.,* 2018).

This would suggest that the current Lake Innes / Cathie opening strategy, continued under projected climate change scenarios, may result in higher ASS risk compared to reverting the Lake Innes to a freshwater system.

The Digital Elevation Model (Figure 10) would suggest if Lake Innes water levels were returned to 1.6m AHD, there is no surface hydraulic connection between Lake Innes and Lake Innes Swamp as assumed by Hale (2013), which would provide support for an engineered sill to be located ~750m south of the artificial cut to maintain high water levels in Lake Innes, without significantly altering the hydrology or ecology of the Innes Swamp (see Figure 15). The location of any engineered sill would be require further investigation of the creek bed and consideration of any heritage and environmental values at the proposed location as part of a full review of the Hale (2013) assessment.

3.4. Short-term recommendations

In light of these findings of this report the following actions are recommended, in order of priority;

1. Time and funding prevented the modelling the likely behaviour and trajectory of the acidification of Lake Innes and an assessment of recovery potential if reverted to freshwater under a range of scenarios. It is recommended that bulk sampling of lake bed sediments (minimum of 6 locations) be undertaken and subsequently incubated under modelled scenario conditions utilising Council's Tuflow hydrological model to provide additional quantitative predictions to this worst case scenario and assess the likely recovery Lake Innes under freshwater reversion conditions.
2. Weekly water quality monitoring, measuring total actual acidity, dissolved aluminium and pH of Lake Innes is recommended to quantify the ASS discharge during and after lake opening events. Recommend at these 4 samples be taken roughly on in each quarter of the lake plus additional sampling of any visual points of acid discharge points entering the lake, such as shown in Figure 9 and Photo 3. Monitoring is recommended to continue until lake water levels return and remain at levels $\geq$ 0.9m AHD.
3. Survey of the lake margins to AHD to confirm the digital elevation model. Data to be used to confirm AASS and PASS horizons to AHD to allow for accurate future decision making on the management of ASS and the Lake system.

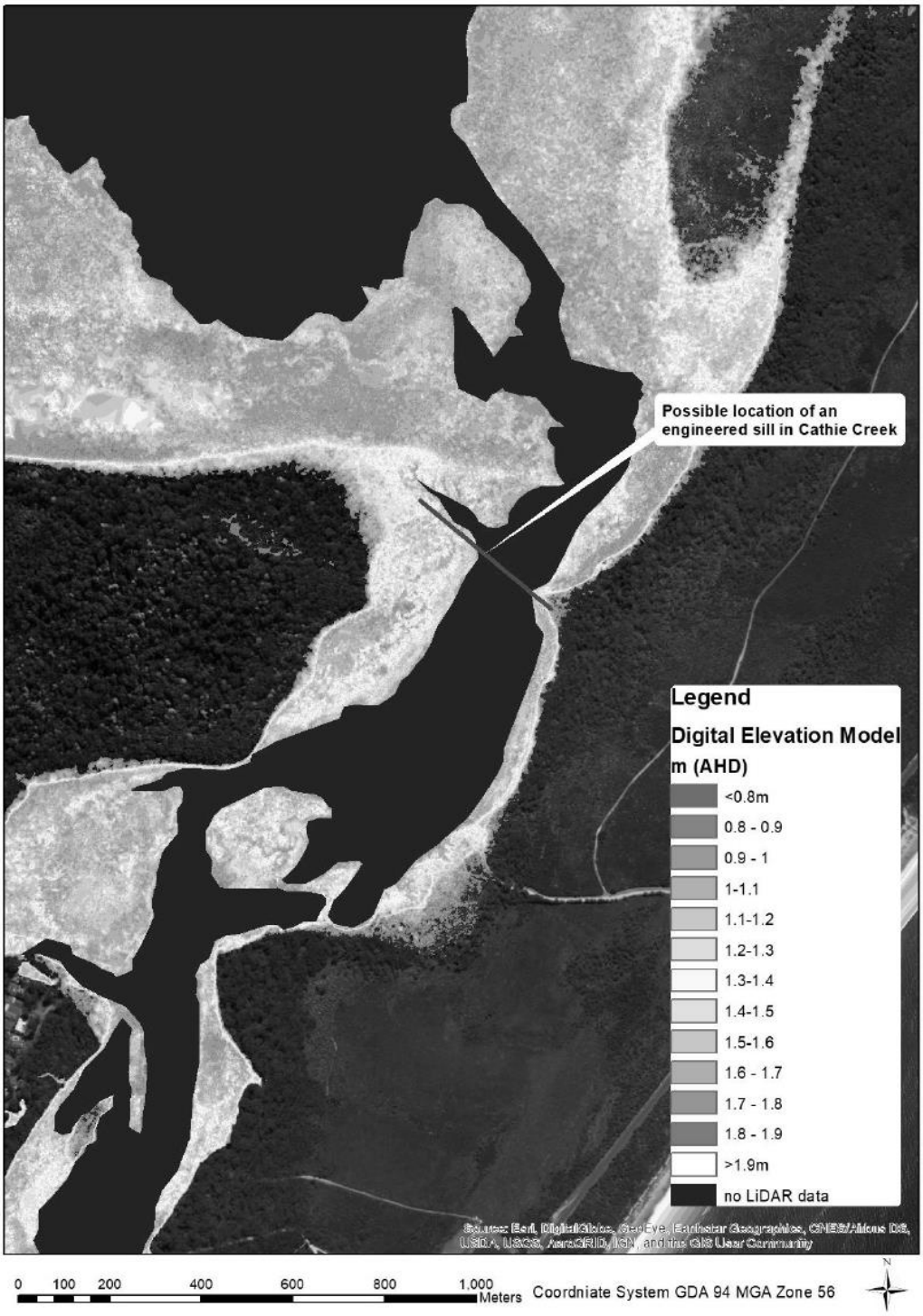


Figure 15: Possible location of an engineered sill in Cathie Creek to isolate Lake Innes

3.5. Long-term recommendations

The following long-term recommendations are provided, in order of priority.

1. In light of these ASS findings, projected climate change and recent ASS research, Council, NSW NPWS and relevant stakeholders review the lake opening strategy and the 2013 Lake Innes Reversion Assessment (Hale, 2013) as part of the development of a Coastal Management Plan under the NSW *Coastal Management Act 2016* for Lake Innes and Lake Cathie.
2. As part of this review, the technical and engineering feasibility of infilling the artificial channel between Lake Innes and Cathie should be also considered in light of recent geotechnical advancements, such as but not limited to the use of sand-filled geotextile containers.
3. Monitor the water quality and presence of MBO formation within Lake Cathie west of Kenwood Drive Bridge to inform future planning and reviews of the lake opening strategy.

4. Glossary

Actual Acidity	The available acidity already present in the soil, often as a consequence of previous oxidation event. It is this acidity that will be most mobilised and discharged following a rainfall event. It is measured in the laboratory using the Titratable Actual Acidity method. It does not aim to include the less soluble acidity (that is Retained Acidity) such as jarosite.
Actual Acid Sulfate Soil	Actual Acid Sulfate Soils (AASS) are soils containing highly acidic soil resulting from the oxidation of soil materials are rich in inorganic sulfur, primarily pyrite. When this oxidation of pyrite produces acidity in excess of the soil material's capacity to neutralise this acidity, the soil material will often acidify to a pH 4 or less, forming an Actual ASS. The recognition of Actual ASS materials can be confirmed by the presence of jarosite in these materials.
The Australian Height Datum	Australian Height Datum (AHD) is the official national vertical datum for Australia and refers to Australian Height Datum 1971. Mean sea level for 1966-1968 was assigned a value of 0.000m.
Acid Neutralising Capacity	Acid Neutralising Capacity (ANC) A measure of a soil or water body's inherent ability to buffer acidity and resist the lowering of the pH.
Holocene	Geological period defining the last 11,000 years to the present.
Jarosite	An acidic, pale yellow (straw- or butter-coloured) iron hydroxysulfate mineral: $KFe_3(SO_4)_2(OH)_6$. Jarosite is a by-product of the ASS oxidation process, forms at pH < 3.7, and is commonly found precipitated along root channels and other soil surfaces exposed to air. It is an environmentally important store of acidity as it can hydrolyse to release acidity relatively rapidly.
Monosulfides	The term given to highly reactive inorganic sulfur compounds with the approximate cation:sulfur ratio of one. Monosulfides are operationally measured as Acid Volatile Sulfide (AVS).
Monosulfidic Black Ooze	Monosulfidic Black Ooze (MBO) is the term used to describe black, gel-like materials (moisture content > 70%), often oily in appearance, greatly enriched in monosulfides (up to 27%), high in organic matter (usually 10% organic carbon) that can form thick (> 1.0 m) accumulations in waterways (including drains), in ASS wetlands.
Net Acidity	The measure of the acidity hazard of ASS materials. Determined from laboratory analysis, it is the result obtained when the values for various components of soil acidity and Acid Neutralising Capacity are substituted into the Acid Base Accounting equation.

(modified from Sullivan et al, 2018b)

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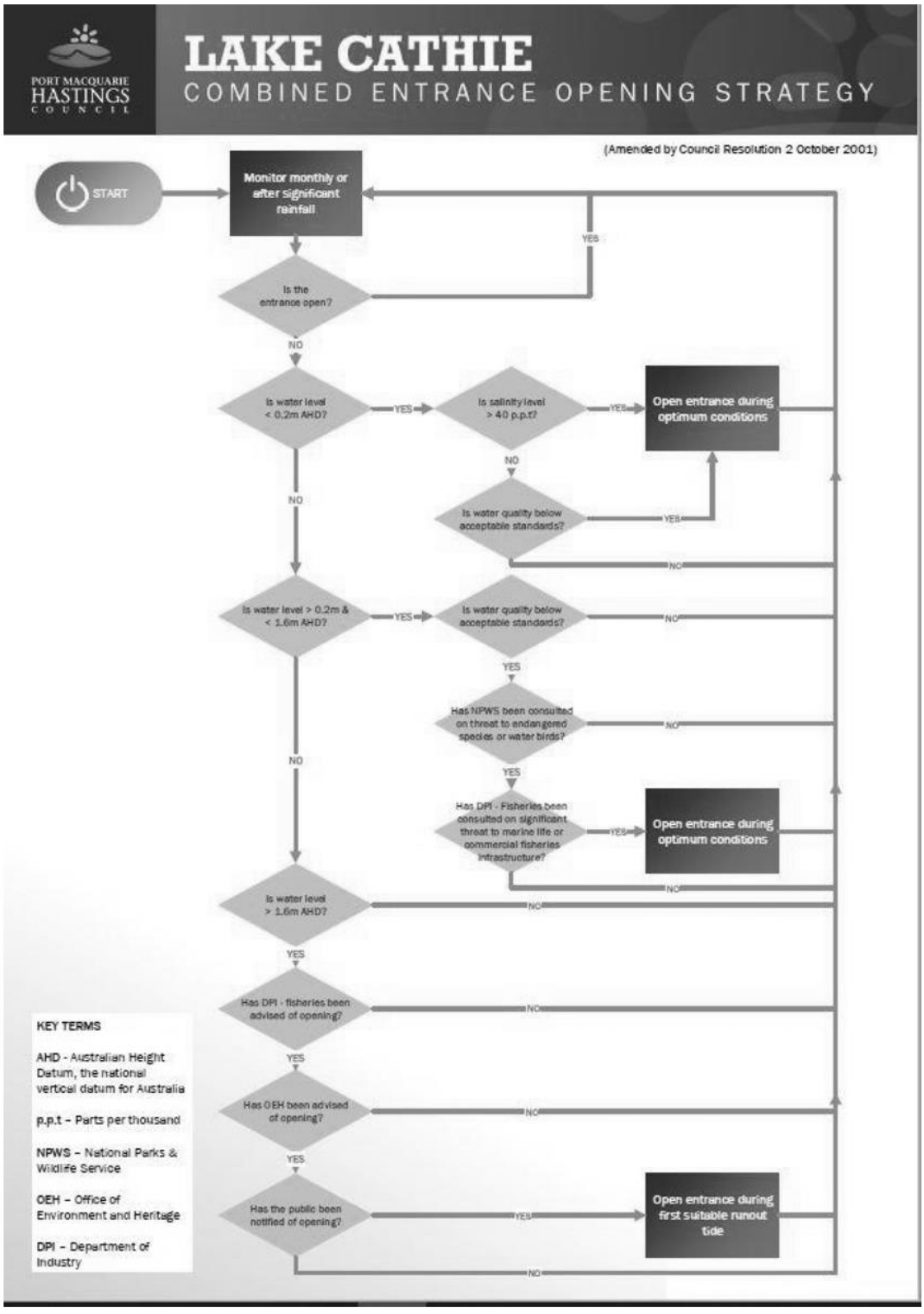
6. Appendix A: Lake Cathie Innes Opening Strategy.



7. Appendix B: Field Sampling Records

sample site	LC-1		gps waypoint	42
depth (cm) below ns	soil horizon description	soil sample depth (cm)	depth to wl (cm)	Other comments
0-10	organic rich, sapric, greasy, black lake bed sediments MBO?	10	40	groundwater seepage at 40cm
10-40	organic rich, fibric, greasy, black lake bed sediments MBO?	30		
40-50	organic rich, fibric, greasy, black lake bed sediments MBO?	50		
sample site	LC-2		gps waypoint	43
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-5	organic rich, sapric, greasy, black lake bed sediments MBO?	5	40	
5-40	organic rich, fine fibric, greasy, black lake bed sediments MBO?	30		
40-60	organic rich, fine fibric, greasy, black lake bed sediments MBO?	50		
sample site	LC-3		gps waypoint	44
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-10	organic rich, sapric, greasy, black lake bed sediments MBO?	5	>50	
10-40	organic rich, fine fibric, greasy, black lake bed sediments MBO?	30		
40-50	grey clay	50		
sample site	LC-4		gps waypoint	45
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-10	organic rich, sapric, greasy, black lake bed sediments MBO?	5	>50	
10-40	organic rich, coarse fibric, greasy, black lake bed sediments MBO?	30		preserved coarse fibourous roots , stained red
40-50	grey clay	50		
sample site	LI-1		gps waypoint	36
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-10	organic rich, sapric, greasy, black lake bed sediments MBO?	10	10	
10-30	organic rich, fibric, greasy, black lake bed sediments MBO?	30		
30-50	organic rich, fibric, greasy, black lake bed sediments MBO?	50		
sample site	LI-2		gps waypoint	37
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-5	organic rich, sapric, greasy, black lake bed sediments MBO?	5	60	
5-30	organic rich, fibric, greasy, black lake bed sediments MBO?	30		
30-50	clay with fibric root matter	50		

sample site	LI-9		gps waypoint	48
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-5	organic rich, sapric, greasy, black lake bed sediments MBO?	5	20	preserved coarse fibourous roots , stained red >40cm
5-20	organic rich, fine fibric, greasy, black lake bed sediments MBO?	20		
20-50	organic rich, fine fibric, greasy, black lake bed sediments MBO?	50		
sample site	LI-10		gps waypoint	50
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-5	organic rich, sapric, greasy, black lake bed sediments MBO?	5	20	
5-20	organic rich, fine fibric, greasy, black lake bed sediments MBO?	20		
20-50	organic rich, fine fibric, greasy, black lake bed sediments MBO?	50		
sample site	LI-11		gps waypoint	50
depth (cm) below ns	soil horizon description	sample depth	depth to wl (cm)	Other comments
0-5	organic rich, sapric, greasy, black lake bed sediments MBO?	5	30	preserved coarse fibourous roots , stained red >40cm
5-30	organic rich, fine fibric, greasy, black lake bed sediments MBO?	30		
30-50	organic rich, fine fibric, greasy, black lake bed sediments MBO?	50		

8. Appendix C: Soil Laboratory Results.

See supplied excel spreadsheet

Environmental Analysis Laboratory data Lake Cathie and Innes Acid Sulfate Soil Risk Assessment - P07937-01 - Port Macquarie Hastings Council

9. Appendix D: Water Sampling Results

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PORT MACQUARIE HASTINGS COUNCIL

NATA
ACCREDITED FOR TECHNICAL COMPETENCE
Accredited for compliance with ISO/IEC 17025 - Testing
Accreditation No. 15581

Analytical Report: H19 0998

Issue Date: 21 May 2019

Customer: Gordon Cameron
Port Macquarie Hastings - Environmental Services
PO Box 84
Port Macquarie NSW 2444

Project Description: Water Investigation - Lake Innes
Date/Time Samples Received: 10/05/2019, 12:35
Sample Temperature: Room Temp.
Date Laboratory Analysis Commenced: 15/05/2019

Comments:
This report supersedes all previous reports. Results relate to the samples as received. The responsibility for sampling rests with the customer.

M. Smith
Laboratory Manager

Analytical Report: H19 0998

		Sample No	H19 0998-1	H19 0998-2	H19 0998-3
		Sample Description	LI 1 - Lake Innes	LI 2 - Lake Innes	LI 3 - Lake Innes
		Sampled By	T. Aaso	T. Aaso	T. Aaso
-	-	Time Sampled	10:00	10:00	10:00
-	-	Date Sampled	10/05/2019	10/05/2019	10/05/2019
ANALYSIS	UNITS	METHOD			
Alkalinity to pH 4.5	mg $CaCO_3$ L^{-1}	MET042	121	122	123

Analytical Report: H19 0998

Key:
Ø NATA Accreditation does not cover the performance of this analysis.
-- Analysis not required.
MET 014 pH analysis performed outside APHA (2017) recommended holding time (15 mins).
Where a result is required to meet a compliance limit or specification the associated uncertainty must be considered.
Uncertainty estimates are available from the laboratory for all accredited test results.

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